Ministry of Higher Education and Scientific Research
Mustansiriyah University
College of Engineering
Elec. Eng. Department

Microprocessor Lectures
Third Year Class

Iraq-Baghdad

2025-2026

1.1 Introduction to Computer & Microprocessor:

What is a Computer? A computer is an electronic machine that accepts information, stores it until the information is needed, processes the information according to the instructions provided by the user, and finally returns the results to the user. The computer can store and manipulate large quantities of data at very high speed, but a computer cannot think. A computer makes decisions based on simple comparisons such as one number being larger than another. Although the computer can help solve a tremendous variety of problems, it is simply a machine. It cannot solve problems on its own.

Microcomputer-small computers: Microcomputers, also called personal computers (PC), can fit next to a desk or on a desktop, or can be carried around. They are either standalone machines or are connected to a computer network, such as a local area network. A local area network (LAN) connects, usually by special cable, a group of desktop PCs and other devices, such as printers, in an office or a building. Microcomputers are of several types:

1. ***Desktop PCs:*** are those in which the case or main housing sits on a desk, with keyboard in front and monitor (screen) often on top.
2. ***Tower PCs:*** are those Microcomputer in which the case sits as a "tower," often on the floor beside a desk, thus freeing up desk surface space.
3. ***Laptop computers (notebook computers):*** are lightweight portable computers with built-in monitor, keyboard, hard-disk drive, battery, and AC adapter that can be plugged into an electrical outlet; they weigh anywhere from 1.8 to 9 pounds.
4. ***Personal digital assistants (PDAs)*** (handheld computers or palmtops) combine personal organization tools-schedule planners, address books, to-do lists. Some are able to send e-mail and faxes. Some PDAs have touch-sensitive screens. Some also connect to desktop computers for sending or receiving information.
5. ***Microcontrollers-tiny computers:*** Microcontrollers, also called embedded computers, are the tiny, specialized microprocessors installed in "smart" appliances and automobiles. These microcontrollers enable PDAs microwave ovens, for example, to store data about how long to cook your potatoes and at what temperature.

1.2 The Microprocessor-Based Personal Computer System:

Computer systems have undergone many changes recently. Machines that once filled large areas have been reduced to small desktop computer systems because of the microprocessor. Even though these desktop computers are compact, they process computing power that was only dreamed of a few years ago. Companies such as DEC (Digital Equipment Corporation, now owned by Hewlett-Packard Company) have stopped producing mainframe computer systems in order to concentrate their resources on microprocessor-based computer systems.

Refer to Figure 1-1 for the block diagram of the personal computer (PC). this diagram also applies to any computer system from the early mainframe computers to the latest microprocessor-based system. The block diagram is composed of three blocks that are interconnected by buses. A bus is a set of common connections that carry the same type of information.

