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Computer Networking 1

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COMPUTER NETWORKING 1

STUDENT TEXT

BLOCK I

This student text provides information and review questions to assist you in achieving the objectives in the Computer Networking block of the Information Technology Fundamentals Course. The information provided pertains to course orientation, safety, risk management, first aid, personal and family countermeasures, legal/ethics, C4I security, cryptology, enterprise systems, digital numbering systems, and computer components.

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Supersedes ST E3ATR3D020 00AB -10 dated January 2011, which is obsolete.

OBJECTIVES

a. Identify basic facts about communications/information professionals.

INTRODUCTION

Networking, in all its aspects, is governed by a multitude of organizations at both the international and national level. In this section we will cover some of the organizations who contribute to the standards that allow a personal computer running a windows operating system, a mainframe computer, and an Apple computer to communicate with each other on the same network.

INFORMATION

Obj. 3a. IDENTIFY BASIC FACTS ABOUT COMMUNICATIONS/INFORMATION PROFESSIONALS.

Standards Organizations

International Organization for Standardization (ISO)

The International Organization for Standardization (ISO) is the world's largest developer of standards. ISO is not an acronym for the organization's full name in either official language. Rather, the organization adopted ISO based on the Greek word *isos*, meaning equal. The organization's founders chose ISO as the universal short form of its name. ISO is a network of the national standards institutes of 157 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system. ISO is a non-governmental organization: its members are not, as is the case in the United Nations system, delegations of national governments. Nevertheless, ISO occupies a special position between the public and private sectors. This is because, on the one hand, many of its member institutes are part of the governmental structure of their countries, or are mandated by their government. On the other hand, other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.

Although ISO's principal activity is the development of technical standards, ISO standards also have important economic and social repercussions. ISO standards make a positive difference, not just to engineers and manufacturers for whom they solve basic problems in production and distribution, but to society as a whole. ISO is able to act as a bridging organization in which a consensus can be reached on solutions that meet both the requirements of business and the broader needs of society, such as the needs of stakeholder groups like consumers and users.

ISO standards contribute to making the development, manufacturing, and supply of products and services more efficient, safer, and cleaner. They make trade between countries easier and fairer. They provide governments with a technical base for health, safety, and environmental legislation. They aid in transferring technology to developing countries. ISO standards also serve to safeguard consumers, and users in general, of products and services, as well as to make their lives simpler.

ISO defined the Open Systems Interconnection (OSI) model that all Internet systems are based on. The OSI model will be discussed in depth in a later topic.

Institute of Electrical and Electronics Engineers (IEEE)

The IEEE, a non-profit organization, is the world's leading professional association for the advancement of technology. Through its global membership, the IEEE is a leading authority on areas

ranging from aerospace systems, computers, and telecommunications to biomedical engineering, electric power, and consumer electronics.

Technology based industrial organizations rely on the IEEE as a source of technical and professional information, resources, and services. To foster an interest in the engineering profession, the IEEE also serves student members in colleges and universities around the world. Other important constituencies include prospective members and organizations that purchase IEEE products and participate in conferences or other IEEE programs.

IEEE has (as of 1 June 2013)

- More than 425,000 members, including more than 116,000 students, in over 160 countries.
- 333 sections in ten geographic regions worldwide.
- 2,195 chapters that unite local members with similar technical interests.
- 2,354 student branches at colleges and universities in 80 countries.
- 38 societies and 7 technical councils representing the wide range of technical interests.
- Publishes more than 148 transactions, journals, and magazines.
- More than 850 IEEE sponsored or cosponsored conferences worldwide each year.
- Nearly 1,400 standards and projects under development.

IEEE 802

IEEE 802, formed in February 1980, has the basic charter to develop and maintain networking standards and recommended practices. The development of the IEEE 802 standards added enhancements to the existing Open Systems Interconnection (OSI) model that all Internet systems are based on. IEEE 802 provided specifications on the type of network interface to use and the components used for internet connection. It also governs the layout of the connector pins, type of connector to be used and other components used to create the cables making up the network. Under the umbrella of the OSI Model, 802.x specifies what will be in each layer and how each layer will interact with the others to make the network function.

IEEE 802 Categories

The LAN standards defined by the 802 committees are classified into 22 categories. Figure 3-1 shows the more common 802 standards in use today.

Specification	Description
IEEE 802.3	Ethernet
IEEE 802.5	Token Ring Networks
IEEE 802.11	Wireless Local Area Networks
IEEE 802.15	Wireless Personal Area Networks
IEEE 802.15.1	Bluetooth Certification
IEEE 802.16	Broadband Wireless Access (WiMAX certification)
IEEE 802.16.m	3Gpp Long Term Evolution (LTE)

Figure 3-1. IEEE 802 Standards

Electronics Industries Alliance (EIA)/Telecommunications Industry Associations (TIA) Standards

The TIA is a trade association that represents worldwide Information and Communications Technology (ICT) industries. TIA writes and maintains voluntary industry standards for telecom products. EIA is a global engineering industry membership association that provides an information and assistance network. The engineering standards and documents offered by the EIA and TIA are coordinated with the American National Standards Institute (ANSI) patents. By following these standards, it allows a wide variety of manufacturer's products to work together.

The EIA/TIA is a national industry association that is best known for publishing electrical wiring and transmission standards. Two common EIA/TIA standards are the RS-232 cable and connector used between computers and external modems, and the EIA/TIA-568-B cabling used in most computer networks.

Internet Corporation for Assigned Names and Numbers (ICANN)

ICANN is a nonprofit organization that has the responsibility for IP address space allocation, protocol parameter assignment, domain name system management and root server system management functions. ICANN was formed in 1998. It is a not-for-profit partnership of people from all over the world dedicated to keeping the Internet secure, stable and interoperable. It promotes competition and develops policy on the Internet's unique identifiers.

To reach another person on the Internet you have to type an address into your computer - a name or a number. That address has to be unique so computers know where to find each other. ICANN coordinates these unique identifiers across the world. Without that coordination we would not have one global Internet.

ICANN does not control content on the Internet. It cannot stop spam and it does not deal with access to the Internet. But through its coordination role of the Internet's naming system, it does have an important impact on the expansion and evolution of the Internet.

The tasks of ICANN include managing the assignment of domain names and IP addresses. To date, much of its work has concerned the introduction of new generic top-level domains. The technical work of ICANN is referred to as the IANA function; the rest of ICANN is mostly concerned with defining policy.

Internet Assigned Numbers Authority (IANA)

IANA is one of the Internet's oldest institutions, with its activities dating back to the 1970s. Today it is operated by ICANN, an internationally-organized non-profit organization set up by the Internet community to help coordinate IANA's areas of responsibilities. ICANN has a structure of supporting organizations that contribute to deciding how ICANN runs, and in turn how IANA develops.

IANA is the body responsible for coordinating some of the key elements that keep the Internet running smoothly. Specifically, IANA allocates and maintains unique codes and numbering systems that are used in the technical standards ("protocols") that drive the Internet.

The network number identifies a specific network and must be assigned by IANA if the network is to be part of the Internet. Network numbers can be obtained from authorized representatives of IANA, referred to as Regional Internet Registries (RIR), or Internet or Online Service Providers (ISPs/OSPs), which have obtained blocks of numbers from one of the authorized representatives of IANA.

IANA's role is to allocate IP addresses from the pools of unallocated addresses to the Regional Internet Registries (RIR) according to their established needs. When an RIR requires more IP addresses for allocation or assignment within its region, IANA makes an additional allocation to the RIR.

Worldwide IP addresses are registered and assigned by one of five subordinate Regional Internet Registries (RIRs): See Figure 3-2.

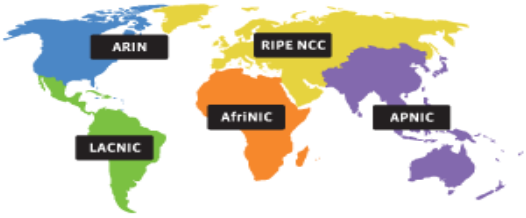

Figure 3-2. Regional Internet Registries

1. **APNIC** (Asia-Pacific Network Information Center),
2. **ARIN** (American Registry for Internet Numbers),
3. **RIPE NCC** (Reseau IP Europeans Network Coordination Center),
4. **LACNIC** (Latin American and Caribbean IP address Registry),
5. **AfriNIC** (African Network Information Center).

