CHAPTER 1

Introduction to Networking

The Study Guide portion of this chapter uses a combination of matching, fill in the blank, multiple choice, and open-ended question exercises to test your knowledge of connecting to the network and network math.

The Lab Exercises portion of this chapter includes all the online curriculum labs and a challenge lab to ensure that you have mastered the practical, hands-on skills needed to connect to the network and to understand network math.

As you work through this chapter, use Module 1 in the CCNA 1 online curriculum or use the corresponding Chapter 1 in the *Networking Basics CCNA 1 Companion Guide* for assistance.

Study Guide

Connecting to the Internet

In its most basic form, a network is a communication system. Computer networks are systems made up of devices, their connections to one another, and the technologies used for information transfer. Computer networks, also known as information networks, play an integral role in today's economy and society. A reliable connection to the Internet, the world's largest information network, is vital to governments, many businesses, organizations, and individuals. Learning how these connections occur and the requirements for connecting to the Internet is the first step to understand information networks.

In this section, you find exercises designed to help you identify terminology associated with information networking, compare and contrast Internet access technologies, and understand the basic components of personal computers (PC). These exercises help you build and test your knowledge in the fundamentals of networking.

Vocabulary Exercise: Matching

Match the definition on the left with a term on the right. This exercise does not necessarily use one-to-one matching. Some definitions might be used more than once and some terms might have multiple definitions.

It is important to understand key terms when learning about PCs and the Internet. Match the following definitions with the proper terms.

Definitions

a. An interface that can be used for serial communication in which only one bit is transmitted at a time.

b. Electronically stored text that allows direct access to other texts by way of encoded links.

c. An expansion board that enables a computer to manipulate and output sounds. It is also known as a sound card.

d. A serial bus interface standard offering high-speed communications and isochronous real-time data services. Also known as IEEE 1394.

e. The network layer protocol in the TCP/IP stack that offers a connectionless internetwork service. It provides features for addressing, type-of-service specification, fragmentation and reassembly, and security.

f. The component that supplies power to a computer.

g. A board that plugs into a PC to give it display capabilities.

h. The main printed circuit board in a computer. It contains the bus, microprocessor, and integrated circuits used to control any built-in peripherals, such as the keyboard, text and graphics display, serial ports and parallel ports, joystick, and mouse interfaces.

i. Device made of semiconductor material that contains many transistors and performs a specific task.

j. A formal description of a set of rules and conventions that govern how devices on a network exchange information.

k. The main part of a PC, which includes the chassis, microprocessor, main memory, bus, and ports. The system unit does not include the keyboard, monitor, or any external devices connected to the computer.

l. A collection of wires on the motherboard through which data and timing signals are transmitted from one part of a computer to another.

m. A computer storage device that uses a set of rotating, magnetically coated disks called platters to store data or programs.

n. Electronic component that stores energy in the form of an electrostatic field that consists of two conducting metal plates separated by an insulating material.

o. The network layer Internet protocol that reports errors and provides other information relevant to IP packet processing.

p. A socket on the motherboard where a circuit board can be inserted to add new capabilities to the computer.

q. An interface capable of transferring more than one bit simultaneously that connects external devices, such as printers.

Terms

___ system unit

___ power supply

___ hypertext

___ Firewire

___ ICMP

___ capacitor

___ video card

___ parallel port

___ integrated circuit

___ expansion slot

___ bus

___ hard disk drive

___ audio card

___ motherboard

___ IP

___ serial port

___ protocol

Vocabulary Exercise: Completion

Complete the following statements by using the proper terms to fill in the blanks.

____________ devices are automatically recognized and configured by the computer operating system (OS).

____________ Internet access is an "always on" technology accessed across traditional cable television systems.

______________________ is the process of configuring multiple devices to access the Internet through a single connection.

A ______________ is a graphical user interface (GUI)–based hypertext client application, such as Internet Explorer, Netscape Navigator, and Firefox, that accesses hypertext documents and other services located on innumerable remote servers throughout the World Wide Web and Internet.

A _________ is an electronic circuit board containing circuitry and sockets into which additional electronic devices on other circuit boards or cards can be plugged. In a computer, it is generally synonymous with or part of the motherboard.

An _________________ is a unique address the CPU uses to communicate with a device.

A ________________ is a processor that consists of a purpose-designed silicon chip and is physically very small.

Primarily used to troubleshoot Internet connections, the ________ utility sends a packet to the specified address and waits for a reply.

A ___________ is a device that amplifies a signal or opens and closes a circuit.

A ____________ technology is a technology that was designed and developed and is owned privately.

A _________ is a small application used to enhance the capabilities of a web browser. They are commonly required to display special data types, such as movies or flash animations.

A __________ is a device that connects computers to telephone lines and passes data across voice circuits.

The __________ is the largest data network on earth.

A computer drive that reads and writes data to a 3.5-inch, circular piece of metal-coated plastic disk is known as a _________________ .

A ____________________ connects workstations, peripherals, terminals, and other devices in a single building or other geographically limited area.

Vocabulary Exercise: Identifying Acronyms and Initialisms

An acronym is a word formed by the first letters in a multiword term. Initialisms are words made of initials pronounced separately. These are used extensively in the information technology (IT) field. Identify the terms associated with the following acronyms.

BBS ____

CPU ____

DSL ____

FTP ____

HTML ____

IRQ ______________________

LED ______________________

NIC ______________________

PCB ______________________

PCMCIA ______________________

RAM ______________________

ROM ______________________

USB ______________________

Compare and Contrast Exercise: Internet Access Technologies

Although larger organizations have multiple methods for connecting to the Internet, home and small office users primarily use one of three access technologies for Internet connections. Complete the following table to compare and contrast dialup modem, DSL, and cable modem access technologies. You might need to consult other sources of information for advantages and disadvantages of these technologies.

	Dialup Modem	DSL	Cable Modem
What type of communication line does this technology use?			
Is it considered an "always on" technology?			
Does this technology provide a high-speed connection to the Internet?			
What is an advantage of this technology?			
What is a disadvantage of this technology?			

Concept Questions

Completely answer the following questions:

1. What are the three requirements for an Internet connection?

   ____

   - ______________________________
   - ______________________________
   - ______________________________

2. What is the difference between a physical connection and a logical connection?

   ____

3. What factors must be considered when deciding on a NIC?

   ____

4. What logical protocols must be configured for Internet connectivity? Within the protocol components, what items must be configured?

   ____

   - ______________________________
   - ______________________________
   - ______________________________
   - ______________________________

   ____

5. A recently installed PC has problems connecting to the Internet. List the steps you use to troubleshoot the network connection.

Journal Entry

Many of today's PCs are designed for specific uses. Often, they are customized at the factory to target particular types of customers. The primary areas of customization include the processor, memory and storage, and expansion cards. Certain applications require powerful processors and plenty of memory. Other applications require generous amounts of storage and upgraded adapter cards. Almost all applications require some type of Internet access option.

You are starting up a small company that focuses on building customized PCs. You decide to design three unique PC types. These PCs will be designed for home, entertainment, and business use. The home PC will be marketed to users who use their home computer for basic word processing, balancing checkbooks, and accessing e-mail using a telephone line. The entertainment PC will be designed for customers who use their PC to play online games, listen to music, and watch movies. The business PC will need to be able to maintain large databases, work with complicated spreadsheets, and connect to the user's company network.

The first step in designing these PCs is to determine the components required to build each computer. List the key components of each type of PC. What are the processor, memory, storage, and expansion card requirements of each type? What Internet access option will be the most feasible for each user?

