CISCO SYSTEMS

Toolbar: Roll over tools

OUTLINE

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Module 1: Introduction to Networking

Module Overview

1.1 Connecting to the Internet

- 1.1.1 Requirements for Internet connection
- 1.1.2 PC basics
- 1.1.3 Network interface card
- 1.1.4 NIC and modem installation
- 1.1.5 Overview of high-speed and dial-up connectivity
- 1.1.6 TCP/IP description and configuration
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1.2 Network Math

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Module Summary

Module Quiz

Close Window

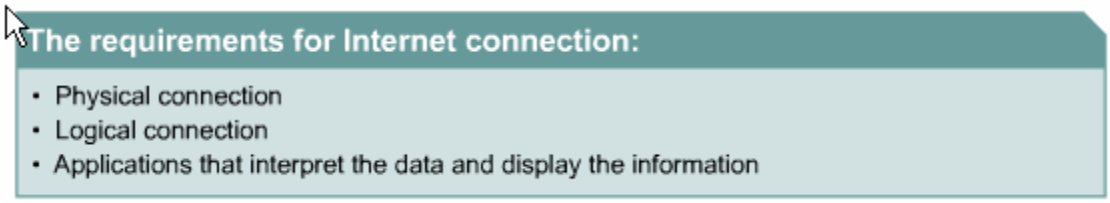
Module 1 Introduction to Networking

Upon completion of this module, the student will be able to perform tasks related to the following:	
1.1	Connecting to the Internet
1.2	Network Math

The Internet is a valuable resource, and connection to it is essential for business, industry, and education. Building a network that will connect to the Internet requires careful planning. Even for the individual user some planning and decisions are necessary. The computer itself must be considered, as well as the device itself that makes the connection to the local-area network (LAN), such as the network interface card or modem. The correct protocol must be configured so that the computer can connect to the Internet. Proper selection of a web browser is also important.

Students completing this lesson should be able to:

- Understand the physical connection that has to take place for a computer to connect to the Internet.
- Recognize the components that comprise the computer.
- Install and troubleshoot network interface cards and/or modems.
- Use basic testing procedures to test the Internet connection.
- Demonstrate a basic understanding of the use of web browsers and plug-ins.



The Internet is the largest data network on earth. The Internet consists of a multitude of interconnected networks both large and small. At the edge of this giant network is the individual consumer computer. Connection to the Internet can be broken down into the physical connection, the logical connection, and the application.

A physical connection is made by connecting a specialized expansion card such as a modem or a network interface card (NIC) from a computer (PC) to a network. The physical connection is used to transfer signals between PCs within the local network and to remote devices on the Internet.

The logical connection uses standards called protocols. A protocol is a formal description of a set of rules and conventions that govern how devices on a network communicate. Connections to the Internet may use multiple protocols. The Transmission Control Protocol/Internet Protocol (TCP/IP) suite is the primary protocol used on the Internet. TCP/IP is a suite of protocols that work together to transmit data.

The application that interprets the data and displays the information in an understandable form is the last part of the connection. Applications work with protocols to send and receive data across the Internet. A web browser displays Hypertext Markup Language (HTML) as a web page. File Transfer Protocol (FTP) is used to download files and programs from the Internet. Web browsers also use proprietary plug-in applications to display special data types such as movies or flash animations.

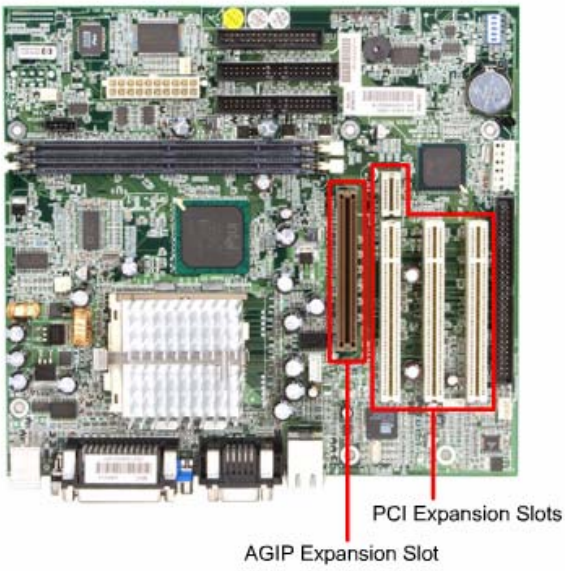
This is an introductory view of the Internet, and it may seem an overly simple process. As the topic is explored in greater depth, it will become apparent that sending data across the Internet is a complicated task

Internet Tutorial

http://library.albany.edu/internet/

How to Connect to the Internet

http://library.albany.edu/internet/ connect.html



Because computers are important building blocks in a network, it is important to be able to recognize and name the major components of a PC. Many networking devices are themselves special purpose computers, with many of the same components as normal PCs.

In order to use a computer as a reliable means of obtaining information, such as accessing Web-based curriculum, it must be in good working order. To keep a PC in good working order will require occasional troubleshooting of simple problems with the computer hardware and software. Therefore it is necessary to be able to recognize the names and purposes of the following PC components:

Small, Discrete Components

- **Transistor** – Device that amplifies a signal or opens and closes a circuit.
- **Integrated circuit (IC)** – Device made of semiconductor material that contains many transistors and performs a specific task.
- **Resistor** – Device made of material that opposes the flow of electric current.
- **Capacitor** – Electronic component that stores energy in the form of an electrostatic field that consists of two conducting metal plates separated by an insulating material.
- **Connector** – The part of a cable that plugs into a port or interface.
- **Light emitting diode (LED)** – Semiconductor device that emits light when a current passes through it.

Personal Computer Subsystems

- **Printed circuit board (PCB)** – A thin plate on which chips or integrated circuits and other electronic components are placed.
- **CD-ROM drive** – Compact disk read-only memory drive, which is a device that can read information from a CD-ROM.
- **Central processing unit (CPU)** – The brains of the computer where most calculations take place. 1
- **Floppy disk drive** – A disk drive that can read and write to floppy disks. 2
- **Hard disk drive** – The device that reads and writes data on a hard disk.
- **Microprocessor** – A silicon chip that contains a CPU.
- **Motherboard** – The main circuit board of a microcomputer 3
- **Bus** – A collection of wires through which data is transmitted from one part of a computer to another.
- **Random-access memory (RAM)** – Also known as Read-Write memory, new data can be written to it and stored data can be read from it. RAM requires electrical power to maintain data storage. If the computer is turned off or loses power, all data stored in RAM is lost.
- **Read-only memory (ROM)** – Computer memory on which data has been prerecorded. Once data has been written onto a ROM chip, it cannot be removed and can only be read.
- **System unit** – 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.
- **Expansion slot** – A socket on the motherboard where a circuit board can be inserted to add new capabilities to the computer. 4
- **Power supply** – The component that supplies power to a computer.

Backplane Components

- **Backplane** – The large circuit board that contains sockets for expansion cards.
- **Network interface card (NIC)** – An expansion board inserted into a computer so that the computer can be connected to a network.
- **Video card** – A board that plugs into a PC to give it display capabilities.
- **Audio card** – An expansion board that enables a computer to manipulate and output sounds.
- **Parallel port** – An interface capable of transferring more than one bit simultaneously that is used to connect external devices such as printers.
- **Serial port** – An interface that can be used for serial communication, in which only 1 bit is transmitted at a time.
- **Mouse port** – A port designed for connecting a mouse to a PC.
- **Power cord** – A cord used to connect an electrical device to an electrical outlet that provides power to the device.

Think of the internal components of a PC as a network of devices, which are all attached to the system bus. In a sense, a PC is a small computer network.