American Registry for Internet Numbers (ARIN)

Established in December 1997, the American Registry for Internet Numbers (ARIN) is a Regional Internet Registry (RIR) incorporated in the Commonwealth of Virginia, USA, and covers the geographic region of United States, Canada, and many Caribbean and North Atlantic Islands. ARIN is one of five (5) RIRs. Regional Internet Registries (RIRs) are nonprofit corporations established for the purpose of administration and registration of Internet Protocol (IP) address space and Autonomous System (AS) numbers.

Communication Competencies

The overall goal of communications is to provide the right information, in the right format, to the right person, at the right time. The core competencies of the Communications and Information AFSCs are:

- Establish the Cyberspace domain
- Control the domain
- Use the domain

In order to meet the competencies above, the Air Force is integrating all information systems into a global information system. In October 2009 the Air Force implemented a new AFSC structure. The enlisted force will provide the technical skill to establish, secure, control, and operate across a broad range of critical infrastructures, war fighting systems, and technologies. The following descriptions provide specialty summaries to help you understand the capabilities included in each skill.

3D0X1 - Knowledge Operations: They will possess application and presentation networking skills necessary for content management, retrieval, and presentation.

3D0X2 - Cyber Systems Operations: They will focus on servers, data storage, software applications, system technologies, protocols, standards and client interfaces.

3D0X3 - Cyber Surety: They use Information Technology resources to monitor and evaluate policy and procedures to protect clients, networks, data/voice systems and databases from unauthorized activity.

3D0X4 - Computer Programmer: They will develop and standardize tools and interfaces as well as possess the ability to transform raw data into actionable C2 information. They will also translate operational offensive and defensive requirements into program code to ensure freedom of maneuver in the cyberspace domain.

3D1X1 - Client Systems Specialist: They will integrate and sustain common client-level voice, data and video devices with a primary focus on end user devices.

3D1X2 - Cyber Transport Systems Specialist: They will focus on sustainment of the network and telecommunication infrastructure, distribution media, and cryptographic equipment, for example.

3D1X3 - RF Transmissions Systems Specialists: They understand space, radio and satellite systems technologies and configurations required to integrate and sustain airborne and terrestrial multi-mode, multi-band radio frequency systems to include wireless voice, data and video systems.

3D1X4 - Cyber Spectrum Specialists: They engineer, nominate and assign frequencies to support communications requirements and coordinate frequency needs with federal, military and civil authorities.

3D1X5 - Radar Systems Specialists: They understand radar technology to support airfield, weather and early warning radar system missions. They will perform search, intercept, ID and location of sources radiating electromagnetic energy for purposes of threat recognition.

3D1X6 - Airfield Systems Specialist: They will understand meteorological, navigational and air traffic control radio, console and recorder technologies and will meet all national airspace system certification requirements.

3D1X7 - Cable/Antenna Systems Specialist: They will link the base campus voice, data and video networks and focus primarily on external communications cables and radio frequency antenna systems.

3D1X8 - Control Systems Specialist: They monitor and control emergency and distribution management systems, and supervisory control and data acquisition systems.

3D1X9 - Mission Systems Specialist: They will perform cyberspace related duties on airborne platforms and will primarily operate, maintain, repair and test airborne communications, sensor, computer and electronic systems.

1B4X1 - On-Net Operations: These are network warfare operators who provide net attack, defense and exploit capabilities to disrupt, deny, degrade or destroy information or the delivery systems themselves. *(–can retrain into at the three-five year point.)*

1B4X2 - Electronic Warfare Operations: They will integrate and sustain operations across the electromagnetic spectrum and will perform search, intercept, ID and location of sources for threat recognition and implement electronic protect and attack measures. *(–can retrain into at the three-five year point.)*.

SUMMARY

Remember, that networking is governed by a multitude of organizations at both the international and national level, such as the International Organization for Standardization (ISO) and the Institute of Electrical and Electronic Engineers (IEEE). These organizations establish the standards that allow computer to communicate with each other on the network.

You are part of an expeditionary aerospace force (EAF) that is capable of rapidly deploying to any part of the world and tailor to the mission with the right combination of capabilities and people.

Read Unit 3 and answer the following questions on a separate sheet of paper. Do not write in this book.

Standard Organizations

1. Who is the largest developer of standards and define the Open Systems Interconnection (OSI) model that all internet systems are based on?

2. _____ is the world's leading professional association for the advancement of technology.

3. What standard provided specifications on the type of network interface to use and the components used for internet connection?

4. The Electronics Industries Alliance (EIA/TIA) standards are the _____ cable and connector used between computers and the _____ cabling used in most computer networks.

5. What is a nonprofit organization that has the responsibility for IP address space allocations?

6. Managing the assignment of domain names and IP addresses are the task of the _____ organization.

7. What organization allocates and maintains unique codes and numbering systems that are used in the technical standards that drive the Internet?

8. The role of the _____ is to allocate IP addresses from the pools of unallocated addresses to the Regional Internet Registries (RIR).

9. Which Regional Internet Registry covers the geographic region of the United States, Canada, and many Caribbean and North Atlantic Islands?

10. What are the four overall goals of communication?

11. What are the three core competencies of Communication Information career fields?

OBJECTIVE

a. Identify principles of digital numbering systems conversions.

b. Identify basic facts about binary coded decimal.

INTRODUCTION

Humans first began counting using sticks, stones, and fingers. The decimal number system used all over the world today probably evolved from finger counting. This system uses 10 different basic symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. Each symbol is called a digit. The symbols are referred to as Arabic numerals, because the Europeans adopted them from the Arabic form of writing.

We have become accustomed to the use of Arabic numerals in the decimal system of number notation. No doubt this system will continue to be popular for everyday use. Therefore, it is important that we review the basic concepts of numbering systems so we can understand the systems used in digital equipment.

The data processor and computer were developed to increase the speed and accuracy with which specific tasks can be done. They process data, allowing us to do other tasks. A computer is a machine that can automatically carry out routing tasks and perform specified alterations of data. Since it deals directly with numbers in various formats, we need to understand numbering systems.

Although any numbering system is possible, only a few have any practical use today. Other numbering systems in common use with computers are the binary with a base of 2, the octal with a base of 8, and the hexadecimal with a base of 16.

Most present day computers use the binary number system because it has only two different symbols. These symbols are 0 and 1; therefore, the digits of a binary number can represent a logic situation of yes or no. Since only two symbols are used, only two different signal conditions are needed to represent them. Fortunately, a large number of electronic components are two-state in nature (ON-OFF).

INFORMATION

Obj. 8a. IDENTIFY PRINCIPLES OF DIGITAL NUMBERING SYSTEMS CONVERSIONS.

Before we get started with number conversions, we will identify the features of any numbering system. Let's start with the different parts of a number.

The ***RADIX*** is written as a subscript to a number, for example $250_{(10)}$. In this case, the (10) identifies the number system and identifies the quantity of Arabic numerals or symbols used in the system. The radix is also referred to as the ***BASE*** of the number system.

Let us say we want to indicate any and all quantities, but we will use only the first two Arabic numerals: 0 and 1. Since the quantity of different digits used is 2, the radix or base subscript is (2) thus the **BINARY NUMBER SYSTEM** is indicated. In the binary system, only a 0 and a 1 can occur. A 1 or a 0 will occur in a place-position of the number. Examples: $11011_{(2)}$, $1010_{(2)}$, $1111_{(2)}$, $1001_{(2)}$, etc.

For another example, use the first ten Arabic symbols (0, 1, 2, 3, 4, 5, 6, 7, 8, 9) followed by six alpha characters (A, B, C, D, E, F) to write all numbers. Since sixteen different symbols are used, the radix or base is (16) and the **HEXADECIMAL NUMBER SYSTEM** is indicated. In the hexadecimal system, only 0 through F can occur in a place-position of the number. Examples: $5DC_{(16)}$, $7E8_{(16)}$.