Note: Now would be a good time to complete the first five lab exercises for Chapter 1. The next section, and the remaining chapter labs, focuses on number systems, conversions, and binary logic.

Network Math

Math is often described as the "universal language," and it has a significant role in information networking. Specific number systems identify network devices and represent data. Network devices use numeric logic to make decisions on how data is handled. Internet connection speeds and information transfer rates are calculated using general math equations. It is important to learn the number systems and math used in networking to understand how networks function.

In this section, you find exercises designed to reinforce number system identification and conversion skills, apply binary logic, and identify different methods of addressing devices. These exercises reinforce the mathematical skills required in networking.

Vocabulary Exercise: Define

Define the following key technology terms:

ASCII ______________________________

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binary ______________________________

bits ______________________________

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Boolean logic ______________________________

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byte ______________________________

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decimal ______________________________

dotted-decimal notation ______________________________

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hexadecimal ______________________________

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IP address ______________________________

____

subnetwork mask ______________________________

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Concept Questions

Answer the following questions completely:

1. Why is it important to understand binary?

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2. Most Internet connection speeds are expressed in bits per second (bps), and data transfer rates are expressed in kilobytes per second (1000 KBps) or megabytes per second (1,000,000 Bps). What is the maximum transfer rate (in KBps) using a 56 kbps dialup line? What is the transfer rate on a 1.5 Mbps DSL link? What is the transfer rate on a 3.0 Mbps cable modem link?

3. How many 640 kb files can be stored on a 1.44 MB floppy disk?

4. A kilobit is defined as 1000 bits. How many bits are actually in a kilobit? Why is there a difference in a defined kilobit and an actual kilobit?

5. Explain the binary logic behind the AND process. How is it used in networking?

6. Why is a subnet mask required when configuring TCP/IP settings?

Note: Now is a good time to complete Curriculum Lab 1-6, Lab 1-7, and Lab 1-8. The following conversion exercise expands on the lessons learned in these labs.

Number Systems Conversion Exercise

Developing the skills for converting between the number systems used in networking is extremely important. For additional practice, complete the following table by converting the given value to the other number systems.

	Decimal	Hexadecimal	Binary
1	23		
2	191		
3	278		
4	127.0.0.1		
5	10.50.148.91		
6		19	
7		3F	
8		0A-CE	
9		BE-AD	
10		87-C3-5E	
11			1011100
12			100111100
13			0010-1101
14			10101010-01010110-10101101
15			11000000.10101000.01100100.00011011

Note: Now would be a good time to test your understanding of number systems with Challenge Lab 1-9, which challenges you to create a unique number system.

Binary Logic ANDing Exercise

In binary logic, the AND operation compares two input values and provides a single output value. This process is used in networking to provide network and subnet addresses by ANDing an IP address with a subnet mask. Because ANDing is a binary operation, the possible inputs are combinations of 1s and 0s, and the resulting output is either a 1 or 0. If both input values are 1, the output is 1. If either input is 0 (or both inputs are 0), the output is 0. In the following example, an IP address of 192.168.10.17 is ANDed to a subnet mask of 255.255.255.0. Both numbers are converted to binary, and the ANDing process returns a result of 192.168.10.0 when converted back to dotted-decimal format. This is the address of the network to which the IP address belongs.

Example

IP Address	192.168.10.17	11000000.10101000.00001010.00010001
Subnet Mask	255.255.255.0	11111111.11111111.11111111.00000000
AND Result	192.168.10.0	11000000.10101000.00001010.00000000

Note: Subnet masks are 32-bit numbers written in dotted-decimal format. In a subnet mask, 1s represent network or subnet bits. 0s show the remaining host bits. Subnet masks always begin with 1s written from the left to the right.

Use the provided tables to AND the corresponding IP addresses with the subnet masks. Record the results as a dotted-decimal number.

IP Address 10.200.165.84

Subnet Mask 255.0.0.0

AND Result

128 64 32 16 8 4 2 1   128 64 32 16 8 4 2 1   128 64 32 16 8 4 2 1   128 64 32 16 8 4 2 1

IP Address 172.16.24.199

Subnet Mask 255.255.0.0

AND Result

128 64 32 16 8 4 2 1   128 64 32 16 8 4 2 1   128 64 32 16 8 4 2 1   128 64 32 16 8 4 2 1

IP Address 172.16.24.199

Subnet Mask 255.255.240.0

AND Result

128 64 32 16 8 4 2 1   128 64 32 16 8 4 2 1   128 64 32 16 8 4 2 1   128 64 32 16 8 4 2 1

IP Address 192.168.100.63

Subnet Mask 255.255.255.0

AND Result

128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1

IP Address 192.168.100.63

Subnet Mask 255.255.255.224

AND Result

128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1

Journal Entry

Because the Internet is a worldwide network, it requires a global-addressing scheme. IP addresses are unique addresses assigned to each host connected to the Internet. Network devices use these addresses to send data from the source to the destination. Without a global-addressing system in place, the Internet would be useless.

List other large-scale or global-addressing systems used in the world today. How are global "address books" maintained for each system? Who is responsible for updating the system?

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Lab Exercises

Curriculum Lab 1-1: PC Hardware (1.1.2)

Objectives

- Become familiar with the basic peripheral components of a PC system.
- Identify PC connections, including network attachments.
- Examine the internal PC configuration and identify major components.
- Observe the boot process for the Windows OS.
- Use the Control Panel to find out information about the PC.

Background/Preparation

Knowing the components of a PC is valuable when troubleshooting, and it is important to your success in the networking field. Before you begin, the instructor or lab assistant must have a typical desktop PC available with all peripherals, such as keyboard, monitor, mouse, speakers or headphones, a NIC, and network cable. The system unit cover should be removed, or you need to have tools to remove it. You can work individually or in teams. In addition, the instructor needs to identify the location of the A+ or PC hardware training materials.

Task 1: Examine the Computer and Peripheral Components Both Front and Back

Note: The components and configuration of the PC you are working with might vary.

Step 1. What are the manufacturer and model number of this computer?

Manufacturer ______________________________

Model Number ______________________________

Step 2. What are the major external components of the PC, including the peripherals?

Component Name	Manufacturer/Description/Characteristics

Task 2: Remove the PC System Unit Cover and Examine the Internal Components

Step 1. List at least eight major internal components inside the system unit. (Use the procedure in Task 4 to find CPU information and the amount of RAM.)

Component Name	Manufacturer/Description/Characteristics

Task 3: Assemble the PC Components and Observe the Boot Process

Step 1. Assemble the PC components, attach all peripherals, and boot the PC. Observe the boot process. The computer should boot to the Windows OS. If the computer does not boot, contact the lab assistant.

Step 2. Did the Windows OS boot okay?

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Step 3. Could you see the memory amount as the system booted?

____

Task 4: Gather Basic Information About the Computer's CPU and RAM

Step 1. Click **Start > Settings > Control Panel**. Click the **System** icon and then the **General** tab. You are viewing information about the computer using the OS. What is the CPU?

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Step 2. In MHz, what is the speed of the CPU?

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____

____

Step 3. How much RAM is installed?

____

Curriculum Lab 1-2: PC Network TCP/IP Configuration (1.1.6)

Objectives

- Identify tools used for discovering a computer's network configuration with various OSs.
- Gather information, including the connection, hostname, MAC (Layer 2) address, and TCP/IP network (Layer 3) address information.
- Compare the network information to that of other PCs on the network.