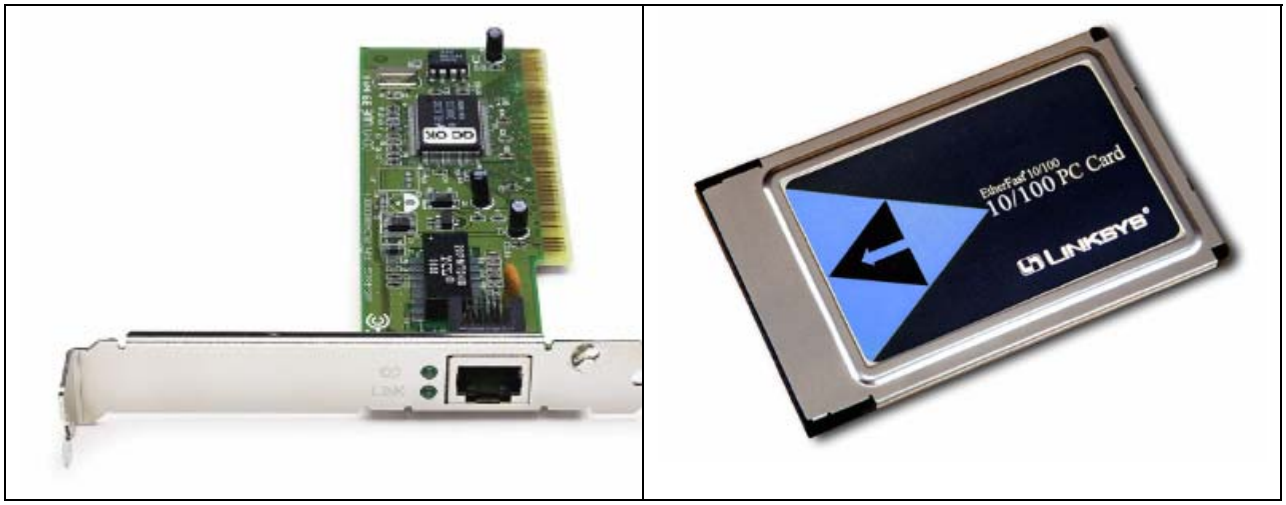
Lab Activity

Lab Exercise: PC Hardware

This lab introduces the basic peripheral components of a PC computer system and PC connections including network attachment.

Computer Basics

http://www.jegsworks.com/Lessons/ lessonintro.htm



A network interface card (NIC) is a printed circuit board that provides network communication capabilities to and from a personal computer. 1 2 Also called a LAN adapter, it resides in a slot on the motherboard and provides an interface connection to the network media. The type of NIC must match the media and protocol used on the local network.

The NIC communicates with the network through a serial connection and with the computer through a parallel connection. The NIC uses an Interrupt Request (IRQ), an I/O address, and upper memory space to work with the operating system. An IRQ is a signal informing the CPU that an event needing attention has occurred. An IRQ is sent over a hardware line to the microprocessor when a key is pressed on the keyboard. Then the CPU enables transmission of the character from the keyboard to RAM. An I/O address is a location in the memory used to enter data or retrieve data from a computer by an auxiliary device. Upper memory refers to the memory area between the first 640 kilobytes (KB) and 1 megabyte (MB) of RAM.

When selecting a NIC, consider the following factors:

- **Protocols** – Ethernet, Token Ring, or FDDI
- **Types of media** – Twisted-pair, coaxial, wireless, or fiber-optic
- **Type of system bus** – PCI or ISA

Interactive Media Activity

PhotoZoom: Network Interface Card

In this PhotoZoom, the student will view a network interface card.

Network Interface Card

http://www.erg.abdn.ac.uk/users/gorry/ course/lan-pages/nic.html

Connectivity to the Internet requires an adapter card, which may be a modem or NIC.

A modem, or modulator-demodulator, is a device that provides the computer with connectivity to a telephone line. The modem converts (modulates) the data from a digital signal to an analog signal that is compatible with a standard phone line. The modem at the receiving end demodulates the signal, which converts it back to digital. Modems may be installed internally or attached externally to the computer using a serial or USB interface. 1 2

The installation of a NIC, which provides the interface for a host to the network, is required for each device on the network. NICs are available in different types depending on the individual device configuration. Notebook computers may have a built-in interface or use a PCMCIA card. Figure 3 shows PCMCIA wired and wireless NICs. Desktop systems may use an internal or external NIC. 4 5

Situations that require NIC installation include the following:

- Adding a NIC to a PC that does not already have one
- Replacing a bad or damaged NIC
- Upgrading from a 10-Mbps NIC to a 10/100-Mbps NIC

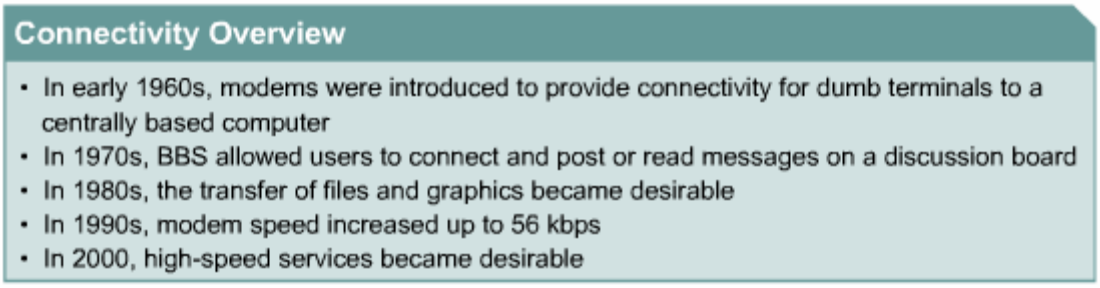
To perform the installation of a NIC or modem the following resources may be required:

- Knowledge of how the adapter is configured, including jumpers and plug-and-play software
- Availability of diagnostic tools

- Ability to resolve hardware resource conflicts

Installing a Network Interface Card

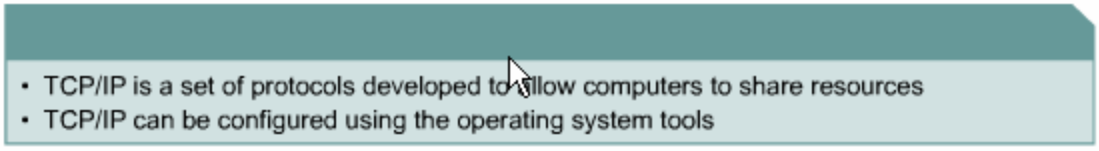
http://www.linfield.edu/~darnett/helpages/ NICinstall/NICStart.html



In the early 1960s, modems were introduced to provide connectivity for dumb terminals to a centrally based computer. Many companies used to rent computer time due to the expense of owning an on-site system, which was cost prohibitive. The connection rate was very slow, 300 bits per second (bps), translating to about 30 characters per second.

As PCs became more affordable in the 1970s, Bulletin Board Systems (BBS) appeared. These BBSs allowed users to connect and post or read messages on a discussion board. Running at 300 bps was acceptable, as this exceeds the speed at which most people can read or type. In the early 1980s, use of bulletin boards increased exponentially and the 300 bps speed quickly became too slow for the transfer of large files and graphics. By the 1990s modems were running at 9600 bps and reached the current standard of 56 kbps (56,000 bps) by 1998.

Inevitably the high-speed services used in the corporate environment, such as Digital Subscriber Line (DSL) and cable modem access, moved to the consumer market. These services no longer required expensive equipment or a second phone line. These are "always on" services that provide instant access and do not require a connection to be established for each session. This gives greater reliability and flexibility, and has led to the ease of Internet connection sharing by small office and home networks.



Transmission Control Protocol/Internet Protocol (TCP/IP) is a set of protocols or rules developed to allow cooperating computers to share resources across a network. To enable TCP/IP on the workstation, it must be configured using the operating system tools. The process is very similar whether using a Windows or Mac operating system.