In any numbering system, using the positional value notation, the digit that carries the least weight (value) is known as the ***LEAST SIGNIFICANT DIGIT (LSD)***. In whole numbers, this is the digit occupying the unit's column. In the decimal system, the LSD seldom occupies any position other than the one at the extreme right of the number. However, in other numbering systems it does not have to be this way. Because of the machine operations, the LSD can be on the extreme left of the number. This should not present any confusion, as long as it is stated that the LSD is on the left. In this course, the LSD can safely be assumed to be on the extreme right of the number, unless otherwise stated.

The ***MOST SIGNIFICANT DIGIT (MSD)*** is the digit that carries the most weight and, unless otherwise noted, is the digit to the extreme left of a number. For example, in the number 3,286, which uses the decimal positional notation, the 3 is the MSD because it represents three thousand. The 6 is the LSD because it represents only six.

Numbers of any numbering system may be expressed in the powers of the radix for that system; the same way that decimal numbers can be expressed in powers of 10.

Example:

$$1 \times 10^0 = 1_{(10)}$$
$$1 \times 10^1 = 10_{(10)}$$
$$1 \times 10^2 = 100_{(10)}$$
$$1 \times 10^3 = 1000_{(10)}$$
$$1 \times 10^4 = 10000_{(10)}$$

The place-value of a digit is determined by its position in the number. That is, the position of the digit, in respect to the point, determines the power of the digit. In the decimal numbering system, the place value multiplies by the base as you move left and divides by the base as you move right. The same basic principles hold true in all numbering systems.

Example:

Decimal	(Base 10)	10,000	1,000	100	10	1
Binary	(Base 2)	16	8	4	2	1
Hexadecimal	(Base 16)		4,096	256	16	1

Although zero has no numerical value, it serves the very important function as a ***PLACE HOLDER*** in modern mathematics. The idea of a place holder is familiar to us through its use in the decimal number system; for example, 505, 5005, 50005. The zero is used for place holding so that place positions, of all digits, of the number are positively located.

It was previously mentioned that a numbering system could be established by using any set of symbols that has a base and follows a logical progression. The numbering systems we will deal with uses the place value concept; a digit in each column is worth the base times the value of the column to the right. Since all of these systems start with the base to the zero power, the first column is the unit's position and each column to the left is a multiple of the base. Using this concept, we can now develop a Weighted Table to show the value of each position in the decimal system (see figure 8-1). Each power of the base has an equivalent value in the decimal system.

These relationships are essential to the study of digital circuits. They will also be used as we convert numbers from one system to another.

Binary Weighted Table

2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	Place Value in Binary
4096	2048	1024	512	256	128	64	32	16	8	4	2	1	Place Value in Decimal

Hexadecimal Weighted Table

16^{4}	16^{3}	16^{2}	16^{1}	16^{0}	Place Value In Hexadecimal
65,536	4096	256	16	1	Place Value In Decimal

Figure 8-1. Weighted Tables

Examples:

All systems, regardless of the base (radix) are basically the same. They have a radix, point, LSD, MSD, and place value.

There are different methods used to convert a decimal number to another system. We will use the weighted table method.

To convert a decimal number to its equivalent expression in another number system, using the weighted table method, you must know the decimal equivalent of the powers of that numbering system. The steps may seem complicated at first, but after you apply them a few times, they will become simple and automatic.

Converting Decimal to another Number System

Step 1. Construct a Weighted Table for the New Base.

Step 2. Determine the largest Place Value of the new base that can be divided into the decimal number.

Step 3. Divide the Place Value obtained from step 2 into the decimal number, record the quotient as the MSD of the converted number, and record the remainder as a whole number.

Step 4. Divide the remainder from step 3 by the quotient as the next digit of the converted number.

Continue dividing the remainders and recording the quotients until the quotient is equal to zero. Fill in the remaining table.

A final observation or help:

- If the base you are converting to is smaller than decimal (10), then the resulting number will appear larger, i.e., $564_{(10)} = 1000110100_{(2)}$.

- If the base you are converting to is larger than decimal, then resulting number will appear smaller, i.e., $564_{(10)} = 234_{(16)}$.

To convert any other base to decimal using the weighted table, use the following rules:

Converting another Number System to Decimal

Step 1 Construct a Weighted Table for the base of the number being converted.

Step 2 Place the digits of number being converted under the appropriate place value positions.

Step 3 Multiply each digit by its respective place value and record the results.

Step 4 Add the results of the multiplied digits to obtain the equivalent decimal number.

Binary

Converting Decimal to Binary

Example: Convert $150_{(10)}$ to its binary equivalent, using the Weighted Table Method.

Step 1.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Place Value in Binary
128	64	32	16	8	4	2	1	Place Value in Decimal

MSD 1 0 0 1 0 1 1 0 LSD Converted Binary Number

Step 2.

2^7 or $128_{(10)}$ is the largest place value that can be divided into $150_{(10)}$

Step 3.

$$\begin{array}{r} 1 \\ 128\overline{)150} \\ 128 \\ \hline 22 \end{array}$$

Step 4.

$$\begin{array}{r} 0 \\ 64\overline{)22} \\ 0 \\ \hline 22 \end{array} \quad \begin{array}{r} 0 \\ 32\overline{)22} \\ 0 \\ \hline 22 \end{array} \quad \begin{array}{r} 1 \\ 16\overline{)22} \\ 16 \\ \hline 6 \end{array} \quad \begin{array}{r} 0 \\ 8\overline{)6} \\ 0 \\ \hline 6 \end{array} \quad \begin{array}{r} 1 \\ 4\overline{)6} \\ 4 \\ \hline 2 \end{array} \quad \begin{array}{r} 1 \\ 2\overline{)2} \\ 2 \\ \hline 0 \end{array} \quad \begin{array}{r} 0 \\ 1\overline{)0} \\ 0 \\ \hline 0 \end{array}$$

Answer: $150_{(10)} = 10010110_{(2)}$

Converting Binary to Decimal

To convert from binary to decimal follow the rules:

Step 1 Construct a Weighted Table for the base 2 numbering system.

Step 2 Place the digits of number being converted under the appropriate place value positions.

Step 3 Multiply each digit by its respective place value and record the results.

Step 4 Add the results of the multiplied digits to obtain the equivalent decimal number.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Binary Place Value
128	**64**	**32**	**16**	**8**	**4**	**2**	**1**	Place Value in Decimal
		1	1	0	1	0	1	Binary number to be converted
X	X	X	X	X	X	X	X	
		32	+ 16		+ 4		+ 1	= 53 $_{(10)}$ Answer

Example: Convert $110101_{(2)}$ to decimal.
Answer: $110101_{(2)} = 53_{(10)}$.

Hexadecimal

The hexadecimal numbering system (Hex for short) has sixteen characters or numerals because its base or radix is 16. These are the characters:
0 1 2 3 4 5 6 7 8 9 A B C D E F (A = 10, B = 11, C = 12, D = 13, E = 14, F = 15)

Converting Decimal to Hexadecimal

Example: Convert $1500_{(10)}$ to hexadecimal using the weighted table method.

Step 1 Construct a hexadecimal weighted table.

Step 2 Determine the largest place value in decimal that can be divided into the decimal number.

Step 3 Divide the place value obtained from step 2 into the decimal number, record the quotient as the MSD of the converted number, and record the remainder as a whole number.

Step 4 Divide the remainder from step 3 by the next largest place value and record the quotient as the next digit of the converted number. Continue dividing the remainders and recording the quotients until the quotient is equal to zero. Fill in the remaining table. If needed, use zeros as place holders.

Step 5 - Convert any number larger than 9 to its alpha equivalent.

Step 1.

16^3	16^2	16^1	16^0	Place Value in Hexadecimal
4096	256	16	1	Place Value in Decimal

Step 2.