Background/Preparation

This lab assumes that you are using any version of Windows. This is a nondestructive lab that you can perform on any machine without changing the system configuration.

Ideally, perform this lab in a LAN environment that connects to the Internet. You can use a single remote connection via a modem or DSL-type connection. You need the IP address information, which your instructor can provide.

The following instructions run the lab twice, reflecting the OS differences between Windows 95/98/Me systems and Windows NT/2000/XP systems. If possible, perform the lab on both types of systems.

Note: All users complete Task 1.

Task 1: Connect to the Internet

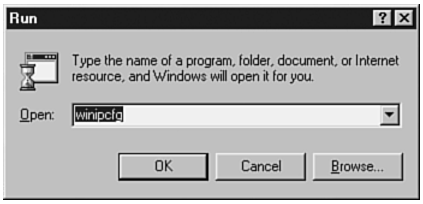
Establish and verify connectivity to the Internet. This task ensures that the computer has an IP address.

Note: Windows 95/98/Me users: Complete Tasks 2 through 6.

Task 2: Gather Basic TCP/IP Configuration Information

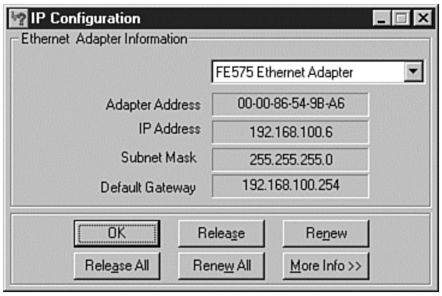
Step 1. Using the taskbar, choose **Start** > **Run** to open the dialog box shown in Figure 1-1. Type **winipcfg** and press **Enter**. (The spelling of **winipcfg** is critical, but the case is not. It is short for Windows IP configuration.)

Figure 1-1 Run Dialog Box



Step 2. The first screen shows the adapter address (or MAC address), IP address, subnet mask, and default gateway. Figure 1-2 shows the basic IP configuration screen. Select the correct adapter if the list contains more than one.

Figure 1-2 Basic IP Configuration Screen



Step 3. The IP address and default gateway should be in the same network or subnet; otherwise, this host would not be able to communicate outside the network. In Figure 1-2, the subnet mask reveals that the first three octets must be the same number in the same network.

If this computer is on a LAN, you might not see the default gateway if it is running behind a proxy server. Record the following information for this computer:

IP address: ______________________________

Subnet mask: ______________________________

Default gateway: ______________________________

Task 3: Compare This Computer's TCP/IP Configuration to That of Others on the LAN

If this computer is on a LAN, compare the information on several machines. Answer the following questions:

1. Are there any similarities?

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2. What is similar about the IP addresses?

____

____

____

3. What is similar about the default gateways?

____

____

____

4. What is similar about the adapter (MAC) addresses?

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____

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5. The IP addresses should share the same network portion. All machines in the LAN should share the same default gateway. Although it is not a requirement, most LAN administrators standardize components such as NICs, so it would not be surprising to find that all machines share the first three hexadecimal pairs in the adapter address. These three pairs identify the manufacturer of the adapter.
6. Record a couple of the IP addresses.

____

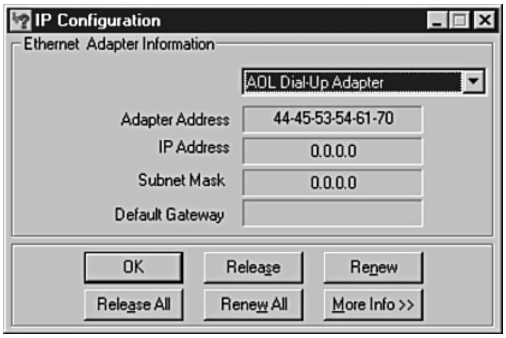
____

____

Task 4: Verify the Selection of a Network Adapter

Step 1. The box at the top of the screen should display this computer's adapter model. Use the drop-down arrow in that box to see any other configurations for this adapter (such as PPP). If this computer connects to the Internet with a dialup account, you might see configurations for a modem. On a server, it is possible to find another NIC in this list, or a machine with both a NIC and a modem could include both configurations in this list. Figure 1-3 shows an AOL modem IP configuration screen. Notice that the figure shows no IP address. This configuration is what a home system could have if the user does not log on to the Internet.

Figure 1-3 AOL Modem IP Configuration Screen

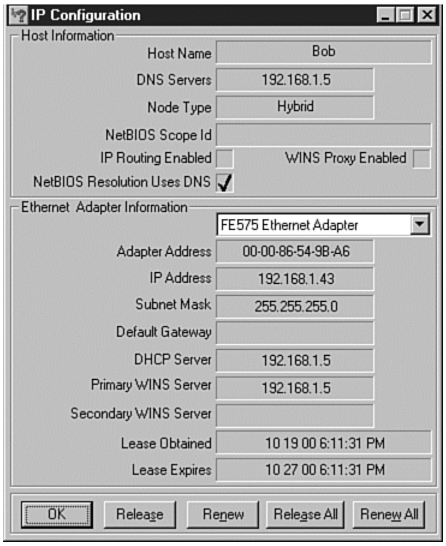


Step 2. Return to the adapter that displays the NIC or modem data with an IP address.

Task 5: Check Additional TCP/IP Configuration Information

Step 1. Click the **More Info** button. Figure 1-4 shows the detailed IP configuration screen.

Figure 1-4 Detailed IP Configuration Screen



Step 2. You should see the following information: the hostname (computer name, NetBIOS name); the Dynamic Host Configuration Protocol (DHCP) server's address, if used; and the date the IP lease starts and ends. Review the remaining information. You might also see entries for DNS and Windows Internet Name Service (WINS) servers, which are used in name resolution.

Step 3. Write the IP addresses of any servers listed.

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____

____

____

Step 4. Write the computer's hostname.

____

Step 5. Write the hostnames of a couple of other computers.

____

Step 6. Do all the servers and workstations share the same network portion of the IP address as your workstation?

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Task 6: Close the Screen When Finished Examining Network Settings

Repeat the preceding steps as necessary to ensure that you can return to and interpret this screen.

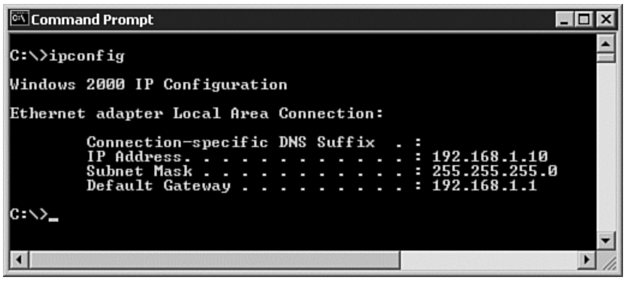
Note: Windows NT/2000/XP users: Complete Tasks 7 through 11.

Task 7: Gather TCP/IP Configuration Information

Step 1. Use the Start menu to open the command prompt (MS-DOS–like) window (**Start** > **Programs** > **Accessories** > **Command Prompt** or **Start** > **Programs** > **Command Prompt**).

Step 2. Figure 1-5 shows the command screen. Type **ipconfig** and press **Enter**. (The spelling of **ipconfig** is critical, but the case is not.)

Figure 1-5 Command Screen: ipconfig Results



Step 3. This screen shows the IP address, subnet mask, and default gateway. The IP address and the default gateway should be in the same network or subnet; otherwise, this host would not be able to communicate outside the network. In the figure, the subnet mask reveals that the first three octets must be the same number in the same network.