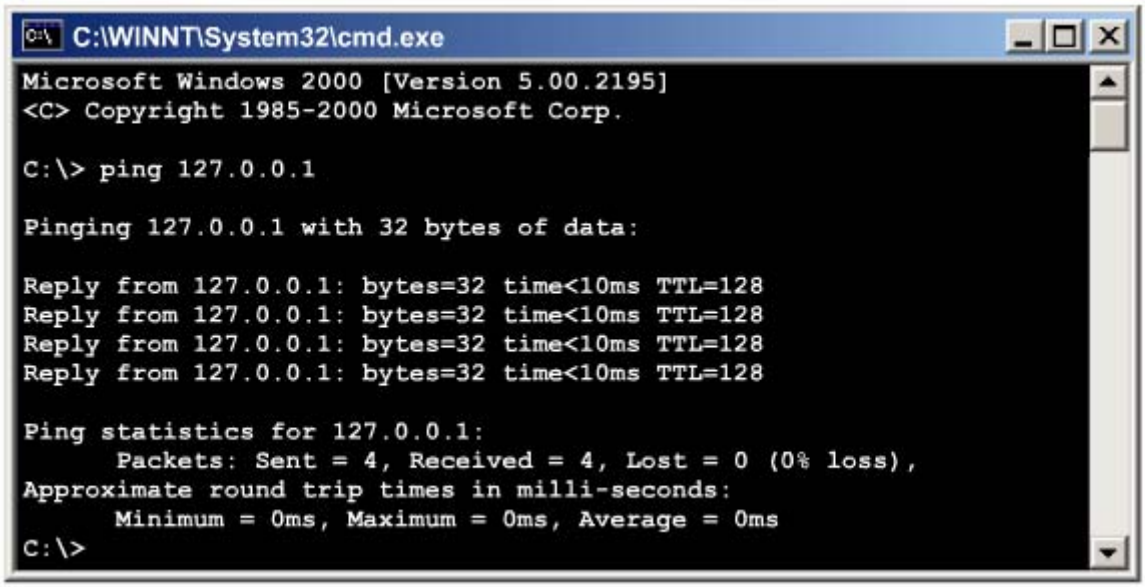
Lab Activity

Lab Exercise: PC Network TCP/IP Configuration

In this lab, the student will identify tools used to discover a computer network configuration with various operating systems

TCP/IP Basics

http://www.wown.com/j_helmig/tcpip.htm



Ping is a utility used to verify Internet connectivity. It is named after the sonar operation used to locate and determine the distance to an underwater object.

The **ping** command works by sending multiple IP packets to a specified destination. Each packet sent is a request for a reply. The output response for a ping contains the success ratio and round-trip time to the destination. From this information, it is possible to determine if there is connectivity to a destination. The **ping** command is used to test the NIC transmit/receive function, the TCP/IP configuration, and network connectivity. The following examples describe the types of ping tests that are commonly used in a network:

- **ping** ***127.0.0.1*** - This ping is unique and is called an internal loopback test. It verifies the operation of the TCP/IP stack and NIC transmit/receive function. [1]
- **ping** *IP address of host computer* - A ping to a host PC verifies the TCP/IP address configuration for the local host and connectivity to the host.
- **ping** *default-gateway IP address* - A ping to the default gateway verifies whether the router that connects the local network to other networks can be reached.
- **ping** *remote destination IP address* - A ping to a remote destination verifies connectivity to a remote host.

Lab Activity

Lab Exercise: Using **ping** and **tracert** from a Workstation

In this lab, the student will learn to use the TCP/IP Packet Internet Grouper (**ping**) command and the Trace Route (**tracert**) command from a workstation.

Using Ping.exe

http://howto.lycos.com/lycos/step/ 1,,26166+25551+19875,00.html

A web browser performs the following functions:

- Contacts a web server
- Requests information
- Receives information
- Displays the results on the screen

A web browser is software that interprets hypertext markup language (HTML), one of the languages used to code web page content. Other markup languages with more advanced features are part of the emerging technology. HTML, the most common markup language, can display graphics, play sound, movies, and other multimedia files. Hyperlinks are embedded in a web page providing a quick link to another location on the same or an entirely different web page.

Two of the most popular web browsers are Internet Explorer (IE) and Netscape Communicator. While identical in the tasks they perform, there are differences between these two browsers. Some websites may not support the use of one or the other, and it can be beneficial to have both programs installed on the computer.

Netscape Navigator: 1

- The first popular browser
- Takes less disk space
- Displays HTML files, performs e-mail and file transfers, and other functions

Internet Explorer (IE): 2

- Powerfully integrated with other Microsoft products
- Takes more disk space
- Displays HTML files, performs e-mail and file transfers, and other functions

There are also many special, or proprietary, file types that standard web browsers are not able to display. To view these files the browser must be configured to use the plug-in applications. These applications work in conjunction with the browser to launch the program required to view the following special files:

- **Flash** – plays multimedia files, which was created by Macromedia Flash
- **Quicktime** – plays video files, which was created by Apple
- **Real Player** – plays audio files

In order to install the Flash plug-in, do the following:

- Go to the Macromedia website.
- Download .exe file. (flash32.exe)
- Run and install in Netscape or IE
- Verify installation and proper operation by accessing the Cisco Academy website

Beyond getting the computer configured to view the Cisco Academy curriculum, computers perform many other useful tasks. In business, employees regularly use a set of applications that come in the form of an office suite, such as Microsoft Office. Office applications typically include the following:

- Spreadsheet software contains tables consisting of columns and rows, and it is often used with formulas to process and analyze data.

- A word processor is an application used to create and edit text documents. Modern word processors allow the user to create sophisticated documents, which include graphics and richly formatted text.
- Database management software is used to store, maintain, organize, sort, and filter records. A record is a collection of information identified by some common theme such as customer name.
- Presentation software is used to design and develop presentations to deliver at meetings, classes, or sales presentations.
- A personal information manager includes an e-mail utility, contact lists, a calendar, and a to-do list.

Office applications are now a part of every day work, as typewriters were before the personal computer

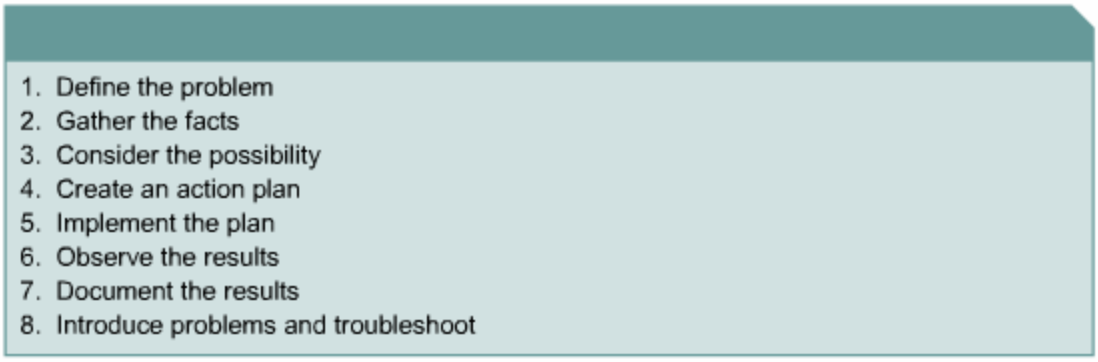
 **Lab Activity**

Lab Exercise: Web Browser Basics

In this lab, the student will learn how to use a web browser to access Internet sites and become familiar with the concept of a URL.

Surf the Web: Web Browsers

http://www.learnthenet.com/english/html/ 12browser.htm



In this troubleshooting lab, problems exist in the hardware, software, and network configurations. The goal, in a pre-determined length of time, is to locate and repair the problems, which will eventually allow access to the curriculum. This lab will demonstrate the complexity in configuring even the simple process of accessing the web. This includes the processes and procedures involved with troubleshooting computer hardware, software, and network systems.

Lab Exercise: Basic PC/Network Troubleshooting Process

In this lab, the student will learn the proper sequence for troubleshooting computer and network problems and become familiar with the more common hardware and software problems

How do I troubleshoot Internet connection problems in Windows XP?

http://www.jsifaq.com/SUBJ/tip4800/ rh4873.htm

Keyboard	Binary Codes
A	01000001
B	01000010
C	01000011
D	01000100
E	01000101
F	01000110
G	01000111
H	01001000

Character	ASCII Value	Binary
	--	--

Computers work with and store data using electronic switches that are either ON or OFF. Computers can only understand and use data that is in this two-state or binary format. 1 is represented by an ON state, and 0 is represented by an OFF state. The ones and zeros are used to represent the two possible states of an electronic component in a computer. They are referred to as binary digits or bits.

The American Standard Code for Information Interchange (ASCII) is the most commonly used code for representing alpha-numeric data in a computer. [1] ASCII uses binary digits to represent the symbols typed on the keyboard. When computers send ON/OFF states over a network, electrical, light, or radio waves are used to represent the 1s and 0s. Notice that each character has a unique pattern of eight binary digits assigned to represent the character.

Because computers are designed to work with ON/OFF switches, binary digits and binary numbers are natural to them. Humans use the decimal number system, which is relatively simple when compared to the long series of 1s and 0s used by computers. So the computer binary numbers need to be converted to decimal numbers.