16^2 or 256 $_{(10)}$ is the largest place value that can be divided into 1500 $_{(10)}$

MSD 5 D C LSD Converted Hexadecimal Number

Step 3.

```
      5
256 )1500
     1280
      220
```

Step 4.

```
                13 = D          12 = C
16 )220         1 )12
    208             12
     12              0
```

Answer: $1500_{(10)} = 5DC_{(16)}$

Converting Hexadecimal to Decimal

Example: Convert $1AC_{(16)}$ to its decimal equivalent, using the weighted table method.

Step 1 Construct a hexadecimal weighted table.
Step 2 Place the digits of the number being converted under their appropriate place value positions.
Step 3 Multiply each digit by its respective place value and record the results.
Step 4 Add the results of step 3 to obtain the equivalent decimal number.

Step 1 Hex weighted table	16^2	16^1	16^0	Hexadecimal Place Value
	256	16	1	Decimal Place Value
Step 2 place six digits	1	A	C	Hexadecimal Number to be converted
Step 3 multiply	x1	x10	x12	NOTE: Alpha character changed to numeric
Step 4 add	256 +	160 +	12 =	$428_{(10)}$

Answer: $1AC_{(16)} = 428_{(10)}$

Converting between Binary and Hexadecimal Numbers

Inspection Method

The Inspection Method of converting binary and hexadecimal numbers is possible because of the unique relationship between the two systems.

Binary to Hexadecimal Conversion:

The binary and hexadecimal relationship can be stated as follows: every fourth place value in binary is equal to the next place value in hexadecimal starting with the zero power in both cases. This relationship is that four places in binary notation correspond to one place in hexadecimal notation. Each hexadecimal digit can be represented by four binary digits. Likewise, every combination of four binary digits has a corresponding hexadecimal digit. This comparison can be illustrated as follows:

The largest four digit binary number you can have in binary, $1111_{(2)}$, is equal to the largest single digit hexadecimal number, $F_{(16)}$. The second important relationship to remember is that there are four

binary positions to each hexadecimal position. Counting in Binary from 0 to 15 may help you see the relationship.

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

Remember: the Binary Weighted Table for the 4 binary bits equals 8421 respectively

The key to converting between binary and hex is to remember that, the binary to hexadecimal relationship is four binary places in binary notation corresponding to one place in hexadecimal notation.

Example: Convert $110101110_{(2)}$ to its hexadecimal equivalent.

Step 1 1 1010 $1110_{(2)}$

Step 2 1 A $E_{(16)}$

Answer $110101110_{(2)} = 1AE_{(16)}$

Example: Convert $7E8_{(16)}$ to its binary equivalent.

Step 1 7 E $8_{(16)}$

Step 2 (0)111 1110 $1000_{(2)}$

Answer $7E8_{(16)} = 11111101000_{(2)}$

Obj. 8b IDENTIFY BASIC FACTS ABOUT BINARY CODED DECIMAL.

Binary Coded Decimal (BCD)

Decimal to BCD

The chart below shows that BCD and BINARY are not the same. BCD looks like binary but it will never go above 1001 (Decimal 9) in a group of four binary digits. That is because BCD is still decimal; but it is decimal that is coded in binary, hence the name BCD (Binary Coded Decimal). That is $00100101_{(2)}$ is not equal to $00100101_{(BCD)}$. However, decimal can be changed directly to BCD, and BCD directly to decimal.

DECIMAL NUMBER	BINARY NUMBER	BINARY CODED DECIMAL

0	0000	0000
1	0001	0001
2	0010	0010
3	0011	0011
4	0100	0100
5	0101	0101
6	0110	0110
7	0111	0111
8	1000	1000
9	1001	1001
10	1010	00010000
15	1111	00010101
18	10010	00011000

To change a decimal to BCD, start at the LSD of the decimal number and work to the MSD. Write out the 8421 values for each decimal digit as an aid. Remember, you must assign four binary bits to each decimal digit.

Rules:

1. Write down the first four place values in the binary system for each decimal digit. Treat each decimal digit as a separate number.

2. Using the weighted table method to change a decimal digit to binary, convert each decimal digit separately to the 4-bit BCD number.

Example: Change $846_{(10)}$ to BCD.

Rule 1	8	4	6	Decimal number
	8421	8421	8421	Place values
Rule 2	1000	0100	0110	BCD number

Answer: $846_{(10)} = 100001000110_{(BCD)}$

From the example, you can see that changing a decimal number to BCD is very similar to converting Hexadecimal to binary.

BCD to Decimal

To change from BCD to decimal remember that BCD-to-decimal conversion is just the reverse of the previous process. Each group of 4 bits is weighted the same as the first four positions of the binary place values. It must be understood that we are not converting a binary number to decimal but BCD number to decimal. For example, $25_{(10)}$ is equal to $11001_{(2)}$, but in BCD it is $100101_{(BCD)}$. While the 8421 code is commonly used, it should be apparent that an infinite number of special codes are possible. In order to interpret these special codes, you must know the system being used.

Rules:

1. Beginning with the LSD separate the binary digits (bits) into groups of 4 bits. Add zeros as necessary to the MSD to make the group of 4 complete.

2. Assign the 8421 place values of the binary weighted table to each group of 4 bits. Convert each 4-digit group to a decimal number. The result is the decimal equivalent of the BCD number.

Example: Change $001000110110_{(BCD)}$ to decimal.

Rule 1. 0010 0011 $0110_{(BCD)}$ Separate the BCD number into groups of 4 bits

Rule 2. 8421 8421 8421 Place values Use the 8421 binary Place Values

2 3 $6_{(10)}$

Answer: $001000110110_{(BCD)} = 236_{(10)}$

Summary

Binary, hexadecimal, and BCD numbering systems are used extensively in today's digital systems. If the rules are followed, the conversions can be made fairly simply. To go from decimal to binary, or hexadecimal divide and subtract. To go from binary or hexadecimal to decimal multiply and add. When converting from decimal to BCD and BCD to decimal, use the 8421 process.

Read Unit 8 and answer the following questions on a separate sheet of paper. Do not write in this book.

Digital numbering systems

1. Base/Radix _____
2. MSD _____
3. LSD _____
4. Place holder _____

$1101_{(2)}$
↑ ↑↑↑
a b c d

Convert the following to Binary:

5. $839_{(10)}$
6. $782_{(10)}$
7. $912_{(10)}$
8. $324_{(10)}$

9. $672_{(10)}$

10. $745_{(10)}$

11. $764_{(10)}$

12. $365_{(10)}$

Convert the following to Decimal:

13. $101100110_{(2)}$

14. $101010101_{(2)}$

15. $110110101_{(2)}$

16. $100011101_{(2)}$

Convert the following to Hexadecimal:

17. $276_{(10)}$

18. $643_{(10)}$

19. $527_{(10)}$

20. $246_{(10)}$

21. $429_{(10)}$

22. $875_{(10)}$

23. $512_{(10)}$

24. $987_{(10)}$

Convert the following to Decimal:

25. $672_{(16)}$

26. $745_{(16)}$

27. $764_{(16)}$

28. $365_{(16)}$

29. $986_{(16)}$

30. $ACD_{(16)}$

31. $3E5_{(16)}$

32. $F10_{(16)}$

Convert the following to Hexadecimal:

33. $101100110101_{(2)}$

34. $110110011101_{(2)}$

35. $100100011010_{(2)}$

36. $110111011001_{(2)}$

Convert the following to Binary:

37. $986_{(16)}$

38. $ACD_{(16)}$

39. $3E5_{(16)}$

40. $F10_{(16)}$

BCD

41. BCD will never go above decimal number _____ in a group of four binary digits.

42. $00100101_{(2)}$ is equal to $00100101_{(BCD)}$. (True…….False)

43. To change decimal to BCD, start at the _____ of the decimal number and work to the _____.

44. When changing a BCD to decimal, begin with LSD and separate the binary digits (bits) into groups of _____ bits.

OBJECTIVES

a. Identify basic facts about computer components.

b. Identify principles of computer components.

