UNIT-I Microprocessor and Microprocessor Development Systems

LECTURE -1

INTRODUCTION:-COMPUTERS

"A Computer is an electronic machine that can solve different problems, process data, and store & retrieve data and perform calculations faster and efficiently than humans".

Since the advent of the first computer different types and sizes of computers are offering different services. Computers can be as big as occupying a large building and as small as a laptop or a microcontroller in systems. The four basic types of computers are.

1. Super computer
2. Mainframe Computer
3. Minicomputer
4. Microcomputer

1.Supercomputer

The most powerful computers in terms of performance and data processing are the supercomputers. These are specialized and task specific computers used by large organizations. These computers are used for research and exploration purposes, like NASA uses supercomputers for launching space shuttles, controlling them and for space exploration purpose.The supercomputers are very expensive and very large in size. It can be accommodated in large air-conditioned rooms; some super computers can span an entire building.

In 1964, Seymour cray designed the first supercomputer CDC 6600.

Uses of Supercomputer:-In Pakistan and other countries Supercomputers are used by Educational Institutes like NUST (Pakistan) for research purposes. Pakistan Atomic Energy commission & Heavy Industry Taxila use supercomputers for Research purposes.

Space Exploration-Supercomputers are used to study the origin of the universe, the dark-matters.

For these studies scientist use IBM’s powerful supercomputer “Roadrunner” at National Laboratory Los Alamos.

Earthquake studies-Supercomputers are used to study the Earthquakes phenomenon. Besides that supercomputers are used for natural resources exploration, like natural gas, petroleum, coal, etc.

Weather Forecasting-Supercomputers are used for weather forecasting, and to study the nature and extent of Hurricanes, Rainfalls, windstorms, etc.

Nuclear weapons testing-Supercomputers are used to run weapon simulation that can test the Range, accuracy & impact of Nuclear weapons.

Popular Supercomputers

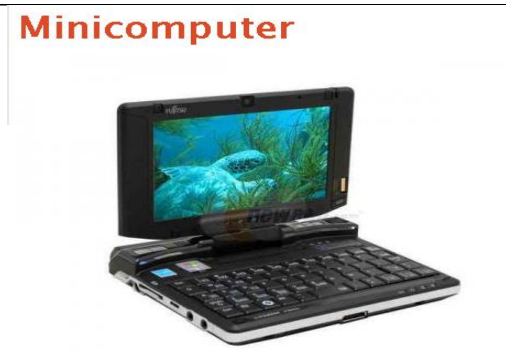
- IBM’s Sequoia, in United States
- Fujitsu’s K Computer in Japan
- IBM’s Mira in United States
- IBM’s SuperMUC in Germany
- NUDT Tianhe-1A in China

2. Mainframe computer:-Although Mainframes are not as powerful as supercomputers, but certainly they are quite expensive nonetheless, and many large firms & government organizations uses Mainframes to run their business operations. The Mainframe computers can be accommodated in large air-conditioned rooms because of its size. Super-computers are the fastest computers with large data storage capacity, Mainframes can also process & store large amount of data. Banks educational institutions & insurance companies use mainframe computers to store data about their customers, students & insurance policy holders.

Popular Mainframe computers

- Fujitsu’s ICL VME
- Hitachi’s Z800

3. Minicomputers:-Minicomputers are used by small businesses & firms. Minicomputers are also called as “Midrange Computers”. These are small machines and can be accommodated on a disk with not as processing and data storage capabilities as super-computers & Mainframes. These computers are not designed for a single user. Individual departments of a large company or organizations use Mini-computers for specific purposes. For example, a production department can use Mini-computers for monitoring certain production process.



Popular Minicomputers

- K-202
- Texas Instrument TI-990
- SDS-92
- IBM Midrange computers

4. Microcomputers.

Desktop computers, laptops, personal digital assistant (PDA), tablets & smartphones are all types of microcomputers. The micro-computers are widely used & the fastest growing computers. These computers are the cheapest among the other three types of computers. The Micro-computers are specially designed for general usage like entertainment, education and work purposes. Well known manufacturers of Micro-computer are Dell, Apple, Samsung, Sony & Toshiba.

Desktop computers, Gaming consoles, Sound & Navigation system of a car, Netbooks, Notebooks, PDA's, Tablet PC's, Smartphones, Calculators are all type of Microcomputers.

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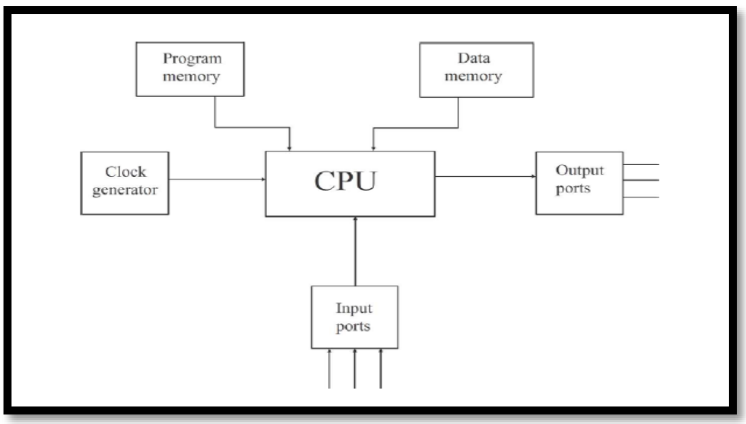
LECTURE -2

Microcomputer Organization:

The basic components of a microcomputer are:

1) CPU
2) Program memory
3) Data memory
4) Output ports
5) Input ports
6) Clock generator.