Sometimes binary numbers need to be converted to Hexadecimal (hex) numbers which reduces a long string of binary digits to a few hexadecimal characters. This makes it easier to remember and to work with the numbers. [2]

Data Representation and Number Systems

http://scholar.hw.ac.uk/site/computing/ subindex_f1ncomp5topic1.html

ASCII Code Chart

http://www.jbase.com/knowledgebase/ manuals/3.0/ 30manpages/man/ AsciiChart.htm

Units	Definition	Bytes*	Bits*	Examples
Bit (b)	Binary digit, a 1 or 0	1	1	On/Off; Open/Closed +5 Volts or 0 Volts
Byte (B)	8 bits	1	8	Represent the letter "X" as ASCII code
Kilobyte (KB)	1 kilobyte = 1024 bytes	1000	8,000	Typical Email = 2 KB 10-page report = 10 KB Early PCs = 64 KB of RAM
Megabyte (MB)	1 megabyte = 1024 kilobytes = 1,048,576 bytes	1 million	8 million	Floppy disks = 1.44 MB Typical RAM = 32 MB CDROM = 650 MB
Gigabyte (GB)	1 gigabyte = 1024 megabytes =1,073741,824 bytes	1 billion	8 billion	Typical Hard Drive = 40 GB or greater
Terabyte (TB)	1 terabyte = 1024 gigabytes = 1,099,511,627,778 bytes	1 trillion	8 trillion	Amount of data theoreti-cally transmittable in optical fiber in one second

A binary 0 might be represented by 0 volts of electricity (0 = 0 volts).

A binary 1 might be represented by +5 volts of electricity (1 = +5 volts).

Computers are designed to use groupings of eight bits. This grouping of eight bits is referred to as a byte. In a computer, one byte represents a single addressable storage location. These storage locations represent a value or single character of data, such as an ASCII code. The total number of combinations of the eight switches being turned on and off is 256. The value range of a byte is from 0 to 255. So a byte is an important concept to understand when working with computers and networks.

Data Representations

http://csep1.phy.ornl.gov/guidry/phys594/ lectures/performance_prog/data.html

Place Value	1000 100 10 1
Base (Exponent)	$10^3 = 1000$ $10^2 = 100$ $10^1 = 10$ $10^0 = 1$
Number of Symbols	10
Symbols	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Rationale	Typical number of fingers equals ten

Numbering systems consist of symbols and rules for using those symbols. The most commonly used numbering system is the decimal, or Base 10, numbering system. Base 10 uses the ten symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. These symbols, can be combined to represent all possible numeric values.

The decimal number system is based on powers of 10. Each column position of a value, from right to left, is multiplied by the number 10, which is the base number, raised to a power, which is the exponent. The power that 10 is raised to depends on its position to the left of the decimal point. When a decimal number is read from right to left, the first or rightmost position represents 10^0 (1), the second position represents 10^1 (10 x 1= 10). The third position represents 10^2 (10 x 10 =100). The seventh position to the left represents 10^6 (10 x 10 x 10 x 10 x 10 x 10 =1,000,000). This is true no matter how many columns the number has.

Example:

$2134 = (2x10^3) + (1x10^2) + (3x10^1) + (4x10^0)$

There is a 4 in the ones position, a 3 in the tens position, a 1 in the hundreds position, and a 2 in the thousands position. This example seems obvious when the decimal number system is used. Seeing exactly how the decimal system works is important because it is needed to understand two other numbering systems, Base 2 and hexadecimal Base 16. These systems use the same methods as the decimal system.

Base 10 (Decimal) Numbering System

http://www.psinvention.com/zoetic/ base10.htm

Place Value	128 64 32 16 8 4 2 1
Base^{Exponent}	$2^7 = 128$ $2^3 = 8$ $2^6 = 64$ $2^2 = 4$ $2^5 = 32$ $2^1 = 2$ $2^4 = 16$ $2^0 = 1$
Number of Symbols	2
Symbols	0, 1
Rationale	Two-state (discrete binary) voltage systems made from transistors can be diverse, powerful, inexpensive, tiny and relatively immune to noise.

Computers recognize and process data using the binary, or Base 2, numbering system. 1 The binary system uses only two symbols, 0 and 1, instead of the ten symbols used in the decimal numbering system. The position, or place, of each digit from right to left in a binary number represents 2, the base number, raised to a power or exponent, starting from 0. These place values are, from right to left, 2^0, 2^1, 2^2, 2^3, 2^4, 2^5, 2^6, and 2^7, or 1, 2, 4, 8, 16, 32, 64, and 128 respectively.

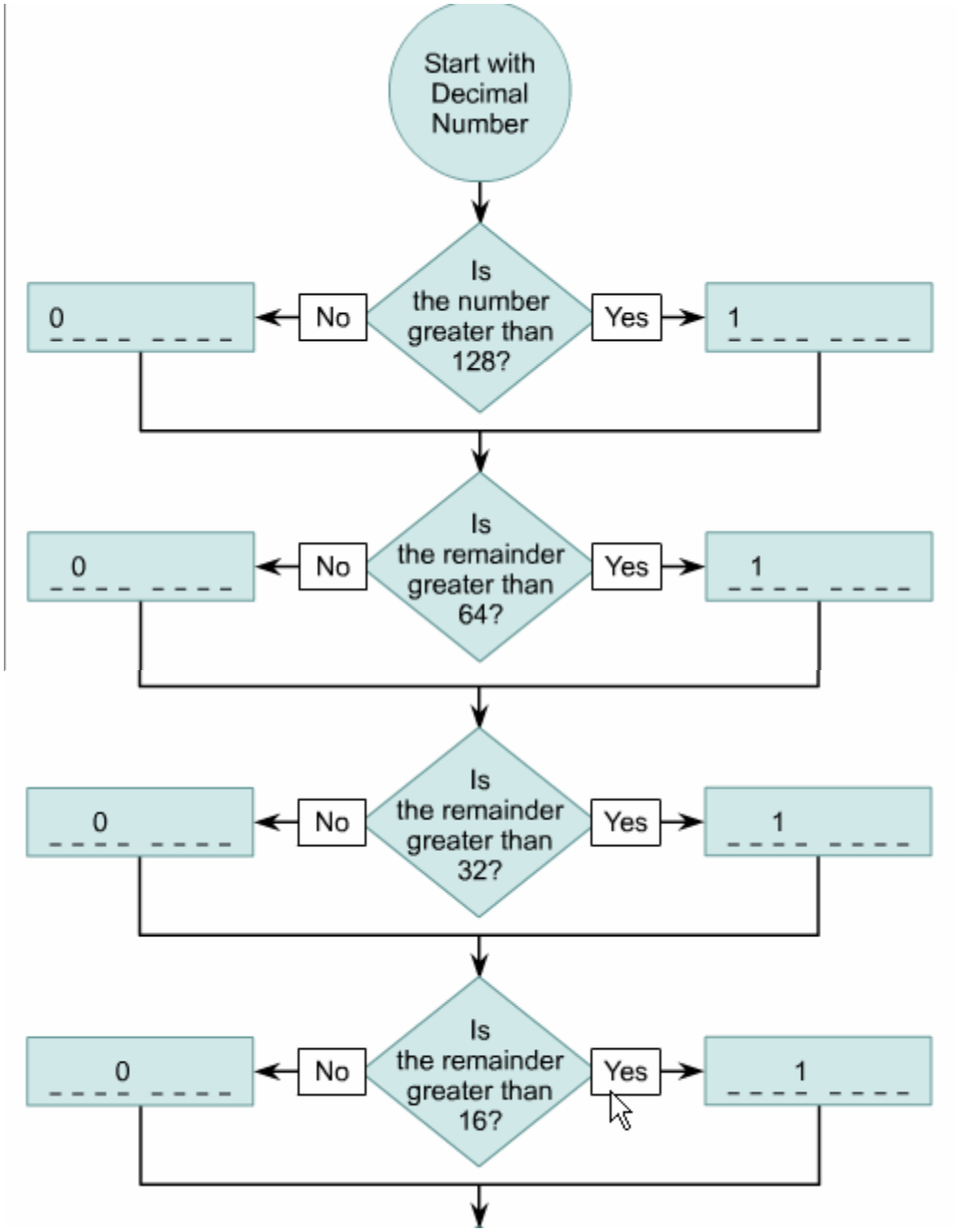
Example:

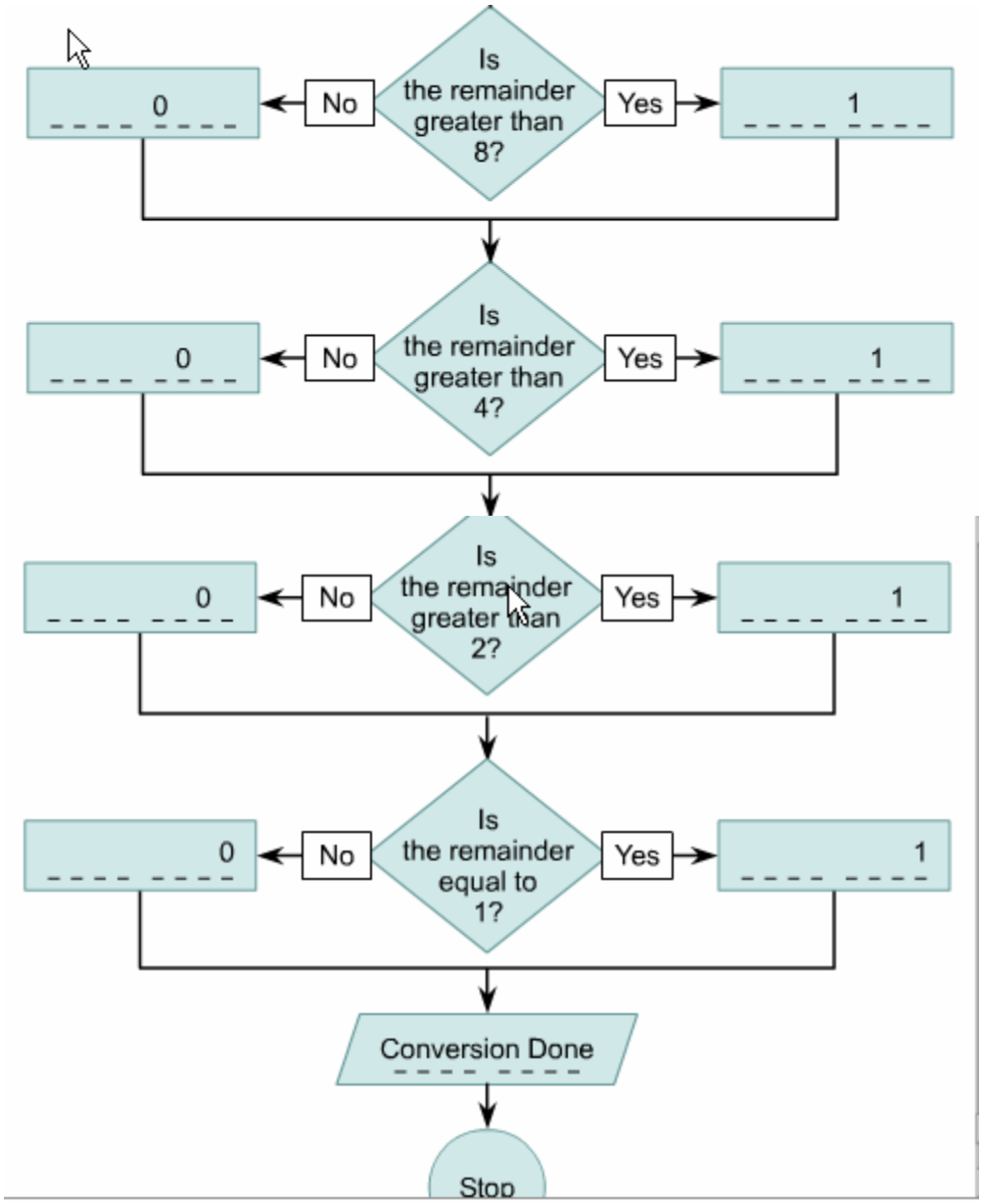
$10110_2 = (1 \times 2^4 = 16) + (0 \times 2^3 = 0) + (1 \times 2^2 = 4) + (1 \times 2^1 = 2) + (0 \times 2^0 = 0) = 22\ (16 + 0 + 4 + 2 + 0)$

If the binary number (10110_2) is read left to right, there is a 1 in the 16s position, a 0 in the 8s position, a 1 in the 4s position, a 1 in the 2s position, and a 0 in the 1s position, which adds up to decimal number 22

Base 2 (Binary) Numbering System

http://www.psinvention.com/zoetic/ base2.htm


Start with Decimal Number
Is the number greater than 128?
No
Yes
0 _ _ _ _ _ _ _ _
1 _ _ _ _ _ _ _ _
Is the remainder greater than 64?
No
Yes
0 _ _ _ _ _ _ _ _
1 _ _ _ _ _ _ _ _
Is the remainder greater than 32?
No
Yes
0 _ _ _ _ _ _ _ _
1 _ _ _ _ _ _ _ _
Is the remainder greater than 16?
No
Yes
0 _ _ _ _ _ _ _ _
1 _ _ _ _ _ _ _ _


Is the remainder greater than 8?
No
0
Yes
1
Is the remainder greater than 4?
No
0
Yes
1
Is the remainder greater than 2?
No
0
Yes
1
Is the remainder equal to 1?
No
0
Yes
1
Conversion Done
Stop

There are several ways to convert decimal numbers to binary numbers. The flowchart in Figure 1 describes one method. The process is trying to figure out which values of the power of 2 that add together to get the decimal number being converted to a binary number. This method is one of several methods that can be used. It is best to select one method and practice with it until it always produces the correct answer.

Conversion exercise

Use the example below to convert the decimal number 168 to a binary number:

- 128 fits into 168. So the left most bit in the binary number is a 1. 168 - 128 leaves 40.
- 64 does not fit into 40. So the second bit in from the left is a 0.
- 32 fits into 40. So the third bit in from the left is a 1. 40 - 32 leaves 8.
- 16 does not fit into 8 so the fourth bit in from the left is a 0.
- 8 fits into 8. So the fifth bit in from the left is a 1. 8 - 8 leaves 0. So, the remaining bits to the right are all 0.

Result: Decimal 168 = 10101000

For more practice, try converting decimal 255 to binary. The answer should be 11111111.

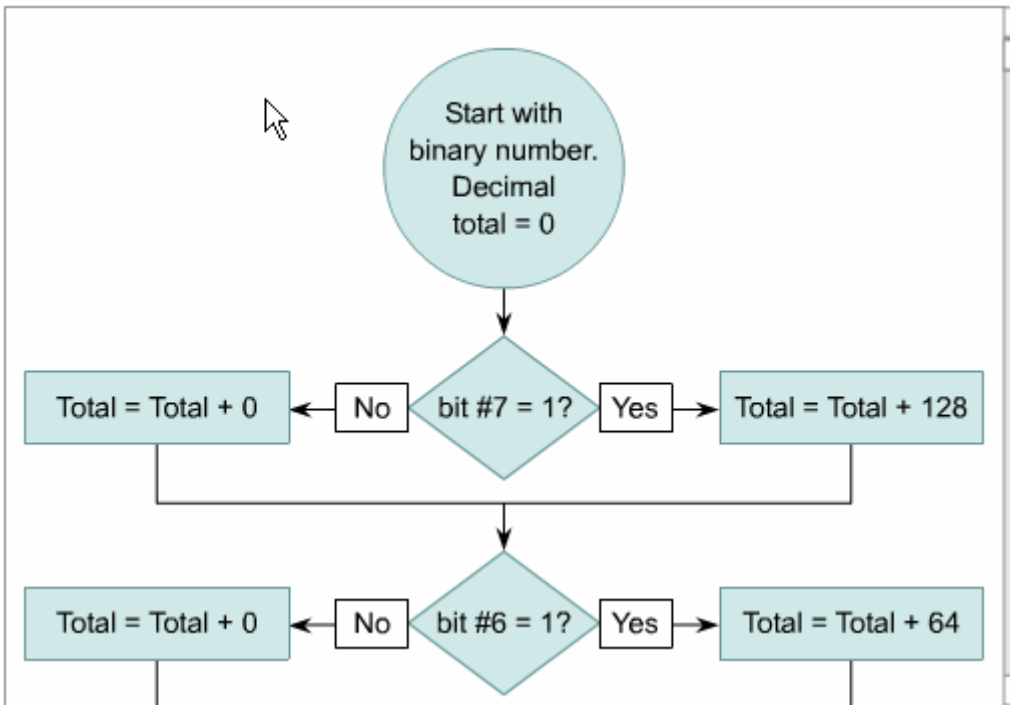
The number converter activity in Figure 2 will provide more practice.