INTRODUCTION

Components of a computer system are grouped into one of two categories: hardware or software. In objective a, we will refer to hardware devices that compose a computer system. The hardware devices includes all the mechanical, electrical, electronic and magnetic devices within the computer and all related peripheral devices such as printers, magnetic storage units and other peripheral devices.

We will begin our discussion on computers by concentrating on basic facts concerning computer components. In objective b, each component will be discussed in greater detail.

INFORMATION

Obj. 9a. IDENTIFY BASIC FACTS ABOUT COMPUTER COMPONENTS

Central Processing Unit (CPU).

The CPU is often referred to as the brains of the computer. Instructions and overall activity is carried out in the CPU**.** Refer to figure 9-1 during the discussion about computer components.

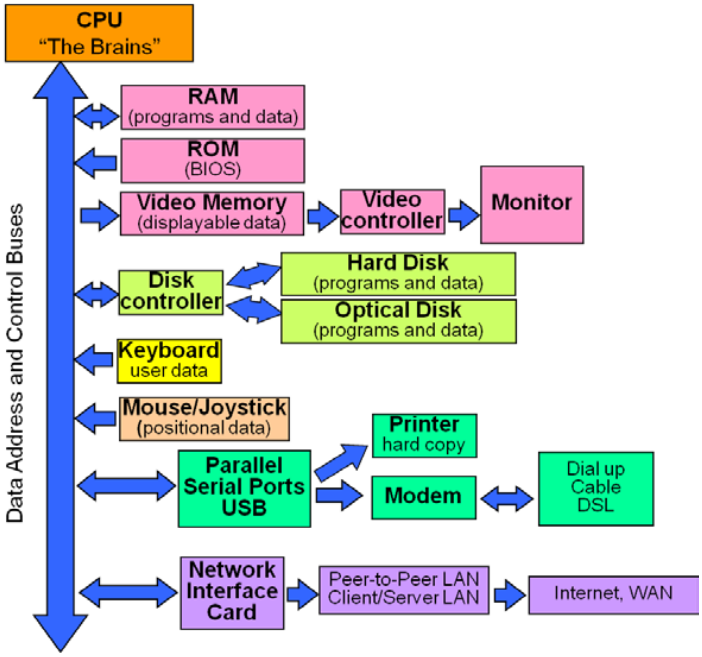

Figure 9-1. Computer components block diagram

Examples**:**

- Retrieve data from memory.
- Output data to memory or ports.
- Perform logic operations, math calculations, logical comparisons, and program control operations, i.e., jump to a new spot, skip next instruction, etc.

Computer Memory

Read Only Memory (ROM).
ROM stores default start up and basic operating information. It is also called permanent memory - information is retained when power is lost. In some cases, such as flash ROM, information can be updated using a special flash program.

Random Access Memory (RAM).
RAM is known as system memory and is the working storage area. It is used by the processor and other devices to temporarily store information. RAM stores programs and data as it is used. RAM is volatile memory, since any data it contains is lost when the power is removed. This category of memory includes Fast Page RAM, Synchronous Dynamic RAM (SDRAM), and Double Data Rate (DDR) RAM.

Input/output (I/O) devices

Keyboard. Enables the user to enter information to the computer.

Mouse/Joystick. Enables the user to enter positional information to the computer.

Monitors. Provide visual display of information for the user.

Video controller. Translates the data in video memory into symbols for the display monitor. It is the input device for the monitor.

Data bus. Data is what needs to be retrieved or stored. The data bus carries the information being transferred.

Address bus. Identifies where the data is located or where it is to be sent to.

Control bus. Controls the flow of data and what process is to be completed.

Disk Controller. The input/output interface between disk drives and the CPU.

Parallel and serial ports. These ports allow a computer to transmit data to and receive data from printers, modems, etc. NOTE: Many devices use USB (Universal Serial Bus) as a means of replacing many varieties of serial and parallel ports. USB has become a standard connection method for many different types of devices by using a standardized interface socket.

Network interface card (NIC). The network interface card allows the computer to be connected to a network.

Storage devices

Video memory. Holds the information presently displayed on the monitor.

Hard Disk drive. Contains rigid, magnetic-particle coated platters inside a protective case. On modern computers, these are normally non-removable and contain several platters. Common hard drives are capable of holding hundreds, even thousands of Gigabytes of data. The hard drive is the main storage center of the PC. Programs and data are stored on the hard disk drive. When needed, the CPU copies blocks of information from the hard drive into RAM.

Optical Media. Compact Disk (CD), Digital Video Disk (DVD), and BluRay Disk (BD) are used for permanent, removable storage of large amounts of data with the use of an optical drive.

Flash Media. A non-volatile computer storage chip that can be electrically erased and reprogrammed. Examples are memory cards, USB flash drives, solid-state drives, etc.

Peripherals

Printer. Produces a hardcopy (paper) version of text or illustrations.

Microphone. Sometimes referred to as a mic or mike, is an acoustic-to-electric transducer or sensor that converts sound into an electrical signal. Microphones are used in computers for recording voice, Voice over IP (VoIP), and for non-acoustic purposes such as ultrasonic checking.

Speaker. An electro-acoustical transducer that converts an electrical signal to sound.

Obj. 9b. IDENTIFY PRINCIPLES OF COMPUTER COMPONENTS

In our last objective we looked briefly at the components that make up a computer. In this objective, we will discuss some of the operating principles of the computer's components.

System Unit

The **system unit** is a box-like case that houses the electronic components of the computer used to process data. Sometimes called a **chassis**, the system unit is made of metal or plastic and protects the internal electronic components from damage. All computers have a system unit. Components inside the system unit include the system board, central processor unit, system clock, memory, buses, expansion cards, ports and power supply.

System Board

Most PCs have included the majority of their electronic components on a single board called the system board. This board is where the CPU, ROM chips, Ram modules, and all controller chips are located. It contains ports and expansion slots to allow enhancing system capabilities as well as connection to various devices. There have been numerous names for this board, including **system board**, **motherboard, logic board** or **mainboard**.

Central Processing Unit (CPU)

The CPU or microprocessor is the brain of a computer system. When a CPU is combined with input/output and memory units it forms a "microcomputer". The CPU consists of a controller, registers, and one or more arithmetic logic units (ALU).

The use of microprocessors is not limited to microcomputers. Microprocessors are currently being used to control I/O operations on large-scale computers, microwave ovens, televisions and automobiles. The word microprocessor and CPU are often used interchangeably.

The CPU tells the system components what to do and when to do it. It makes all the decisions for the rest of the system. It turns the system on and off at the proper time and in the proper order. This makes the entire system work in harmony. All CPU's contain internal components the most common are the control unit, arithmetic logic unit, memory and an input/output section.

Control Unit

To solve a problem or process data, a number of operations must be carried out in sequence. A series of instructions, called a program, is used to control these operations. The control unit decodes the instructions. Then the control unit produces a series of control signals. The control signals are used by the other units to complete the action called for by the instruction.

Arithmetic Logic Unit

The arithmetic logic unit (ALU) can only add and perform logic operations. By manipulation of the input data, the unit can simulate subtraction, multiplication, and division. When the proper program is followed, problems in geometry, trigonometry, algebra, calculus, and logic reasoning can be solved.

Basic input/output

These functions provide communication between CPU components and provide the initial communication between system memory and device controllers.

Registers

Registers are small, high-speed computer circuits (normally internal to the CPU function) that hold values of internal operations, such as the address of the instruction being executed and the data being processed. For example in the CPU's control unit, registers are temporary memory storage locations that the command processor interacts with directly. Some of its' registers hold address information, such as where in RAM the next command is to come from. Typical register names might be general purpose, instruction register, memory address register, status register, flag register. Pointers for queues, stacks, and buffers on some mini and mainframes also take the form of a special purpose registers.

System board busses

The CPU communicates with all other devices through well-defined signal paths called busses. There are three common buses on the system board: address bus, data bus, and control bus. The name of the bus is determined by the type of signal that it carries - address, data, or control.

Address Bus

An address is defined as a label, symbol, or other set of characters used to designate a location or register where information is stored. The conductors carrying the address signals are referred to as the address bus. The address bus is a unidirectional bus. Data (addresses) travel from the CPU to addressable memory locations in RAM.