Note: If this computer is on a LAN, you might not see the default gateway if it is running behind a proxy server. Record the following information for this computer.

Task 8: Record the Following TCP/IP Information for This Computer

IP address: ______________________________

Subnet mask: ______________________________

Default gateway: ______________________________

Task 9: Compare This Computer's TCP/IP Configuration to That of Others on the LAN

If this computer is on a LAN, compare the information of several machines.

1. Are there any similarities?

____

____

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2. What is similar about the IP addresses?

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3. What is similar about the default gateways?

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4. Record a couple of the IP addresses.

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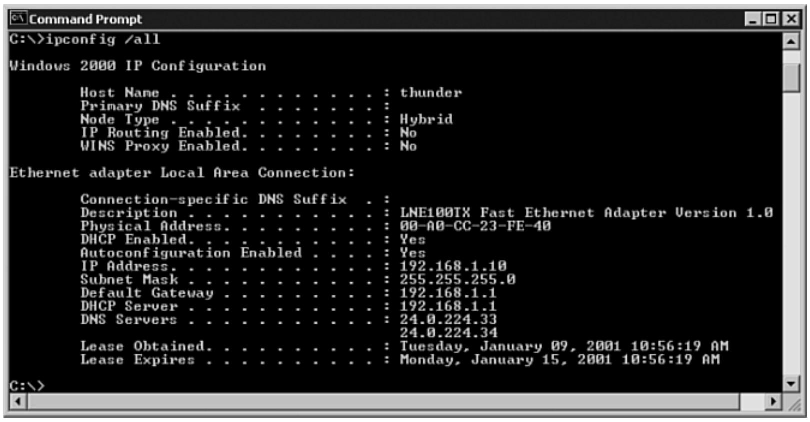
Task 10: Check Additional TCP/IP Configuration Information

Step 1. To see more information, type **ipconfig /all** and press **Enter**. Figure 1-6 shows the detailed IP configuration screen.

Figure 1-6 Command Screen: ipconfig /all Results



Step 2. You should see the following information: the hostname (computer name, NetBIOS name); the DHCP server's address, if used; and the date the IP lease starts and ends. Review the information. You might also see entries for DNS servers, which are used in name resolution.

Step 3. Figure 1-6 reveals that the router performs both DHCP and DNS services for this network. This network is likely a small office/home office (SOHO) or small branch office implementation.

Step 4. You also see the physical (MAC) address and the NIC model (description). In the LAN, what similarities do you see in the physical (MAC) addresses?

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Step 5. Although it is not a requirement, most LAN administrators standardize components such as NICs, so it would not be surprising to find that all machines share the first three hex pairs in the adapter address. These three pairs identify the manufacturer of the adapter.

Step 6. Write the IP addresses of any servers listed:

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____

Step 7. Write the computer's hostname.

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Step 8. Write the hostnames of a couple of other computers.

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Step 9. Do all the servers and workstations share the same network portion of the IP address as your workstation?

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Task 11: Close the Screen When Finished Examining Network Settings

Repeat the preceding steps as necessary to make sure that you can return to and interpret this screen.

Reflection

Based on your observations, what can you deduce about the following results from three computers connected to one switch?

Computer 1

IP address: 192.168.12.113

Subnet mask: 255.255.255.0

Default gateway: 192.168.12.1

Computer 2

IP address: 192.168.12.205

Subnet mask: 255.255.255.0

Default gateway: 192.168.12.1

Computer 3

IP address: 192.168.112.97

Subnet mask: 255.255.255.0

Default gateway: 192.168.12.1

Should they be able to talk to each other? Are they all on the same network? Why or why not? If something is wrong, what is most likely the problem?

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Curriculum Lab 1-3: Using ping and tracert from a Workstation (1.1.7)

Objective

- Learn to use the TCP/IP packet Internet groper (**ping**) command from a workstation.
- Learn to use the traceroute (**tracert**) command from a workstation.
- Observe name-resolution occurrences using WINS and DNS servers.

Background/Preparation

This lab assumes that you are using any version of Windows. This is a nondestructive lab that you can perform on any machine without changing the system configuration.

Ideally, perform this lab in a LAN environment that connects to the Internet. You can use a single remote connection via a modem or DSL-type connection. You need the IP addresses that were recorded in the previous lab. The instructor might also furnish additional IP addresses.

Note: Ping has been used in many denial of service (DoS) attacks, and many school network administrators have turned off ping and echo reply from the border routers. If the network administrator has turned off echo reply, it is possible for a remote host to appear to be offline when the network is operational.

Task 1: Establish and Verify Connectivity to the Internet

This task ensures that the computer has an IP address.

Task 2: Access the Command Prompt

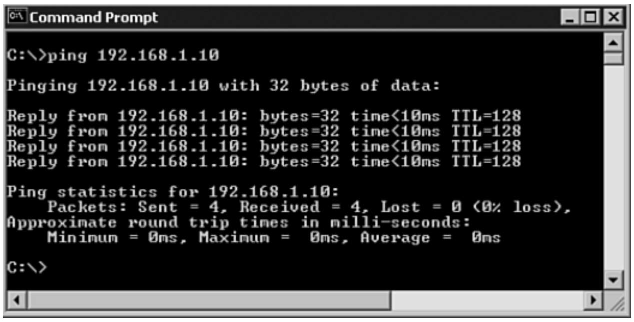
Windows 95/98/Me users: Use the Start menu to open the MS-DOS prompt window (**Start** > **Programs** > **Accessories** > **MS-DOS Prompt** or **Start** > **Programs** > **MS-DOS**).

Windows NT/2000/XP users: Use the Start menu to open the Command Prompt window (**Start** > **Programs** > **Accessories** > **Command Prompt** or **Start** > **Programs** > **Command Prompt** or **Start** > **All Programs** > **Command Prompt**).

Task 3: Ping the IP Address of Another Computer

Step 1. In the window, type **ping**, a space, and the IP address of a computer recorded in the previous lab. Figure 1-7 shows the successful results of pinging this IP address.

Figure 1-7 Successful Ping Results: IP Address



Ping uses the Internet Control Message Protocol (ICMP) echo-request and echo-reply feature to test physical connectivity. Because ping reports on four attempts, it gives an indication of the reliability of the connection. Review the results and verify that the ping is successful. Was the ping successful? If not, perform appropriate troubleshooting.

____

Step 2. If a second networked computer is available, ping the IP address of the second machine. Note the results.

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Task 4: Ping the IP Address of the Default Gateway

Ping the default gateway's IP address if you listed one in the previous exercise. A successful ping means there is physical connectivity to the router on the local network and probably the rest of the world.

Task 5: Ping the IP Address of a DHCP or DNS Server

Step 1. Ping the IP address of any DHCP or DNS servers listed in the previous exercise. If the ping works for either server and it is not in the network, what do your results indicate?

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Step 2. Was the ping successful?

____

If not, perform appropriate troubleshooting.

Task 6: Ping This Computer's Loopback IP Address

Step 1. Type the following command:

ping 127.0.0.1

The 127.0.0.0 network is reserved for loopback testing. If the ping is successful, TCP/IP is properly installed and functioning on this computer.

Step 2. Was the ping successful?