These components are shown in figure below:



Microcomputer System

Central Processing Unit:

The CPU consists of ALU (Arithmetic and Logic Unit), Register unit and control unit. The CPU retrieves stored instructions and data word from memory; it also deposits processed data in memory.

a) ALU (Arithmetic and Logic Unit)

This section performs computing functions on data. These functions are arithmetic operations such as additions subtraction and logical operation such as AND, OR rotate etc. Result are stored either in registers or in memory or sent to output devices.

b) Register Unit:

It contains various register. The registers are used primarily to store data temporarily during the execution of a program. Some of the registers are accessible to the uses through instructions.

c) Control Unit:

It provides necessary timing & control signals necessary to all the operations in the microcomputer. It controls the flow of data between the µp and peripherals (input, output & memory). The control unit gets a clock which determines the speed of the µp

The CPU has three basic functions
1) It fetches an instructions word stored in memory.
2) It determines what the instruction is telling it to do.(decodes the instruction)
3) It executes the instruction.
4) It looks for control signal such as interrupts and provides appropriate responses.
5) It provides states, control, and timing signals that the memory and input/output section can use.

Executing the instruction may include same of the following major tasks.
1. Transfer of data from reg. to reg. in the CPU itself.
2. Transfer of data between a CPU reg. & specified memory location.
3. Performing arithmetic and logical operations on data from a specific memory location or a designated CPU register.
4. Directing the CPU to change a sequence of fetching instruction, if processing the data created a specific condition.
5. Performing housekeeping function within the CPU itself in order to establish desired condition at certain registers.

Program Memory:
The basic task of a microcomputer system into ensure that its CPU executes the desired instruction sequence is the program properly. The instruction sequence is stared in the program memory on initialization- usually a power up and manual reset the processor starts by executing the instruction in a predetermined location in program memory. The first instruction of the program should therefore be in this location in typical µp basic system, the program to be executed is fixed one which does not change. Therefore µp program are store on ROM, or PROM, EPROM, EEPROM.
In the trainer kit, ROM contains only the monitor program. The user program is not stored in ROM because it needs not to be stored permanently.

Data Memory:

A microcomputer manipulates data according to the algorithm given by the instruction in the program in the program memory. These instruction may require intermediate results to be stored, the functional block in µc have same internal reg. which can also be used if available for such storage external data memory is needed if the storage requirements is more. Apart from intermediate storage, the data memory may also be used to provide data needed by the program, to store some of the results of the program. Data memory is used for all storage purposes other than storage of program. Therefore, they must have head write capability RWM or RAM. It stores both the instructions to be executed (i.e. program) and the data involved. It usually contains ROM (Read memory). The ROM can only read and cannot be written into and is non volatile that is, it retains its contents when the power is turned off. A ROM is typically used to store instructions and data that do not change.

For example, it stores the monitor program if a microcomputer. One can either read from or write into a RWM. The RWM is volatile, that is it does not retain its contents when the power is turned off. It is used to store user programmes & data which are temporary might change during the course of executing a program. Both ROM & RWM are RAM (Random access memory). RWM is respectively. During a memory read operation, the content of the addressed location is not destroyed. During a unit operation, the original content of the addressed location is destroyed. Both ROM & RWM are arranged into words, each of which has a unique address. The address of a word is memory location and it is placed in parentheses. Therefore, **X** is an address and (**X**) is the content of that address **X**.

The address decodes taken an address and from the control unit and select the proper memory location and obtaining its content takes a certain amount of time, this times is the access time of the memory. The access time affects the speed of the computer, pins, and the computer must obtain the instruction and data from the memory. Computer memory as usually RAM so that all memory location have the same access time.

The computer must wait shiner of unit's memory, typical memory access time range from several uses. Memory sections often subdivided into units called pages. The entire memory section may involve million of cords, when a page contains between 256 & 4k warts. The computer may access a memory location by first decreasing a particular page and then accessing a location on that page.

The advantage of paging is that the computer can reach several locations on the same page with just the address in the page. The process is like describing street address by first specifying aspect and them listing the have numbers.

The control section transfers data to or from memory as follows.
1. The control section reads an address to the memory.
2. The control section sends a read and write signal to the memory to indicate, the direction of the transform.
3. The control section waits until transfer has been completed .this delay precedes the actual data's transfer in the input case and follows it in the output case.

Input/Output Ports:

The input & output ports provide the microcomputer the capability to communicate with the outside world. The input ports allow data to pass from the outside world to the µc data which will be used in the data manipulation being done by the microcomputer to send data to output devices.