Data Bus

The content of each storage register is referred to as "DATA." A binary bit is a single one or zero, stored in a flip-flop format. Eight separate conductors are required to transfer a byte of data at one time. These eight conductors are referred to as a "data bus". If there were eight flip-flops in each storage register, the register would store eight binary "BITS" (1 byte) of data. The data bus allows data to travel to/from the CPU. In order for the CPU to communicate with other devices of hardware, it must be able to read data from input devices and write data to output devices. Data is read to the CPU from ROM, RAM or any input device and written to RAM and any output device. In short, the data bus is a bi-directional device allowing the CPU to function as a transmitter and receiver of data.

Control Bus

The control bus manages several "control" signals, and these signals are used to control the timing and the direction of data flow (transfer) to and from the storage registers. Also, it sends commands to devices that are not under the direct command of the control unit such as input/output devices.

Computer memory

Computer memory provides a means of storing data and programs. This section examines two types of memory utilized in today's data systems. ROM (Read only memory) and RAM (Random Access Memory) are located on the motherboard or in a module that plugs into the motherboard.

ROM

Read only memory (ROM) is part of memory used to store programs permanently in a computer. ROM refers to memory chips storing data that only can be read. This memory is solid state and accessed randomly. ROM is non-volatile and retains its data when power is removed from the computer. ROM chips contain data, instructions or information that is recorded permanently. For example, ROM contains the **Basic Input/Output System** (BIOS), which is a sequence of instructions the computer follows to load the operating system and other files when you first turn the computer on. Many other devices also contain ROM chips.

RAM

Random access memory (RAM) is solid state memory located in the computer. RAM is where input programs, either from the hard drive or other storage device, are temporarily stored. This allows computer to operate faster because RAM is accessed faster than the hard drive or optical drive. Ram is volatile memory. All data stored is lost when power is removed. RAM chips often are smaller in size than processor chips. RAM chips usually reside on a small circuit board, called a memory module, which inserts into the motherboard.

Input/output (I/O) Devices

Input Devices

An **input device** allows a user to enter data and commands into the memory of a computer. Input devices include items such as keyboards, pointing devices and optical scanners. Although scanners are input devices they will be discussed under peripherals.

Keyboard.

Many people use a keyboard as one of their input devices. A keyboard is an input device that contains keys you press to enter data and commands into the computer. Desktop computer keyboards usually have from 101 to 105 keys. The keyboard is a series of single-pole single-throw switches mounted on a circuit board. The switches are arranged mechanically so that when a key is pressed, the switch contacts will close. The switch closure is encoded as an American Standardized Code for Information Interchange (ASCII) or extended ASCII character.

Mouse.

A mouse is a pointing device that fits comfortably under the palm of your hand. The mouse is the most widely used pointing device for desktop computers. Moving the mouse moves the cursor in the same direction on the monitor. Although there are many types of computer mice, the optical mouse is the most common type of mouse used today. The optical mouse uses either a Light Emitting Diode (LED) or an infrared laser diode or laser for short, to track movement. Although each type can be used on most non-porous surfaces, they provide more accuracy with the use of a mouse pad.

Output Devices

An output device is used to convey the information generated by a computer to a user. Commonly used output devices include monitors and printers. We will discuss printers later when we discuss peripheral devices.

Monitors.

The monitor is the most common output device. To display an image on a monitor, the computer sends a signal through the video card in the system unit. A video card converts digital output from the computer into an analog video signal and sends the signal through a cable to the monitor. There are basically two types of monitors available; Liquid Crystal Display (LCD) and Light Emitting Diode (LED). The LCD and LED monitor function is basically the same except for the light source. Also, know as a flat panel monitor LCD monitors were primarily used in portable devices such as laptop computers. However, their compact form, low power consumption and high resolutions made them desirable over the bulky, heavy, power hungry Cathode Ray Tube (CRT) monitor for desktop computers. LCD/LED displays utilize two sheets of polarized material with a liquid crystal solution between them. An electric current is passed through the liquid causing the crystals to align so that light from the Cold Cathode Fluorescent Lamp (CCFL) or Light Emitting Diode (LED) cannot pass through them. Each crystal, therefore acts like a shutter, either allowing light to pass through or blocking it.

Network interface card.

The network interface card (NIC) is an input/output device installed in the computer. All computers must have a NIC in order to be connected to a network. Every NIC has a Media Access Control (MAC) address; it is the computers unique hardware address on the network. The NIC receives and converts incoming electrical signals (serial) into digital signals (parallel) for delivery to the machine, and converts digital information (parallel) into electrical signals (serial) for outgoing network communications.

Storage devices

Storage devices are used in computer systems to store the data or programs permanently on some type of medium. Four types of storage devices will be discussed: flash media, hard drives, Optical media and magnetic tapes.

Flash Media

Flash media is a non-volatile computer storage chip that can be electrically erased and reprogrammed. It was developed from EEPROM (electrically erasable programmable read-only memory). There are two types, the NAND and NOR (Not And & Not Or logic gates). The NAND type is primarily used in memory cards, USB flash drives, solid-state drives, and similar products, for general storage and transfer of data. The NOR type allows a single machine word (byte) to be written and/or read independently. The NOR type allows true random access and direct code execution. It is used as a replacement for the older EPROM and as an alternative to certain kinds of ROM applications.

Hard Drives

The hard disk drive (HDD), Figure 9-2, evolved to answer the incessant demands for permanent high-volume file and data storage in the PC. The hard drive holds the operating system, which boots the system, stores the multi-megabyte applications and files that we rely on, and even provides "virtual memory" for systems that are lean on RAM.

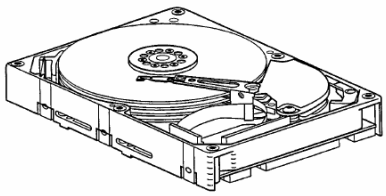

Figure 9-2. Hard Disk Drive

A hard-disk drive is a magnetic recording media applied to a substrate material, rotated at a high rate of speed. Hard drives figure 9-3 use rugged, solid substrates, called *platters*. The data is stored in locations formed by concentric rings called tracks. The tracks are separated at various points called sectors. The sector represents the basic storage unit of the hard drive. Magnetic read/write heads in close proximity to the media can step rapidly across the spinning media to the track where the data is located. Once over the track the read/write heads float over the track until the selected sector passes. This as in the floppy is random/sequential positioning. The read/write heads detect or create flux transitions, as required to read data from or write data to the disk.

The disk controller controls the transfer of data, instructions and information from a disk to the rest of the computer. Some users refer to the disk controller as an interface.

Read/write heads in a hard-disk drive must travel extremely close to the surface of each platter, but can never actually contact the media while the drive is running. Instead, R/W heads are made to float within micro inches of a platter surface by suspending the heads on a layer of moving air. Disk (platter) rotation creates a slight cushion that elevates the heads.

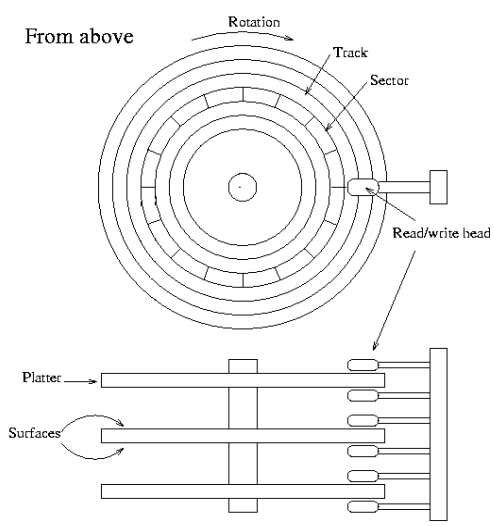

Figure 9-3. Hard disk tracks and sectors

Optical Media

Compact Disk (CD), Digital Video Disk (DVD), and BluRay Disk (BD) are used for permanent, removable storage of large amounts of data. Optical media is a disk that resembles the disk used by an audio compact disk player. Due to its increased data storage capability, the optical disk has replaced the floppy disk in most computer systems. The optical drive records data on the optical disk by etching pits into its surface. There are two areas on a disk the pit and the no pit areas (lands). A low power laser is used to read the data by directing the laser to the selected sector where the data is stored. The pit causes the light to diffuse (appear absent) while the no pit area causes maximum reflection of light. These reflections or no-reflections conditions are received by the receiving device (light detector) and converted into 1s and 0s.