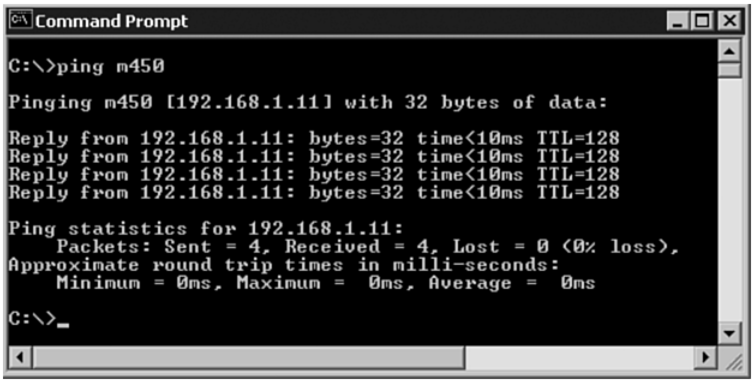
____

If not, perform appropriate troubleshooting.

Task 7: Ping the Hostname of Another Computer

Step 1. Ping the computer's hostname that you recorded in the previous lab. Figure 1-8 shows the successful result of pinging the hostname.

Figure 1-8 Successful Ping Results: Hostname



Step 2. Review the results. Notice that the first line of output shows the hostname (**m450**, in the example) followed by the IP address. This output means that the computer was able to resolve the hostname to an IP address. Without name resolution, the ping would have failed because TCP/IP only understands valid IP addresses, not names.

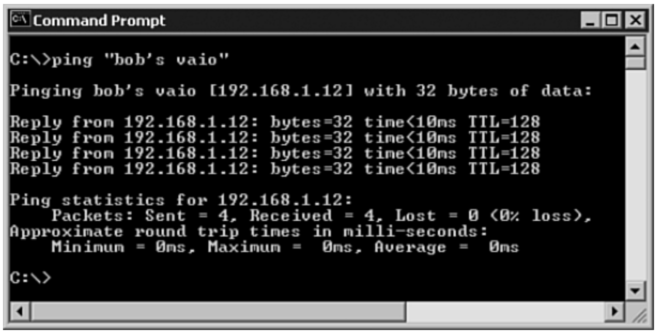
Step 3. A successful ping means that you can perform the connectivity and discovery of IP addresses with only a hostname. In fact, using hostnames is how many early networks communicated. Successfully pinging a hostname also shows that a WINS server is probably working on the network. WINS servers or a local **lmhosts** file resolves computer hostnames to IP addresses. If the ping fails, chances are the network is not running NetBIOS-name-to-IP-address resolution.

Note: It would not be uncommon for Windows 2000 or XP networks to not support this name-resolution feature. It is an old and often unnecessary technology.

Step 4. If the last ping worked, ping the hostname of another computer on the local network. Figure 1-9 shows the possible results.

Note: You must type the name in quotes because the command language does not like the space in the name.

Figure 1-9 Successful Ping Results: Computer on the Local Network

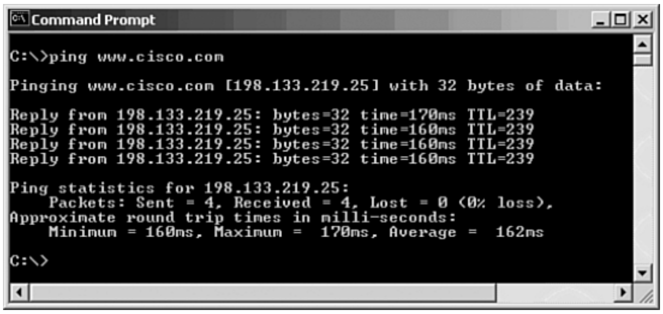


Task 8: Ping the Cisco Website

Step 1. Type the following command to ping the Cisco website (see Figure 1-10):

ping www.cisco.com

Figure 1-10 Successful Ping Results: Cisco Website



The first output line shows the Fully Qualified Domain Name (FQDN) followed by the IP address. A DNS server somewhere in the network was able to resolve the name to an IP address. DNS servers resolve domain names (not hostnames) to IP addresses.

Without name resolution, the ping would have failed because TCP/IP only understands valid IP addresses, not names. It would not be possible to use a web browser without name resolution.

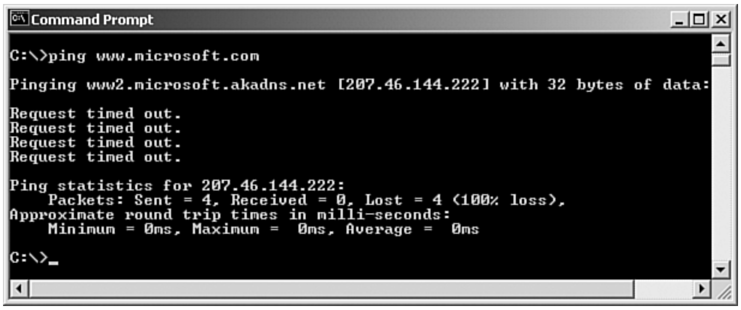
With DNS, you can verify connectivity to computers on the Internet using a familiar web address (domain name) without needing the actual IP address. If the nearest DNS server does not know the IP address, it asks a DNS server higher in the Internet structure.

Task 9: Ping the Microsoft Website

Step 1. Type the following command to ping the Microsoft website (see Figure 1-11):

ping www.microsoft.com

Figure 1-11 Unsuccessful Ping Results: Microsoft Website



Notice that the DNS server was able to resolve the name to an IP address, but there is no response. Some Microsoft routers are configured to ignore ping requests. Networks frequently implement this security measure.

Step 2. Ping some other domain names and record the results. An example is **ping www.msn.de**.

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Task 10: Trace the Route to the Cisco Website.

Step 1. Type **tracert www.cisco.com** and press **Enter** to generate the results shown in Figure 1-12.

Figure 1-12 Tracert Results for Cisco Website

```
Command Prompt
C:\>tracert www.cisco.com

Tracing route to www.cisco.com [198.133.219.25]
over a maximum of 30 hops:

  1   <10 ms    10 ms   <10 ms  10-37-00-1.internal.alp.dillingen.de [10.37.0.1]
  2   <10 ms   <10 ms   <10 ms  194.95.207.11
  3    20 ms   <10 ms    10 ms  ar-augsburg2.g-win.dfn.de [188.1.37.145]
  4   <10 ms   <10 ms    10 ms  ar-augsburg1.g-win.dfn.de [188.1.74.193]
  5   <10 ms   <10 ms    10 ms  cr-muenchen1.g-win.dfn.de [188.1.74.33]
  6    10 ms    10 ms    10 ms  cr-frankfurt1.g-win.dfn.de [188.1.18.81]
  7    10 ms    10 ms    10 ms  so-6-0-0.ar2.FRA2.gblx.net [208.48.23.141]
  8    10 ms    10 ms    10 ms  pos3-0-622M.cr1.FRA2.gblx.net [62.16.32.73]
  9    30 ms    30 ms    20 ms  so0-0-0-2488M.cr2.LON3.gblx.net [195.8.96.174]
 10    30 ms    30 ms    20 ms  pos1-0-622M.br1.LON3.gblx.net [195.8.96.189]
 11    30 ms    30 ms    31 ms  sl-bb21-lon-5-0.sprintlink.net [213.206.131.25]
 12   100 ms   100 ms    90 ms  sl-bb20-msq-10-0.sprintlink.net [144.232.19.69]
 13   110 ms   110 ms   110 ms  sl-bb20-rly-15-1.sprintlink.net [144.232.19.94]
 14   171 ms   160 ms   170 ms  sl-bb22-sj-5-1.sprintlink.net [144.232.9.125]
 15   161 ms   160 ms   170 ms  sl-bb25-sj-12-0.sprintlink.net [144.232.3.210]
 16   160 ms   181 ms   160 ms  sl-gw11-sj-10-0.sprintlink.net [144.232.3.134]
 17   170 ms   151 ms   160 ms  sl-ciscopsn2-11-0-0.sprintlink.net [144.228.44.14]
 18   170 ms   151 ms   160 ms  sjck-dirty-gw1.cisco.com [128.107.239.5]
 19   160 ms   160 ms   161 ms  sjck-sdf-ciod-gw1.cisco.com [128.107.239.106]
 20   160 ms   150 ms   161 ms  www.cisco.com [198.133.219.25]

Trace complete.
```

Step 2. **tracert** is TCP/IP's abbreviation for trace route. Figure 1-12 shows the successful result when you run **tracert** from Bavaria in Germany. The first output line shows the FQDN followed by the IP address. Therefore, a DNS server was able to resolve the name to an IP address. Then, you see a list of all the routers the tracert requests had to pass through to get to the destination.