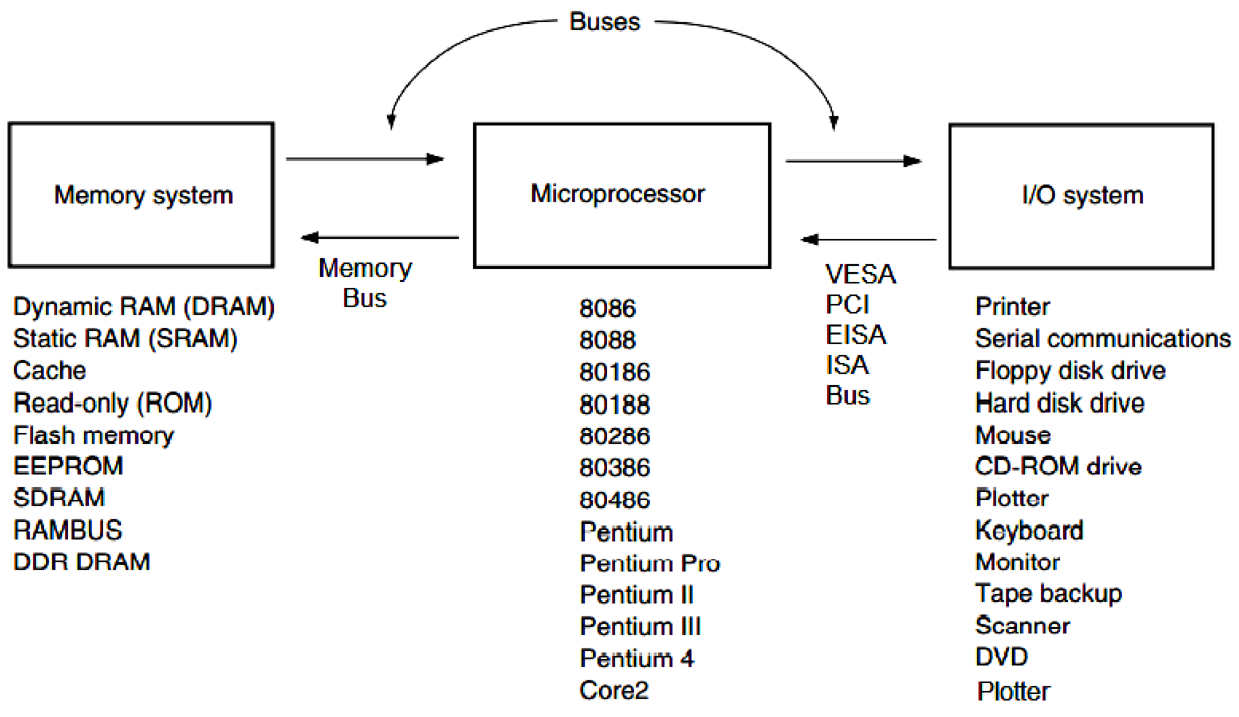

Fig. (1-1): The block diagram of a microprocessor-based computer system.

1.3 Memory and Input / Output (I/O) System:

The memory structure of Intel-microprocessor based PC system is divided into three main parts: TPA (transient program area), system area, and XMS (extended memory system). Figure 1-2 illustrates the memory map of a PC system. The first 1M byte of memory the real memory because the Intel microprocessor is often designed to function in this area in its real mode of operation.

Extended memory contains up to 15M bytes in microprocessor-based computer in addition to the first 1M byte of real memory.

The TPA holds the DOS (disk operating system) operating system and other programs that control the computer system. The TPA also stores any currently active or inactive application programs.

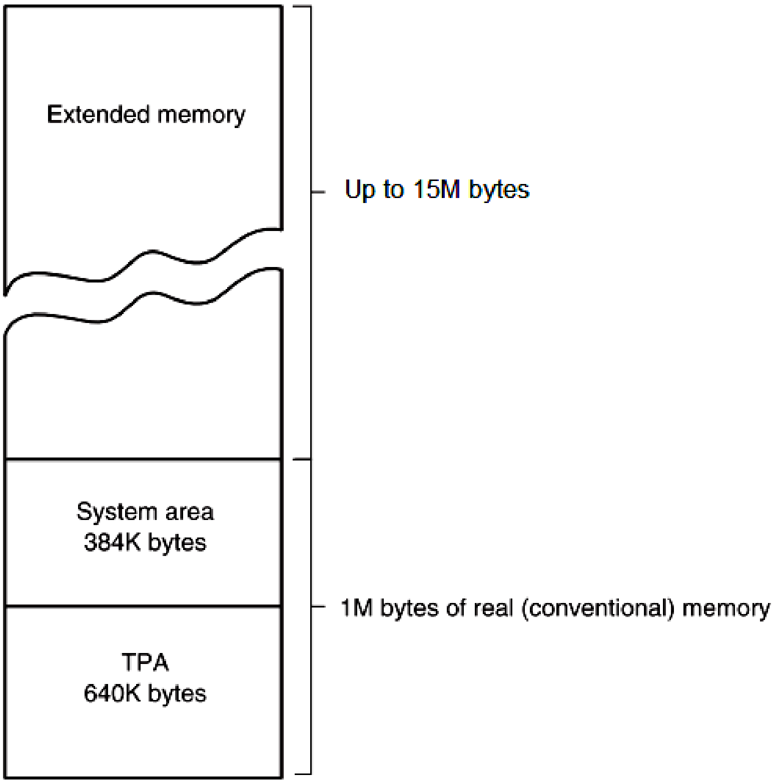

Fig. (1-2): The memory map of the personal computer system.