Magnetic Tape

A magnetic tape unit performs the operation of reading and writing on magnetic tape. The tape is a storage device, storing the data until it is ready to be entered into the system. Output data from the computer can be stored on tape for later use by the system. Information stored on tape can be read repeatedly without destroying the data. If new information is written over old information, the old information is destroyed. If the magnetic tape is subjected to stray magnetic fields, the data may be destroyed. Temperature and humidity may also affect the magnetic tape. Storage areas are usually temperature and humidity controlled to prevent problems.

All tape systems have a major disadvantage. The data is stored in sequential format. When a large tape is being used it may take considerable time to locate the desired data. For example, if a tape is at the beginning of the reel (rewound), and the desired data is at the end of the reel, the entire tape must pass under the read head before the desired data can be read. This is known as sequential access and can cause a large increase in processing time.

Peripherals

Peripherals are devices that work with a computer system yet are not needed to operate a computer. Although they are not needed and can be thought as add-ons they can make a big difference in the computers overall capabilities. We will look at the printer, scanner and the facsimile as peripheral devices.

Printers.

A printer is an output device that produces text and graphics on a physical medium such as paper. Printed information is called hard copy because the information exists physically and is a more permanent form of output than that presented on a display device (soft copy) such as a monitor. Generally, printers are either impact or non-impact.

Impact Printers. An impact printer forms characters and graphics on a piece of paper by striking a mechanism against an ink ribbon that physically contacts the paper. A dot matrix printer is an impact printer that produces printed images when tiny wire pins on a print head mechanism strike an inked ribbon. When the ribbon presses against the paper, it creates dots that form characters and graphics.

Non-Impact Printers. A non-impact printer forms characters and graphics on a piece of paper without actually striking the paper. Some spray ink, while others use heat and pressure to create images. Because these printers do not strike the paper, they are much quieter than impact printers.

Inkjet Printers. An inkjet printer is a type of non-impact printer that forms characters and graphics by spraying tiny drops of ink onto a piece of paper. Inkjet printers can produce letter quality text and graphics in both black and white and color print on a variety of paper types.

Laser Printers. A laser printer is a high-speed, high-quality non-impact printer. Laser printers can print text and graphics in very high quality resolutions. Laser printers cost more than inkjet printers but are much faster.

Operating in a manner similar to a copy machine, a laser printer creates images using a laser beam and powdered ink, called toner, which is packaged in a cartridge. The laser beam produces an image on a special drum inside the printer. Toner sticks to the drum by means of static and is transposed to paper when the paper passes under the drum.

Optical Scanner.

An optical scanner, usually called just a scanner, is a light-sensing input device that reads printed text and graphics and then translates the results into a form the computer can use.

A scanner is similar to a copy machine except it creates a file of the document instead of a paper copy. The file can be stored on a disk, displayed on the screen, printed, faxed, sent via e-mail or included in another document.

Summary

In this objective we discussed the components of a computer system to include all the mechanical, electrical, electronic and magnetic devices. We also discussed the principles of computer components and their function as it relates to the overall operation of the computer.

Read Unit 9 and answer the following questions on a separate sheet of paper. Do not write in this book.

1. What produces a hardcopy version of text or illustrations?

2. What carries the information being transferred?

3. Which bus identifies where the data is located or where it is to be sent to?

4. What does the Control Bus control?

5. What allows the computer to be connected to a network?

6. What device tells the system components what to do and when to do it?

7. Where is the arithmetic logic unit located?

8. What component of the CPU decodes instructions?

9. What component of the CPU performs math and logic functions?

10. What component of the CPU stores data and instructions?

11. What bus allows addressing of memory locations?

12. Which bus allows the CPU to function as a transmitter/receiver of data?

13. What motherboard component stores the BIOS?

14. Which motherboard component stores programs temporarily and allows the computer to operate faster?

15. Which input device works on the principle that a closed switch is detected and code is generated?

16. Which input device uses infrared light to detect horizontal and vertical movements?

17. What are concentric rings located on the platter of a hard drive called?

18. What is the name of the basic storage unit of a hard drive?

19. Hard drive read/write heads touch the platter. True or False

20. A low power _____ is used to read data from a CD ROM.

21. Printers fall into two categories impact or _____.

22. What type of printer uses tiny print wires to push an inked ribbon into paper?

23. What type of printer uses tiny drops of ink to form characters on the paper?

24. What type of printer uses toner attracted to a drum to print characters on paper?

25. What peripheral device uses a light sensing device to read printed text and graphics?

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Glossary of Terms

5-M model: Provides a basic frame work for analyzing systems and determining the relationship between composite elements that work together to perform the mission

A
Address Bus: Identifies where the data is located or where it is to be sent to.
AED: Automated External Defibrillator.
AFI: Air Force Instruction
AFOSH: Air Force Occupational Safety and Health Standards.
Algorithm: A detailed set of instructions used to encrypt and decrypt information.
ALU: Arithmetic Logic Unit.
Arithmetic Logic Unit: Part of the CPU that can add and perform logic operations
AS: Autonomous System.

B
Basic Input/Output System: Sequence of instructions the computer follows to load the operating system when you first turn the computer on.
BCD: Binary Coded Decimal.
BD: BluRay Disk.
Binary Number System: A numbering system utilizing only two symbols, 0 and 1
BIOS: Basic Input/Output System.
BLACK: Normal unsecured circuits and equipment, ciphertext.
Busses: A well defined signal path for digital signals to follow.

C
Cautions: A statement used for protection of equipment and property.
CCFL: Cold Cathode Fluorescent Lamp
CDROM: Compact Disk Read Only Memory CD ROMs are used for permanent, removable storage of large amounts of data.
C-E: Communications–Electronics.
Ciphertext: Encrypting plaintext results in unreadable gibberish.
Classified Information: Information that has been determined to require protection against unauthorized disclosure in the interest of national defense.
Codes: Based on language entities of variable length such as symbols, words, or phrases.
Communications Security: A security program that supports Information Assurance. It protects information by using the proper application of crypto security, physical security, and transmission security measures.
COMPUSEC: Computer Security.
COMSEC: Communications Security.
Confidential: Disclosure of this information could cause some damage to our national security.
Control Bus: Controls the flow of data and what process is to be completed.
CPR: Cardiopulmonary Resuscitation.
CPU: Central Processing Unit.
CRT: Cathode Ray Tube.
Cyberspace: A domain characterized by the use of electronics and the electromagnetic spectrum to store, modify and exchange data via networked systems and associated physical infrastructures.
Crypto Analysis: the science of trying to break a coding system so that the information can be revealed to an unauthorized user.

Cryptography (Crypto): The process of concealing the meaning of a message rather than its existence. The use of coding systems to encrypt and decrypt information.
Cryptology: The study of information secrecy.
CRYPTOSEC: Cryptographic Security.
Cryptographic Security: The protection that results from the proper use of cryptographic systems.
Cyber Ethics: A code of behavior for using the Internet.

D
Data Bus: The data bus carries the information being transferred.
Decryption: The restoration of encrypted data to its original plain text.
DEFCON: Defense Condition.
Defense Information System Network: The backbone for the DoD worldwide communications network.
Defense Red Switch Network: Provides voice communications up to Top Secret.
Defense Switched Network: Provides non-secure dial-up voice service.
DES: Data Encryption Standard.
DHHS: U.S. Department of Health and Human Services.
DHS: Department of Homeland Security.
DISA: Defense Information Systems Agency.
Disk Controller: The input/output interface between disk drives and the CPU.
DISN: Defense Information System Network.
DISN-LES: DISN Leading Edge Services.
DRSN: Defense Red Switch Network.
DSN: Defense Switched Network.
DoD: Department of Defense.
DVD: Digital Video Disk.