Step 3. **tracert** actually uses the same echo requests and replies as the **ping** command does but in a slightly different way. Observe that **tracert** actually contacted each router three times. Compare the results to determine the consistency of the route. In the preceding example, note the relatively long delays after routers 11 and 13, possibly because of congestion. The main thing to notice is the relatively consistent connectivity. Each router represents a point where one network connects to another network and the packet was forwarded through.

Task 11: Trace Other IP Addresses or Domain Names

Use **tracert** on other domain names or IP addresses and record the results. An example is **tracert www.msn.de**.

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Task 12: Trace a Local Hostname or IP Address

Use the **tracert** command with a local hostname or IP address. It should not take long because the trace does not pass through any routers. Figure 1-13 offers a demonstration.

Figure 1-13 Tracert Results for a Local Hostname

```
Command Prompt
C:\>tracert lh-1700us

Tracing route to lh-1700us [10.37.0.186]
over a maximum of 30 hops:

  1   <10 ms   <10 ms   <10 ms  lh-1700us [10.37.0.186]

Trace complete.

C:\>_
```

Reflection

If the preceding tasks are successful and **ping** or **tracert** can verify connectivity with an Internet website, what does this indicate about the computer's configuration and about routers between the computer and the website? What, if anything, is the default gateway doing?

Curriculum Lab 1-4: Web Browser Basics (1.1.8)

Objectives

- Learn how to use a web browser to access Internet sites.
- Become familiar with the concept of a URL.
- Use a search engine to locate information on the Internet.
- Access selected websites to learn the definitions of networking terms.
- Use hyperlinks to jump from the current website to other websites.

Background/Preparation

A web browser is a powerful tool that many people use every day to surf around different sites (cyber places) on the World Wide Web. With a web browser, you can find anything from airline flight information to the directions on how to get to a specific address. A browser is a client application program or software that is loaded on the PC to gain access to the Internet and local web pages.

The website name, such as **www.cisco.com,** is a uniform resource locator (URL). This URL points to the World Wide Web server (**www**) in the Cisco domain (**cisco**) under the commercial domain (**com**).

When you enter the URL, the browser makes a request of a DNS server to convert the URL to an IP address, which contacts the site.

You can use a browser to access search engines, such as http://www.yahoo.com, http://www.excite.com, http://www.lycos.com, and http://www.google.com, by typing the name in the address bar.

Several websites provide definitions of networking and computer terms and acronyms. You can use them to learn more about networking and to do research on the Internet. Two of these sites are http://www.whatis.com and http://www.webopedia.com. Most websites contain *hyperlinks*, which are underlined and highlighted words. By clicking a hyperlink, you "jump" to another page on the current site or to a page on another website.

To perform this lab, you must have a computer configured with an up-to-date browser and Internet access.

Task 1: Start the Web Browser

If you use a modem to make the connection, you must dial your service provider before you can start your web browser. What version of Netscape or Internet Explorer are you using?

Task 2: Identify the Location or Address Field

After you start your browser, click and highlight the Location field (Netscape) or Address field (Internet Explorer) in the toolbar at the top of the page. Press the **Delete** key to delete the current address.

Task 3: Type in a Web URL

Type **http://www.cisco.com** and press **Enter**. This task is how you navigate from one site to another on the World Wide Web.

Task 4: Type in Another Web URL

To load a new page, type in a new URL, such as http://www.cnn.com. Notice the status on the bottom bar of your browser. What do you see?

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Task 5: Use the Browser Management Buttons

Step 1. Each button on top of your browser has a function. If you position the mouse over a button, a box appears that identifies the button.

Step 2. Click the **Back** button. What did it do?

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Step 3. Click the **Forward** button. Does it return you to the CNN website?

____

Step 4. Click the **Reload** or **Refresh** button. What do you think it does?

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Step 5. Type **http://www.microsoft.com** and press **Enter**. Click the **Stop** button as the window loads. What happens?

____

Task 6. Use a Search Engine

Type the URL for a search engine, such as http://www.google.com. Search for the word **browser**. What is the result?

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Task 7: Access Networking Terms Definitions Websites

Step 1. Enter the URL for **http://www.webopedia.com**. Enter the keyword **browser**. What is the result?

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Step 2. What hyperlinks are available?

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Step 3. Enter the URL for **http://www.whatis.com**. Look up the keyword **domain name system**. Click the exact match for "domain name system" under whatis.com terms. What does it say about DNS?

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Reflection

Identify a way in which you can navigate from one site to another.

If you see the same graphics or text at the NBA site, what should you do to ensure that you can see updated news?

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Curriculum Lab 1-5: Basic PC/Network Troubleshooting Process (1.1.9)

Objectives

- Learn the proper sequence for troubleshooting computer and network problems.
- Become familiar with the more common hardware and software problems.
- Given a basic problem situation, be able to troubleshoot and resolve the problem.

Background/Preparation

The ability to effectively troubleshoot computer problems is an important skill. The process of identifying the problem and trying to solve it requires a systematic, step-by-step approach. This lab introduces some basic hardware and software problems to solve and helps you become more familiar with PC components and the software required to use the Cisco curriculum. The process of trying to solve a problem is fairly straightforward. Some of the suggestions here are more than you need to solve basic hardware and software problems, but they provide a framework and guidelines to use when more complex problems arise. The instructor's version of the lab provides a list of sample problems that the instructor can introduce.

Use the following seven basic tasks for PC and network troubleshooting.

Task 1: Define the Problem

Use the proper terminology to describe what is happening or not happening. For example, "the PC can't get to the Internet" or "the PC cannot print."

Task 2: Gather the Facts

Observe the symptoms and characterize or identify the source of the problem:

- Is it hardware (check for lights and noises) or software (errors on screen) related?
- Does it affect only this computer or user or are others also impacted?
- Does it affect only this software or more than one application?
- Is this the first time it has happened, or has it happened before?
- Did someone recently change anything on the PC?
- Get the opinions of others who might have more experience.
- Check websites and troubleshooting knowledge databases.

Task 3: Consider the Possibilities

Using the facts you gathered, identify one or more possible causes and potential solutions. Rank the solutions in order of the most likely to the least likely cause.

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Task 4: Create an Action Plan

Develop a plan that involves the single most likely solution. You can try the other options if the original solution fails. In developing your plan, consider the following:

- Check the simplest possible causes first. Is the power turned on or is the cable plugged in? Verify hardware first and then software. (Do any lights come on?)
- If it is a network problem, start at Layer 1 of the Open System Interconnection (OSI) model and work your way up. Studies show that the majority of problems occur at Layer 1.
- Can you use substitution to isolate the problem? If the monitor does not work, the problem could be the monitor, video adapter, or cables. Try another monitor to see whether that corrects the problem.