Lab Exercise: Decimal to Binary Conversion

In this lab, the student will learn and practice to convert decimal values to binary values

Binary Numbers

http://www.netlingo.com/more/binary.html



Binary Number	Decimal Number
11010110	
Try New Number	Check Answer

There are two basic ways to convert binary numbers to decimal numbers. The flowchart in Figure 1 shows one example.

Binary numbers can also be converted to decimal numbers by multiplying the binary digits by the base number of the system, which is Base 2, and raised to the exponent of its position. 2

Example:

Convert the binary number 01110000 to a decimal number.

Note: Work from right to left. Remember that anything raised to the 0 power is 1. Therefore $2^0 = 1$

0	**128**	**0**
1	**64**	**64**
1	**32**	**32**
1	**16**	**16**
0	**8**	**0**
0	**4**	**0**
0	**2**	**0**
0	**1**	**0**

Lab Exercise: Binary to Decimal Conversion

In this lab, the student will learn and practice the process of converting binary values to decimal values.

Binary Numbers

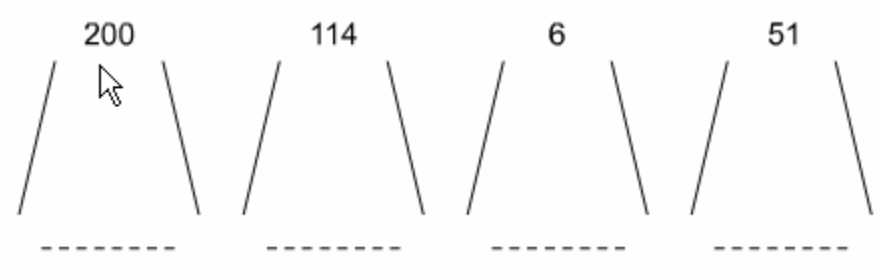
http://www.netlingo.com/more/binary.html

Binary	11001000		01110010		00000110		00110011
Decimal	200	.	114	.	6	.	51
	number	dot	number	dot	number	dot	number

Currently, addresses assigned to computers on the Internet are 32-bit binary numbers. 1 To make it easier to work with these addresses, the 32-bit binary number is broken into a series of decimal numbers. To do this, split the binary number into four groups of eight binary digits. Then convert each group of eight bits, also known as an octet into its decimal equivalent. Do this conversion exactly as was shown in the binary-to-decimal conversion topic on the previous page.

When written, the complete binary number is represented as four groups of decimal digits separated by periods. This is referred to as dotted decimal notation and provides a compact, easy to remember way of referring to the 32 bit addresses. This representation is used frequently later in this course, so it is necessary to understand it. When converting to binary from dotted decimal, remember that each group, which consists of one to three decimal digits represents a group of eight binary digits. If the decimal number that is being converted is less than 128, zeros will be needed to be added to the left of the equivalent binary number until there are a total of eight bits

Convert 200.114.6.51 to its 32-bit binary equivalent. 2



Convert 10000000 01011101 00001111 10101010 to its dotted decimal equivalent. 3

10000000 01011101 00001111 10101010

IP Addressing Architecture

http://www2.rad.com/networks/1994/ ip_addr/tcpip2.htm

Hexadecimal (hex) is used frequently when working with computers since it can be used to represent binary numbers in a more readable form. 1The computer performs computations in binary, but there are several instances when the binary output of a computer is expressed in hexadecimal to make it easier to read.

Converting a hexadecimal number to binary, and a binary number to hexadecimal, is a common task when dealing with the configuration register in Cisco routers. Cisco routers have a configuration register that is 16 bits long. The 16-bit binary number can be represented as a four-digit hexadecimal number. For example, 0010000100000010 in binary equals 2102 in hex. The word hexadecimal is often abbreviated 0x when used with a value as shown with the above number: 0x2102

Decimal	Binary	Hexadecimal
0	00000000	00
1	00000001	01
2	00000010	02
3	00000011	03
4	00000100	04
5	00000101	05
6	00000110	06
7	00000111	07
8	00001000	08
9	00001001	09
10	00001010	0A
11	00001011	0B
12	00001100	0C
13	00001101	0D
14	00001110	0E
15	00001111	0F
16	00010000	10
32	00100000	20
64	01000000	40
128	10000000	80
255	11111111	FF

Like the binary and decimal systems, the hexadecimal system is based on the use of symbols, powers, and positions. [2] The symbols that hex uses are 0 - 9, and A, B, C, D, E, and F. [3]

Notice that all possible combinations of four binary digits have only one hexadecimal symbol, where it takes two in decimal. The reason why hex is used is that two hexadecimal digits, as opposed to decimal that would require up to four digits, can efficiently represent any combination of eight binary digits. In allowing two decimal digits to represent four bits, using decimal could also cause confusion in reading a value. For example, the eight bit binary number 01110011 would be 115 if converted to decimal digits. Is that 11-5 or 1-15? If 11-5 is used, the binary number would be 1011 0101, which is not the number originally converted. Using hexadecimal, the conversion is 1F, which always converts back to 00011111.

Hexadecimal reduces an eight bit number to just two hex digits. This reduces the confusion of reading long strings of binary numbers and the amount of space it takes to write binary numbers. Remember that hexadecimal is sometimes abbreviated 0x so hex 5D might be written as "0x5D".

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

128	64	32	16	8	4	2	1

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

128	64	32	16	8	4	2	1

To convert from hex to binary, simply expand each hex digit into its four bit binary equivalent. 4 5

Converting Binary Number to Hexadecimal Number

10010010000101111101111101110011001001
Converts to:
0001 0010 0100 0101 1111 0111 1101 1100 1001
Converts to:
1 2 4 5 F 7 D C 9
So:
10010010000101111101111101110011001001 binary
= 1245F7DC9 hexadecimal

Converting Hexadecimal Number to Binary Number

0x2102
Converts to:

2	1	0	2
0010	0001	0000	0010

So:
2102 hexadecimal converts to: 0010 0001 0000 0010 binary

Lab Activity

Hexadecimal Conversions

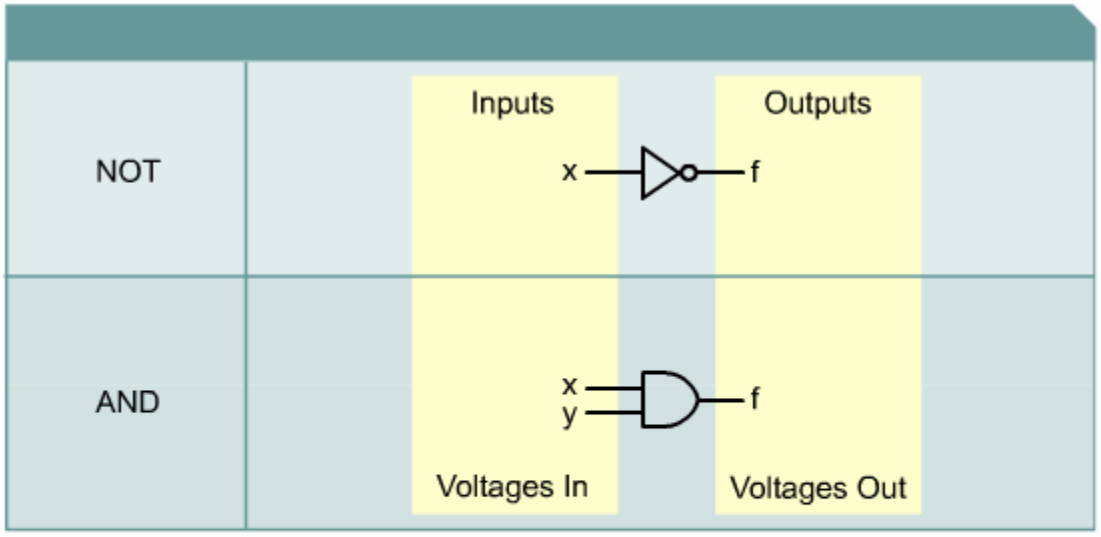
In this lab, the student will learn the process to convert hexadecimal values to decimal and binary values.