Figure 1-3 shows the organization of the TPA in a computer system. The DOS memory map shows how the many areas of the TPA are used for system programs, data, and drivers. It also shows a large area of memory available for application programs. Hexadecimal memory addresses or memory locations are used to number each byte of the memory system.

The Interrupt vector access various features of the DOS, BIOS (basic I/O system), and applications. The BIOS is a collection of programs stored in either a read-only-memory (ROM) or flash memory that operate many of the I/O devices connected to your computer system. Note that a flash memory is an EEPROM (electrically erasable programmable read-only memory) that is erased in the system electrically, while the ROM is a device that must be programmed in a special machine called an EPROM programmer for an EPROM (erasable programmable read-only memory) or at the factory when a ROM is fabricated.

The BIOS and DOS (disk operating system) communication areas contains transient data used by programs to access I/O devices and the internal features of the computer system. These are stored in the TPA so they can be changed as the system operates. Note that the TPA contains read/write (R/W) memory called RAM or random access memory so it can change as a program executes.

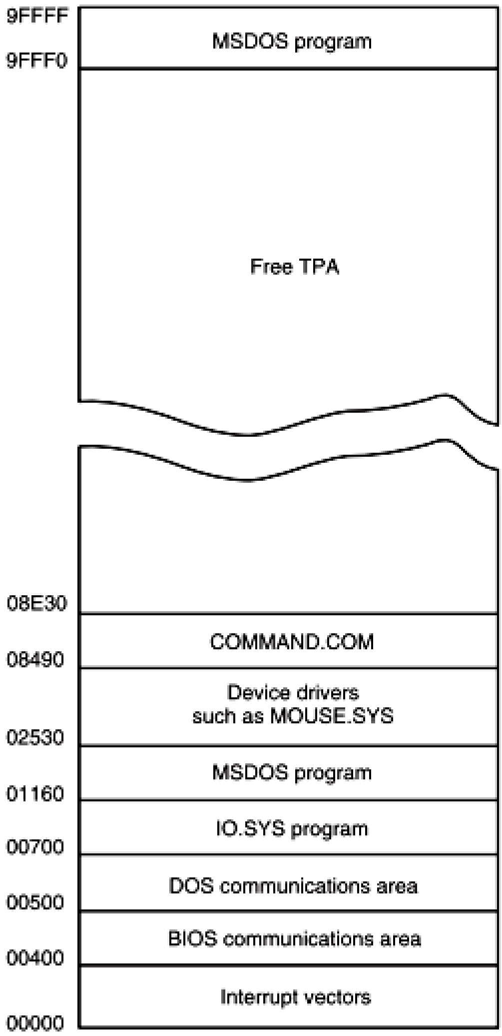

Fig. (1-3): The memory map of the TPA in a PC (this map vary between systems).

The size of the driver area and number of drivers changes from one computer to another. Drivers are programs that control installable I/O devices such as a mouse, disk cache, hand scanner, CD-ROM memory (Compact Disk Read-Only Memory), DVD (Digital Versatile Disk), or installable devices, as well as programs. Installable drivers are programs that control or drive devices or programs that are added to the computer system.

The system area, although smaller than the TPA and contains programs on either a ROM or flash memory and also areas of read/write (RAM) memory for data storage. Figure 1-4 shows the system area of a typical computer system.