Task 5: Implement the Plan

Make changes from your plan to test the first possible solution.

Task 6: Observe the Results

Step 1. If the problem is solved, document the solution. Double-check to make sure everything still works.

Step 2. If the problem is not resolved, restore the changes and return to your plan to try the next solution. If you do not reverse this change, you will never know whether the solution was a later change or a combination of two changes.

Task 7: Document the Results

Always document your results to assist in solving similar problems as well as developing a documentation history for each device. If you are going to replace part of the devices, it might be nice to know if any are frequent sources of trouble or if they have recently been reconditioned.

Task 8: Introduce Problems and Troubleshoot

Step 1. Work in teams of two. Team member A (or the instructor) selects two problems from a list of common hardware and software problems and introduces the problems into the computer. The desired goal is to run one of the videos or movies from the online curriculum or the CD.

Step 2. Team member A (or the instructor) should create the hardware or software problems with the computer while the other team member is out of the room and then turn off the computer and monitor.

Step 3. After team member B identifies the problems and corrects them, switch places, and let the other team member introduce some new problems.

Step 4. Each team member solving a problem should fill in the following table based on the symptoms observed, problems identified, and solutions.

Team Member A

	Symptom Observed	Problem Identified	Solution
Problem 1			
Problem 2			

Team Member B

	Symptom Observed	Problem Identified	Solution
Problem 1			
Problem 2			

Curriculum Lab 1-6: Decimal to Binary Conversion (1.2.5)

Objectives

- Learn the process for converting decimal values to binary values.
- Practice converting decimal values to binary values.

Background/Preparation

Knowing how to covert decimal values to binary values is valuable when converting human readable IP addresses in dotted-decimal format to machine-readable binary format. This is normally done for calculation of subnet masks and other tasks. The following is an example of an IP address in 32-bit binary form and dotted-decimal form:

Binary IP address: 11000000.10101000.00101101.011110001

Decimal IP address: 192.168.45.121

Table 1-1 provides a simple tool to easily convert binary values to decimal values. You create the first row by counting right to left from one to eight for the basic eight bit positions (although it would work for any size binary value). The value row starts with one and doubles (Base 2) for each position to the left.

Table 1-1 Converting Binary to Decimal Values

Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1

You can use the same conversion table and simple division to convert decimal values to binary. To convert the decimal number 207 to binary, start with 128 (2^7) and divide by each lesser power of 2 until the remaining number is either a 0 or 1. Refer to the following division example and the steps list that follow.

128 ÷ 207

128

———

64 79

64

———

8 15

8

———

4 7

4

———

2 3

2

———

1

To convert 207 to binary, follow these steps:

Step 1. Start with the leftmost value (largest) and see whether you can divide the decimal value by it. Because it will go once, put a 1 in the third row of Table 1-2 under the 128 value and calculate the remainder (79).

Step 2. Because you can divide the remainder by the next value (64), put a 1 in the third row under the 64 value of Table 1-2.

Step 3. Because you cannot divide the remainder by either 32 or 16, put 0s in the third row of Table 1-2 under the 32 and 16 values.

Step 4. Continue until there is no remainder.

Step 5. If necessary, use the fourth row in Table 1-2 to check your work.

Table 1-2 Converting 207 to Binary

Position	8	7	6	5	4	3	2	1	**Result**
Value	128	64	32	16	8	4	2	1	
	1	1	0	0	1	1	1	1	
	128	64			8	4	2	1	**207**

Step 6. Convert the following decimal values to binary:

A. 123 ____________________________

B. 02 _____________________________

C. 67 _____________________________

D. 7 ______________________________

E. 252 ____________________________

F. 91 _____________________________

G. 116.127.71.3 ____

___________.___________.___________.___________

H. 255.255.255.0 ____

___________.___________.___________.___________

I. 192.143.255.255 ____
____

___________.___________.___________.___________

J. 12.101.9.16 ____

___________.___________.___________.___________

Curriculum Lab 1-7: Binary to Decimal Conversion (1.2.6)

Objectives

- Learn the process for converting binary values to decimal values.
- Practice converting binary values to decimal values.

Background/Preparation

The following is an example of an IP address in 32-bit binary form and dotted-decimal form:

Binary IP address: 11000000.10101000.00101101.01111001

Decimal IP address: 192.168.45.121

Binary data consists of 1s and 0s (ON and OFF). Although you can group binary data in varying increments, such as 3 or 4 digits (110 or 1011), in TCP/IP, it is usually grouped in 8-digit groups called *bytes*.

A byte (8 bits) can range from 00000000 to 11111111, creating 256 combinations with decimal values ranging from 0 to 255. IP addressing uses 4 bytes (32 bits) to identify both the network and specific device (node or host). The example at the beginning of this lab is an example of an IP address in both binary decimal formats.

Table 1-3 provides a simple tool for easily converting binary to decimal values. You create the first row by counting right to left from one to eight for the basic eight bit positions (although it would work for any size binary value). The value row starts with 1 and doubles (Base 2) for each position to the left.

Table 1-3 Converting Binary to Decimal Values

Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1

Complete the following steps:

Step 1. Enter the binary bits (for example, 10111001) in the third row of Table 1-4.

Step 2. Put the decimal values in the fourth row only for the third row 1s. Technically, you are multiplying the second-row values by the third row.

Step 3. Sum the fourth row (across).

Table 1-4 Converting 10111001 to Decimal

Position	8	7	6	5	4	3	2	1	**Result**
Value	128	64	32	16	8	4	2	1	
	1	0	1	1	1	0	0	1	
	128	32	16	8	1	**185**			

Step 4. Convert the following binary values to decimals:

A. 1110 ____________

B. 100110 ___________

C. 11111111 _________

D. 11010011 _________

E. 01000001 _________

F. 11001110 _________

G. 01110101 _________

H. 10001111 _________

I. 11101001.00011011.10000000.10100100 _____._____._____._____

J. 10101010.00110100.11100110.00010111 _____._____._____._____

Curriculum Lab 1-8: Hexadecimal Conversion (1.2.8)

Objectives

- Learn the process for converting hexadecimal values to decimal and binary values.
- Learn the process for converting decimal and binary values to hexadecimal values.
- Practice converting between decimal, binary, and hexadecimal values.

Background/Preparation

Table 1-5 provides a useful decimal-to-hexadecimal-to-binary conversion table.

Table 1-5 Decimal-to-Hexadecimal-to-Binary Conversion

Decimal	Hexadecimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

You use the hexadecimal number system to refer to the binary numbers in a NIC or Internet Protocol version 6 (IPv6) address. The word *hexadecimal* comes from the Greek word for 16 and is often abbreviated 0x (zero and lowercase x). Hexadecimal numbers use 16 unique digits to display any combination of 8 binary digits as only 2 hexadecimal digits.

A byte (8 bits) can range from 00000000 to 11111111, creating 256 combinations with decimal values ranging from 0 to 255 or hexadecimal values 0 to FF. Each hexadecimal value represents only 4 binary bits. The alpha (A–F) values are not case sensitive.

Table 1-6 provides a simple tool for easily converting hexadecimal to decimal values using the same techniques as covered in binary to decimal conversions in the previous lab. The first row is the two hexadecimal positions. The value row starts as 1 and 16 (Base 16) for each position to the left.