The Hexadecimal Number System

http://www.math.ohiou.edu/~just/hex.htm

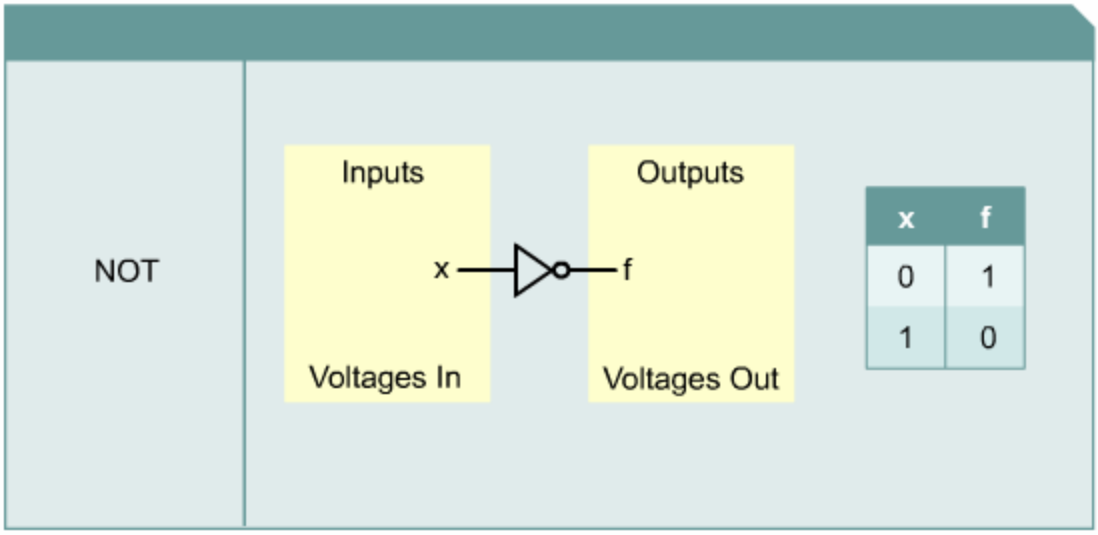
Boolean logic is based on digital circuitry that accepts one or two incoming voltages. 1 Based on the input voltages, output voltage is generated. For the purpose of computers the voltage difference is associated as two states, on or off. These two states are in turn associated as a 1 or a 0, which are the two digits in the binary numbering system.

Boolean logic is a binary logic that allows two numbers to be compared and a choice generated based on the two numbers. These choices are the logical AND, OR and NOT. With the exception of the NOT, Boolean operations have the same function. They accept two numbers, which are 1 or 0, and generate a result based on the logic rule.



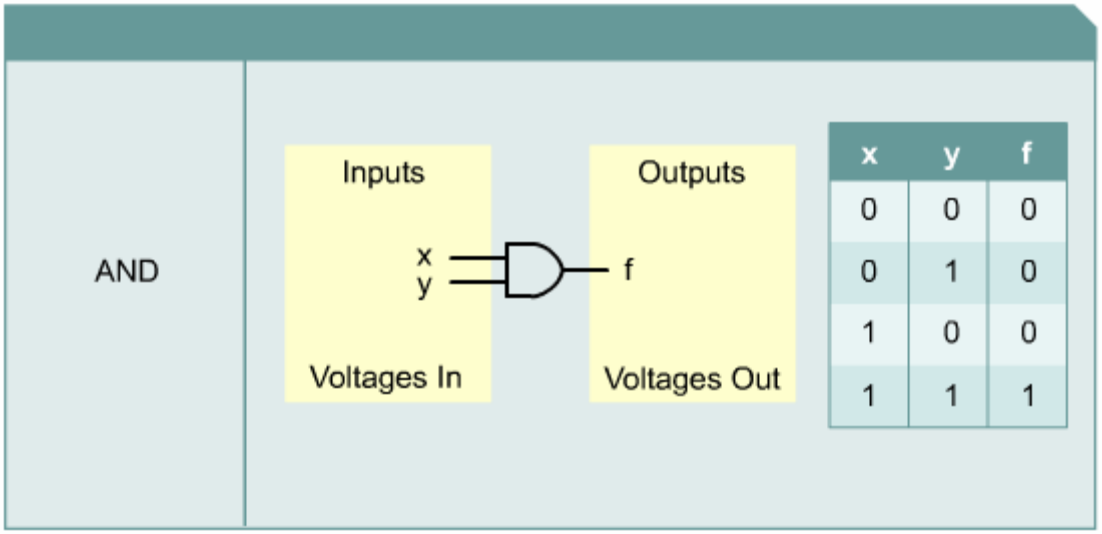
Logic gates accept one or two input values (voltages).

The NOT operation takes whatever value is presented, 0 or 1, and inverts it. A one becomes a zero and a zero becomes a one. Remember that the logic gates are electronic devices built specifically for this purpose. The logic rule that they follow is whatever the input is, the output is the opposite.



If x is 1 then f is 0 otherwise f is 1.

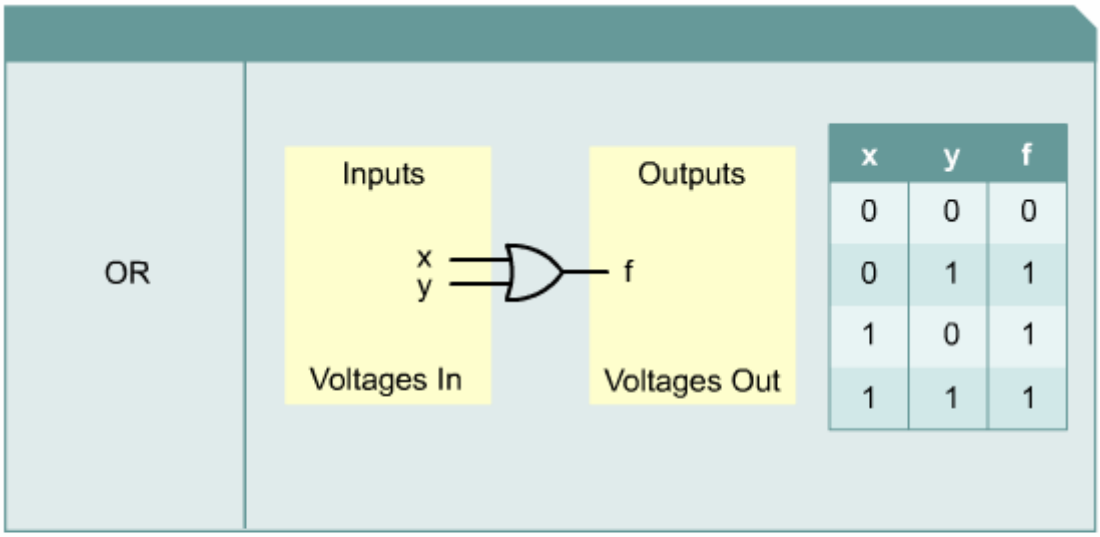
The AND operation takes two input values. If both are 1, the logic gate generates a 1 output. 3 Otherwise it outputs a 0. There are four combinations of input values. Three of these combinations generate a 0, and one combination generates a 1.



x	y	f
0	0	0
0	1	0
1	0	0
1	1	1

If x is 1 and y is 1 then f is 1 otherwise f is 0.