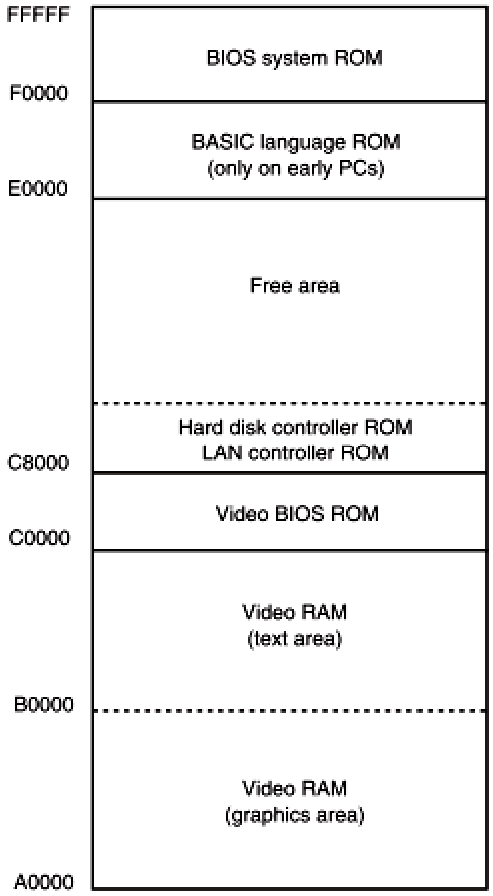

Fig. (1-4): The system area of a typical PC.

The first area of the system space contains video display RAM and video control programs on ROM or flash memory. The size and amount of memory used depends on the type of video display adapter attached to the system. Display adapters generally have their video RAM, which stores graphical or bit-mapped data. The video display adapter include the earlier CGA (color graphic adapter) and EGA (enhanced graphic adapter) or one of the many newer form of VGA (variable graphic array). The video BIOS located on a ROM or flash memory, is contains programs that control the DOS video display.

If a hard disk memory is attached to the computer, the interface card might contain a ROM. The size, location, and presence of the ROM depends on the type of hard disk adapter attached to the computer.

Windows Systems. Modern computers use a different memory map with Windows than the DOS memory maps of Previous Figures. The Windows memory map appears in Figure 1–5 and has two main areas, a TPA and a system area. The difference between it and the DOS memory map are the sizes and locations of these areas.

The Windows TPA is the first 2G bytes of the memory system while the Windows system area is the last 2G bytes of memory. It appears that the same idea used to construct the DOS memory map was also used in a modern Windows-based system. The system area is where the system BIOS is located and also the video memory. Also located in the system area is the actual Windows program and drivers. Every program that is written for Windows can use up to 2G bytes of memory. This is even true in a 64-bit system, which does allow access to more memory, but not as a direct part of Windows. Information that is larger than 2G must be swapped into the Windows TPA area from another area of memory. In future versions of Windows and the Pentium, this will most likely be changed. The current version of Windows 64 (which is now a part of Windows Vista) supports up to 8G bytes of Windows memory.

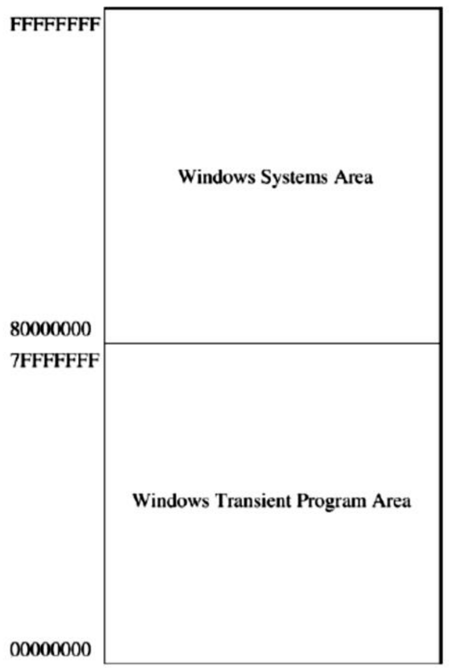

Fig. (1-5): The memory map used by Windows XP.

Does this mean that any program written for Windows will begin at physical address 00000000H? No, the memory system physical map is much different for the linear programming model shown in Figure 1–5. Every process in a Windows Vista, Windows XP, or Windows 2000 system has its own set of page tables, which define where in the physical memory each 4K-byte page of the process is located. This means that the process can be located anywhere in the memory, even in noncontiguous pages. As far as an application is concerned, you will always have 2G bytes of memory even if the computer has less memory. The operating system (Windows) handles assigning physical memory to the application and if not enough physical memory exists, it uses the hard disk drive for any that is not available.

The I/O (input/output) space in a computer system extends from I/O port, an I/O port address is similar to a memory address, except that instead of addressing memory, it addresses an I/O device. The I/O devices allow the microprocessor to communicate between itself and the outside world. Figure 1–6 shows the I/O map found in many personal computer systems.