E
EIA: Electronics Industries Alliance.
Einstein: An intrusion detection system that monitors the network gateways of government departments and agencies in the United States for unauthorized traffic.
Electronics Industries Alliance: National industry association that is best known for publishing electrical wiring and transmission standards.
Emanations: Give off some type of electromagnetic signals.
Emission Security: Results from all measures taken to deny unauthorized persons information of value, which might be derived from interception and analysis of unintentionally emitted electrical signals.
EMSEC: Emission Security.
Encryption: The conversion of data into a form that cannot be easily understood by unauthorized people.
Enterprise System: A communications backbone that connects every computer (and associated devices) at every location in an organization.
ESIM: Emission Security Information Messages.
Ethics: Standards by which one should act based on values.

F
Facsimile: Used to transfer copies of documents.
Fax: Short for facsimile.
FISMA: Federal Information Security Management Act of 2002.

Flash Media: A non-volatile computer storage chip that can be electrically erased and reprogrammed.
FOIA: Freedom of Information Act.
For Official Use Only: A designation applied to unclassified information that is exempt from mandatory release to the public under the Freedom of Information Act.
FOUO: For Official Use Only.
FW&A: Fraud, Waste and Abuse.

G
GIG: Global Information Grid.
GSA: General Services Administration.

H
Hard Disk Drive: Hard Disk drives use, rigid, magnetic-particle coated platters contained inside a protective case. On modern computers, these are normally non-removable and contain several platters. Common hard drives are capable of holding hundreds of Gigabytes of data. The hard drive is the main storage center of the PC. Programs and data are stored on the hard disk drive. When needed, the CPU copies blocks of information from the hard drive into RAM.
HDD: Hard disk drive.
Hexadecimal Number System: A numbering system that uses sixteen symbols.
High Voltage Circuits: 600 volts or above.
HIPAA: Health Insurance Portability and Accountability Act of 1996.

I
I/O: Input/Output.
IA: Information Assurance.
IANA: Internet Assigned Numbers Authority.
ICANN: Internet Corporation for Assigned Names and Numbers. A nonprofit organization that has the responsibility for IP address space allocation.
IDS: Intrusion Detection System.
IEEE: Institute of Electrical and Electronics Engineers is the world's leading professional association for the advancement of technology.
IEEE 802: Develop and maintain networking standards and recommended practices.
IIW: Information-in-Warfare.
Infiltration: To penetrate with hostile intent.
INFOCON: INFORMATION CONDITIONS.
Information Assurance: Measures that protect and defend information and information systems by ensuring their availability, integrity, confidentiality, authentication, and non-repudiation.
Intrusion Detection System: Monitors network traffic and monitors for suspicious activity and alerts the system or network administrator.
Integral: The whole part of a number.
IO: Information Operations.
IP: Internet Protocol.
ISO: International Organization for Standardization the world's largest developer of standards.
ISR: Intelligence, surveillance, and reconnaissance.
IW: Information Warfare.

K
Keyboard: A keyboard enables the user to enter information to the computer.

L
LCD: Liquid Crystal Display.
LED: Light Emitting Diode.
LSD: Least Significant Digit.

M
MAC: Media Access Control.
MAC Address: Contained on the NIC, an unique hardware address.
Memory Card: Small flash memory used in small electronic devices.
Microcomputer: When a CPU is combined with input/output and memory units it forms a "microcomputer.
Microphone: A microphone, sometimes referred to as a mic or mike, is an acoustic-to-electric transducer or sensor that converts sound into an electrical signal.
Monitor: Provides visual display of information for the user.
Mouse/Joystick: Enables the user to enter positional information to the computer.
MSD: Most Significant Digit.

N
Network Interface Card (NIC): Allows the computer to be connected to a network.
NIPRNet: Unclassified but Sensitive Internet Protocol Network.

O
Official Information: Communicated or documented knowledge that is owned, produced or controlled by the DOD.
Official System of Records: A file system that is authorized by law or Executive Order and controlled by an Air Force or lower level directive that is needed to carry out an Air Force mission or function.
OI: Operating Instruction.
Optical Media: Compact Disk (CD), Digital Video Disk (DVD), and BluRay Disk (BD)
OSI: Open Systems Interconnection.

P
Parallel and serial ports: The parallel and serial ports allow computer to transmit data to and receive data from printers, modems, etc.
Pathogens: Biological agents that cause disease or illness.
PDS: Protected Distribution System.
Peripherals: Devices that work with a computer system and are not needed to operate a computer.
PHI: Personal health care information.
Physical Security: The part of security concerned with active and passive measures designed to prevent unauthorized access to any Air Force resource.
Plaintext: Data that can be read and understood without any special measures is called plaintext.
PPE: Personal Protective Equipment.
Printer: A printer or print device produces a hardcopy (paper) version of text or illustrations.
Protected Distribution System: A wire line or fiber-optics telecommunication system that includes terminals and adequate acoustical, electrical, electromagnetic, and physical safeguards to permit its use for the unencrypted transmission of classified information.

R

RAM: Random Access Memory.
RED: Classified or sensitive information, plaintext.
RIR: Regional Internet Registries.
RM: Risk Management
ROE: Rules of Engagement.
ROM: Read Only Memory.
Rules of Engagement: Determine when, where, and how, force shall be used.

S

Secret Information: Information that could cause serious damage to national security
Secret Internet Protocol Router Network: A computer network that provides classified data transfer between DoD components up to information classified as secret.
Sector: The basic storage unit of the hard drive.
Sensitive Unclassified: Information that the loss, misuse, or unauthorized access to or modification of, could adversely affect the national interest or the conduct of federal programs, or the privacy to which individuals are guaranteed.
Signal Infiltration: Incorporated within the software or hardware itself (for instance, passwords, coded signals, firewalls, terminal identification, isolation, and system monitors).
SIPRNet: Secret Internet Protocol Router Network.
Solid State Disk Drive: A data storage device that uses solid-state memory (flash memory) to store data in the same manner as a traditional hard disk drive.
Speaker: A speaker or speaker system is an electro-acoustical transducer that converts an electrical signal to sound.
Standard Tactical Entry Point: Router networks connected at various entry points around the world.
STEP: Standard Tactical Entry Point.
System Board: Most PCs have included the majority of their electronic components on a single board called the system board. This board is where the CPU, ROM chips, Ram modules, and all controller chips are located. It contains ports and expansion slots to allow enhancing system capabilities as well as connection to various devices. There have been numerous names for this board, including system board, motherboard, logic board or mainboard.

T

TEMPEST: A special program designed to identify problems with Emission Security by studying incidents of unintentionally emitted signals and searching for ways to correct this significant problem.
THREATCON: Threat Conditions.
Top Secret information: Information that could cause exceptionally grave damage to national security.
TRANSEC: Transmission Security.
Transmission Security: All measures designed to protect intentional transmissions from interception and exploitation by means other than crypto analysis.
Traumatic shock: A depressed condition of many of the body functions due to failure of enough blood to circulate through the body following serious injury.

U

UCMJ : Uniform Code of Military Justice.
UMD: Unit Manning Document.

Unclassified but Sensitive Internet Protocol Network: Formerly known as the Non-secure Internet Protocol Router Network, provides unclassified data transfer between DoD components, as well as providing controlled Internet access.
Unclassified Information: Official information that may not necessarily have specific security safeguards, but still requires protection.
United States Code: The official, subject matter order, compilation of the Federal laws of a general and permanent nature that are currently in force.
USB: Universal Serial Bus.
US-CERT: United States Computer Emergency Readiness Team.

V
Values: Core beliefs such as duty, honor, and integrity that motivate attitudes and actions.
Video controller: Video Controller translates the data in video memory into symbols for the display monitor. It is the input device for the monitor
Video memory: Video Memory holds the information presently displayed on the monitor.
VOIP: Voice over IP.

W
Warnings: Statements used for protection of personnel.

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R

S

T