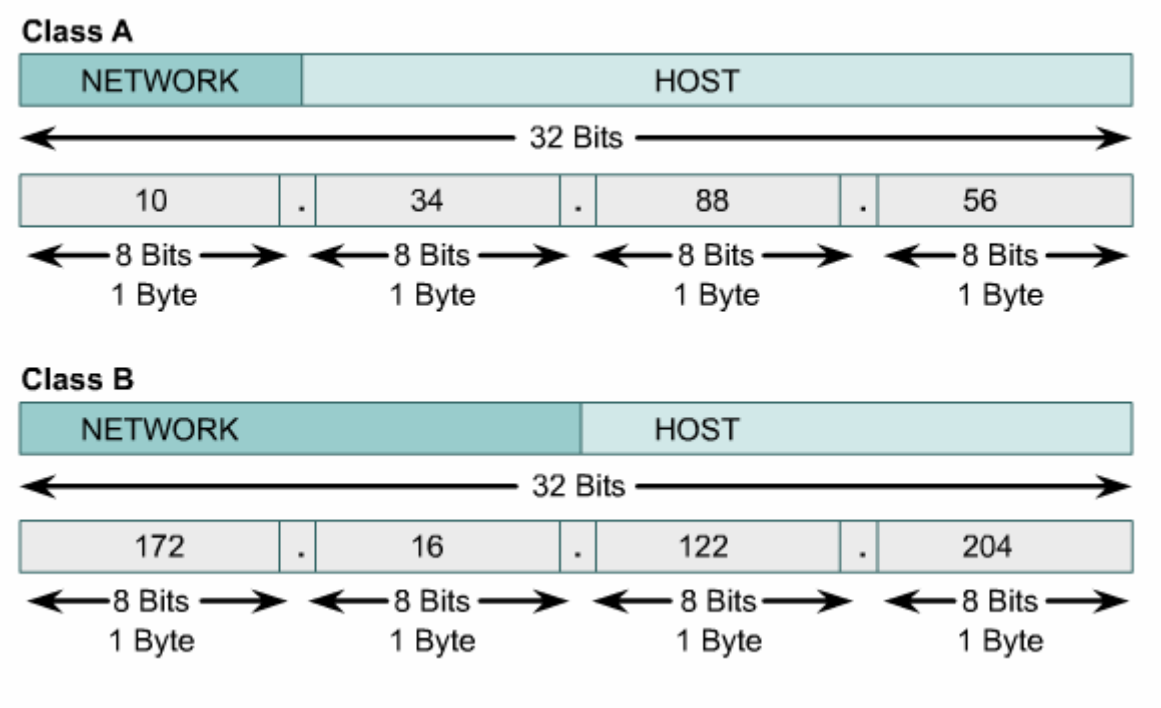
The OR operation also takes two input values. 4 If at least one of the input values is 1, the output value is 1. Again there are four combinations of input values. This time three combinations generate a 1 output and the fourth generates a 0 output.



The two networking operations that use Boolean logic are subnetwork and wildcard masking. The masking operations provide a way of filtering addresses. The addresses identify the devices on the network and allows the addresses to be grouped together or controlled by other network operations. These functions will be explained in depth later in the curriculum.

How Boolean Logic Works

http://www.howstuffworks.com/boolean.htm



The 32-bit binary addresses used on the Internet are referred to as Internet Protocol (IP) addresses. 1 The relationship between IP addresses and network masks will be addressed in this section.

When IP addresses are assigned to computers, some of the bits on the left side of the 32-bit IP number represent a network. The number of bits designated depends on the address class. The bits left over in the 32-bit IP address identify a particular computer on the network. A computer is referred to as the host. The IP address of a computer consists of a network and a host part that represents a particular computer on a particular network.

To inform a computer how the 32-bit IP address has been split, a second 32-bit number called a subnetwork mask is used. This mask is a guide that indicates how the IP address should be interpreted by identifying how many of the bits are used to identify the network of the computer. The subnetwork mask sequentially fills in the 1s from the left side of the mask. A subnet mask will always be all 1s until the network address is identified and then be all 0s from there to the right most bit of the mask. The bits in the subnet mask that are 0 identify the computer or host on that network. Some examples of subnet masks are:

11111111000000000000000000000000 written in dotted decimal as 255.0.0.0

or

11111111111111110000000000000000 written in dotted decimal as 255.255.0.0

In the first example, the first eight bits from the left represent the network portion of the address, and the last 24 bits represent the host portion of the address. In the second example the first 16 bits represent the network portion of the address, and the last 16 bits represent the host portion of the address.

Converting the IP address 10.34.23.134 to binary would result in:

00001010.00100010.00010111.10000110

Performing a Boolean AND of the IP address 10.34.23.134 and the subnet mask 255.0.0.0 produces the network address of this host:

00001010.00100010.00010111.10000110
11111111.00000000.00000000.00000000
00001010.00000000.00000000.00000000

Converting the result to dotted decimal, 10.0.0.0 is the network portion of the IP address, when using the 255.0.0.0 mask.

Performing a Boolean AND of the IP address 10.34.23.134 and the subnet mask 255.255.0.0 produces the network address of this host:

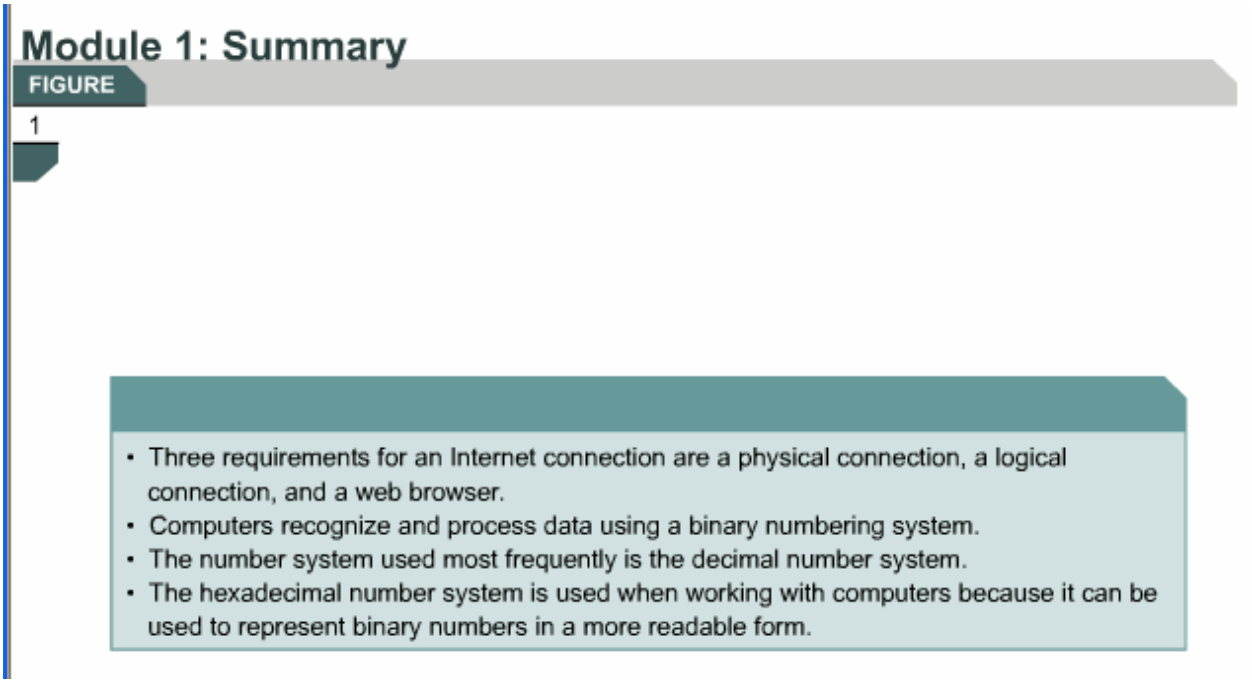
00001010.00100010.00010111.10000110
11111111.11111111.00000000.00000000
00001010.00100010.00000000.00000000

Converting the result to dotted decimal, 10.34.0.0 is the network portion of the IP address, when using the 255.255.0.0 mask.

This is a brief illustration of the effect that a network mask has on an IP address. The importance of masking will become much clearer as more work with IP addresses is done. For right now it is only important that the concept of the mask is understood.

IP Addressing Fundamentals

http://support.wrq.com/tutorials/ tutorial.html



An understanding of the following key points should have been achieved:

- The physical connection that has to take place for a computer to connect to the Internet
- The primary components of a computer
- Installation and troubleshooting network interface cards and/or modems
- Basic testing procedures to test the Internet connection
- Web browser selection and configuration
- The Base 2 number system
- Binary number conversion to decimal
- The hexadecimal number system
- Binary representation of IP addresses and network masks
- Decimal representation of IP addresses and network masks