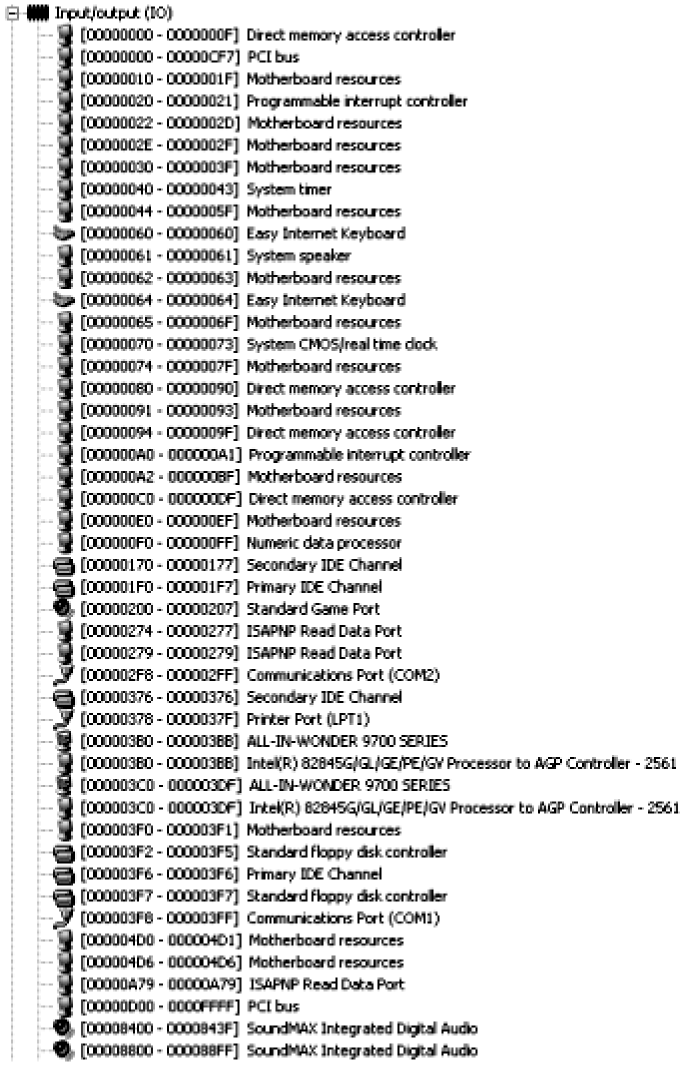

Fig. (1-6): Some I/O locations in a typical PC.

Various I/O devices that control the operation of the system are usually not directly addressed. Instead, the system BIOS ROM addresses these basic devices, which can vary slightly in location and function from one computer to the next. Access to most I/O devices should always be made through Windows, DOS, or BIOS function calls to maintain compatibility from one computer system to another.

1.4 The Microprocessor:

The microprocessor, sometimes referred to as the CPU (central processing unit), is the controlling element in a computer system. The microprocessor controls memory and I/O through a series of connections called buses. The buses select an I/O or memory device, transfer data between an I/O device or memory and the microprocessor, and control the I/O and memory system. Memory and I/O are controlled through instructions that are stored in the memory and executed by the microprocessor.

The microprocessor performs three main tasks for the computer system: (1) data transfer between itself and the memory or I/O systems, (2) simple arithmetic and logic operations, and (3) program flow via simple decisions.

The power of the microprocessor is in its capability to execute billions of millions of instructions per second from a program or software (group of instructions) stored in the memory system. This stored program concept has made the microprocessor and computer system very powerful devices. Table 1–1 shows the arithmetic and logic operations executed by the Intel family of microprocessors.

Table (1–1) Simple arithmetic and logic operations.

Operation	*Comment*
Addition	
Subtraction	
Multiplication	
Division	
AND	Logical multiplication
OR	Logic addition
NOT	Logical inversion
NEG	Arithmetic inversion
Shift	
Rotate	

Another feature that makes the microprocessor powerful is its ability to make simple decisions based upon numerical facts. Table 1–2 lists the decision-making capabilities of the Intel family of microprocessors.

Table 1–2 Decisions found in the all microprocessors.