Table 1-6 Hexadecimal to Decimal Conversion

Position	2	1
Value	16	1

Note: At the end of this lab, you use the Windows scientific calculator to check your work.

Steps for Hexadecimal to Decimal Conversion

Step 1. Break the hexadecimal value into pairs starting at the right edge, inserting a 0 if necessary to complete the first pair (for example, 77AE becomes 77 and AE), as done in Table 1-7.

Step 2. Put each hexadecimal pair in the third row. The value in parentheses is the decimal value of hexadecimal values A–F.

Step 3. To get the decimal values in the fourth row, multiply the second-row values by the third row.

Step 4. Sum the fourth row (across).

Table 1-7 Converting Hexadecimal to Decimal

Position	2	1	Result	Position	2	1	Result
Value	16	1		**Value**	16	1	
	7	7			$A_{(10)}$	$E_{(14)}$	
	112	7	**119**		160	14	**174**

Add decimal 119 (hexadecimal 77) and decimal 174 (hexadecimal AE) for a total of decimal 293.

Steps for Decimal to Hexadecimal Conversion

Step 1. To be valid for the purposes of this lab, the decimal value is between 0 and 256. You derive the first hexadecimal value by dividing the decimal value by 16. If the value is greater than 9, you need to put it in hexadecimal form (A–F).

Step 2. The second value is the remainder from Step 1. If the value is greater than 9, you need to put it in hexadecimal form (A–F).

Step 3. For example, 209 divided by 16 is 13 (D in hexadecimal) with a remainder of 1, equaling D1.

Steps for Hexadecimal to Binary Conversion

Step 1. This is the easiest conversion, as long as you remember that each hexadecimal value converts to four binary bits, so work right to left. For example, convert 77AE to binary.

Step 2. Starting with E, you can use Table 1-5 at the beginning of this lab to go directly to binary. The alternative is to convert the value to decimal (E = 14), and then use the last four binary positions of the table (see Table 1-8).

14 divided by 8 is 1 with a remainder of 6.

6 divided by 4 is 1 with a remainder of 2.

2 divided by 2 is 1 with no remainder.

If necessary, add 0s to end up with 4 bits.

Table 1-8 Hexadecimal to Decimal Conversion

Position	4	3	2	1	Result
Value	8	4	2	1	
	1	1	1	0	
	8	4	2		**14**

Step 3. Using the same technique, A becomes 1010, and the total so far is 10101110 (see Table 1-9).

Table 1-9 Hexadecimal to Decimal Conversion

Position	4	3	2	1	Result
Value	8	4	2	1	
	1	0	1	0	
	8		2		**10**

Step 4. Using the same technique, the two 7s each become 0111, and the total in binary is now is 01110111.10101110 (see Table 1-10).

Table 1-10 Hexadecimal to Decimal Conversion

Position	4	3	2	1	Result
Value	8	4	2	1	
	0	1	1	1	
		4	2	1	**7**

Steps for Binary to Hexadecimal Conversion

Step 1. Each hexadecimal value equals 4 binary bits, so start by breaking the binary value into 4-bit units from right to left. Add any leading 0s required to end up with all 4-bit values. 01101110 11101100 would become 0110 1110 1110 1100.

Step 2. You can use Table 1-5 to go directly to hexadecimal. The alternative is to convert each 4-bit binary value to decimal (0–15) and then convert the decimal to hexadecimal (0–F), as shown in Table 1-11.

Table 1-11 Converting Binary to Hexadecimal

Position	4	3	2	1	Result	Position	4	3	2	1	Result
Value	8	4	2	1		**Value**	8	4	2	1	
	1	1	0	0	1	1	1	0			
	8	4	**12 or C**		8	4	2		**14 or E**		

Step 3. In Table 1-12, binary 1100 is converted to decimal 12 or hexadecimal C. Binary 1110 is then converted to decimal 14 or hexadecimal E. Although not shown in the table, binary 1110 converts to hexadecimal E and 0110 converts to hexadecimal 6. The result is 6E–EC.

Practice

Convert the following values in Table 1-12 to the other two forms.

Table 1-12 Converting Decimal-to-Hexadecimal-to-Binary

	Decimal	Hexadecimal	Binary
1		A9	
2		FF	
3		BAD1	
4		E7-63-1C	
5	53		
6	115		
7	19		
8	212.65.119.45		
9			10101010
10			110
11			11111100.00111100
12			00001100.10000000.11110000.11111111

Checking Conversions with the Windows Calculator

It is important to be able to manually perform the preceding calculations. However, you can check your work using the Windows calculator applet. Access the calculator by choosing **Start > Programs > Accessories** > **Calculator**. Click the **View** menu and make sure that the calculator is in **Scientific** mode. Click the button for the type of number you will be entering (hexadecimal, decimal, or binary), and then enter the number in that form. To convert from one form to another, click one of the alternate options.

Challenge Lab 1-9: Understanding Number Systems

Objectives

- Learn the fundamental components of number systems.
- Create a unique number system.
- Test the newly created number system by converting new system values to the decimal format.

Background

Number systems are developed following a Base X notation. These systems use powers of the base value and a number of unique symbols. The Base 10, or decimal, number system uses the powers of 10 and 10 unique symbols (0, 1, 2, 3, 4, 5, 6, 7, 8, and 9). Binary is a Base 2 number system that uses 0 and 1 as its symbols. Hexadecimal is Base 16 and uses 0 through 9 and A through F for its 16 symbols.

Creating a unique number system is done by choosing a decimal number for the base value and identifying the symbols that will be used in the system. You can test the newly created system by converting the values to the decimal system.

Task 1: Create a Foundation for a Base 3 Numbering System

Draw a four-column, five-row table. Label the top row with Position, the next row with Power, and the third row from the top with Value.

Task 2: Label the Positions 1 Through 4 from Right to Left

Populate the Power row with the powers of 3. Begin with 3^0 in the right column followed by 3^1, 3^2, and 3^3. Reflect the corresponding decimal value of each power in the Value row.

Task 3: Define Symbols and Create a Symbol Table

Define the three symbols to be used in the numbering system, and create a table showing each symbol and its corresponding decimal value. Because it is a Base 3 system, the three values are 0, 1, and 2.

Task 4: Use Symbols to Fill in the Fourth Row

Write a four-character value using the newly defined symbols in the fourth row of the table.

Position	4	3	2	1
Power	3^3	3^2	3^1	3^0
Value	27	9	3	1
Symbol				
Value				

Task 5: Calculate Decimal Values to Fill in the Fifth Row

To get the decimal values for the fifth row, multiply the decimal value of each symbol in row four by the corresponding value in row three.

Position	4	3	2	1
Power	3^3	3^2	3^1	3^0
Value	27	9	3	1
Symbol	X	Y	X	Z
Value				

Task 6: Complete the Conversion

Add the values in the fifth row to complete the conversion process.

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Task 7: Convert Base 3 to Decimal

Convert the following Base 3 values to decimal format:

Base 3	Base 10
YXZY	______________
YZXX	______________
XZZZ	______________

Task 8: Determine the Largest Decimal Value

Determine the largest decimal value that can be expressed using four Base 3 characters. How would it be expressed in Base 3?

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Task 9: Describe Converting Decimal to Base 3

Describe the process to convert decimal values into Base 3.

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Challenge

Create a Base 5 numbering system by following the tasks of this lab. Ensure the numbering system is unique by using five simple object drawings as the symbols of the system. Have the instructor or a friend test the system by converting the values into decimal format. (You need to provide them the symbol to decimal conversion chart you create.)