Decision	*Comment*
Zero	Test a number for zero or not-zero
Sign	Test a number for positive or negative
Carry	Test for a carry after addition or a borrow after subtraction
Parity	Test a number for an even or an odd number of ones
Overflow	Test for an overflow that indicates an invalid result after a signed addition or a signed subtraction

A **bus (or Buses)** is a common group of wires that interconnect components in a computer system. The buses that interconnect the sections of a computer system transfer address, data, and control information between the microprocessor and its memory and I/O systems. Figure 1–6 shows how these buses interconnect various system components such as the microprocessor, read/write memory (RAM), read-only memory (ROM or flash), and a few I/O devices.

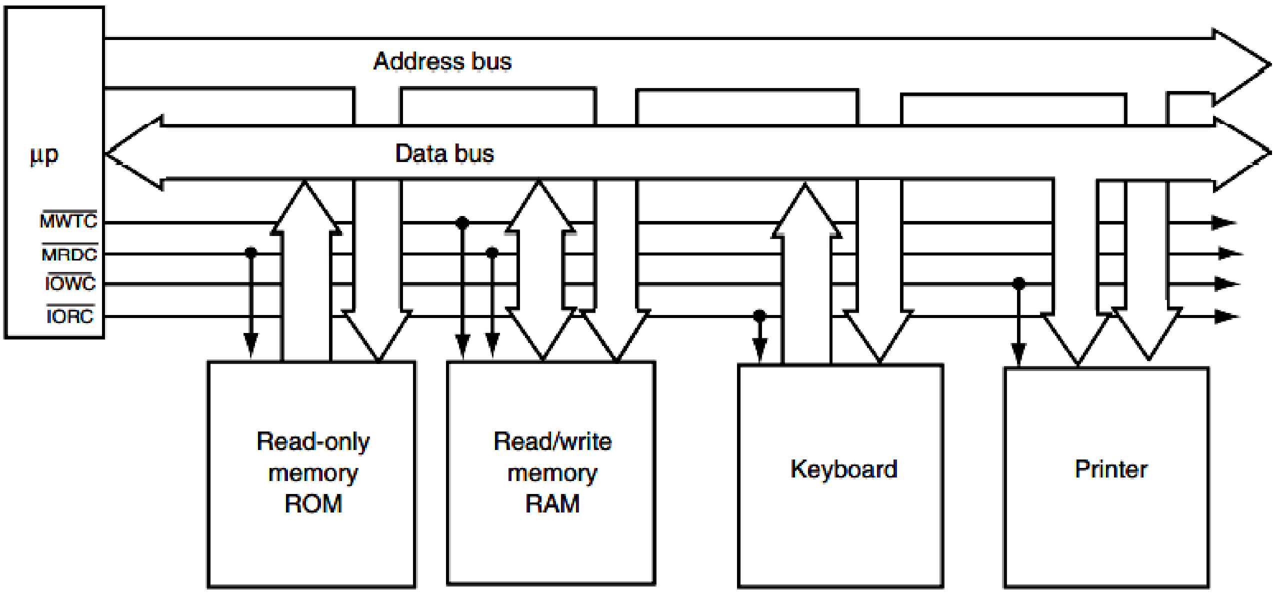

Fig. (1-6): The block diagram of a computer system showing the address, data, and control bus structure.

The address bus requests a memory location from the memory or an I/O location from the I/O devices.

The data bus transfers information between the microprocessor and its memory and I/O address space.

The control bus contains lines that select the memory or I/O and cause them to perform a read or write operation. In most computer systems, there are four control bus connections: $\overline{MRDC}$ (memory read control), $\overline{MWTC}$ (memory write control), $\overline{IORC}$ (I/O read control), and $\overline{IOWC}$ (I/O write control). Note that the over-bar indicates that the control signal is active-low; that is, it is active when a logic zero appears on the control line.

The microprocessor reads the contents of a memory location by sending the memory an address through the address bus. Next, it sends the memory read control signal ($\overline{MRDC}$) to cause the memory to read data. Finally, the data read from the memory are passed to the microprocessor through the data bus. Whenever a memory write, I/O write, or I/O read occurs, the same sequence ensues, except that different control signals are issued and the data flow out of the microprocessor through its data bus for a write operation.