The user can enter instruction (i.e. program) and data in memory through input devices such as keyboard, or simple switches, CRT, disk devices, tape or card readers. Computers are also used to measure and control physical quantities like temperature, pressure, speed etc. For these purposes, transducers are used to convent physical quantise into proportional electrical signals A/D computers are used to convert electrical signals into digital signals which are sent to the compute.

The computer sends the results of the computation to the output devices e.g. LED, CRT, D/A converters, printers etc.. These I/O devices allow the computer to communicate with the outside world I/O devices are called peripherals.

Clock Generator:

Operations inside the µp as well as in other parts of the µc, are usually synchronous by nature. The clock generator generates the appropriate clock periods during which instruction executions are carried out by the microprocessor.

This condition ensures that events in different path of the systems can proceed in a systematic fashion. Some of the microprocessors have an internal clock generator circuit to generate a clock signal.

These microprocessors require an external crystal or RC network to be connected at the appropriate pins for deciding the operating frequency (e.g. 8085). Some microprocessors require an external clock generator (e.g. 8086).

These microprocessors also provide an output clock signal which can be used by other devices in the microcomputer system for their can timing and synchronizing.

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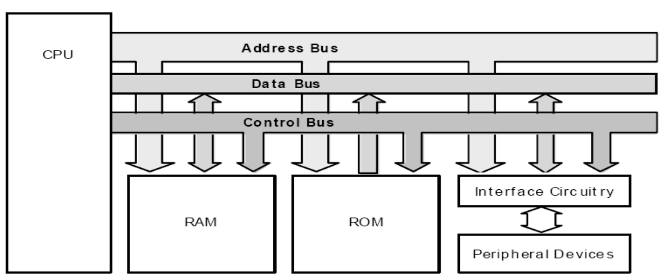
LECTURE -3

The microprocessor, also known as the Central Processing Unit (CPU) is the brain of all computers and many household and electronic devices. Multiple microprocessors, working together, are the "hearts" of data centres, Super computers, communications products, and other digital devices.

Microprocessor:

It is a semiconductor device consisting of electronic logic circuits manufactured by using either a Large scale (LSI) or Very Large Scale (VLSI) Integration Technique. It includes the ALU, register arrays and control circuits on a single chip.
The microprocessor has a set of instructions, designed internally, to manipulate data and communicate with peripherals. This process of data manipulation and communication is determined by the logic design of the microprocessor called the architecture.
The era microprocessors in the year 1971, the Intel introduced the first 4-bit microprocessor is 4004. Using this the first portable calculator is designed. The following table1 shows the list of Intel microprocessors.

Microcomputer Block Diagram



Computer system consist primary of :-
1- Microprocessor.
2- Memory.
3- Input.
4- Output.

1. ALU : ALU stands for Arithmetical Logical Unit. As name indicates it has two parts:

a. Arithmetical unit which is responsible for mathematical operations like addition, subtraction, multiplication and division,

b. Logical unit which is dedicated to take logical decisions like greater than, less than, equal to, not equal to etc. (Basically AND/OR/NOT Operations)

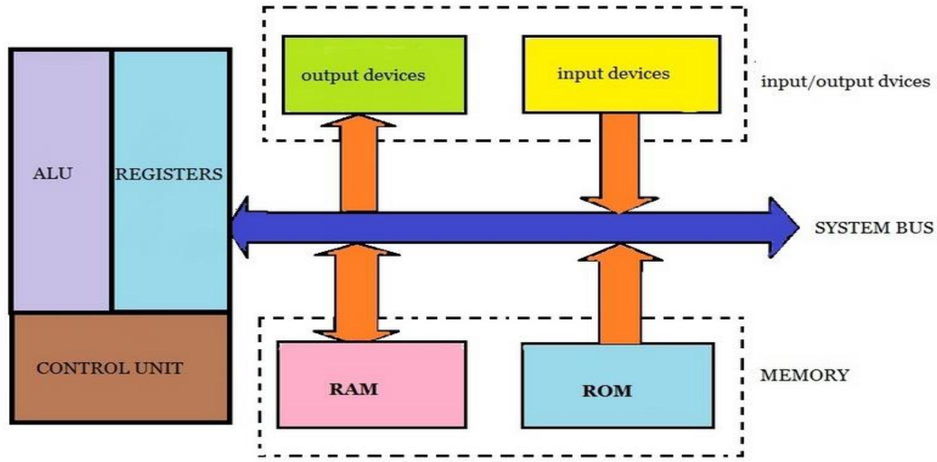


Fig 1 The Microprocessor block diagram

2. Register Array: Registers are small storage devices that are available to CPU or processors. They act as temporary storage for processing of intermediate data by mathematical or logical operations.

3. Control: This part of CPU is dedicated to coordinate data flow and signal flow through various types of buses i.e. Data Bus, Control Bus, and Address Bus etc. It directs data flow between CPU and storage and I/O devices.

4. Memory: There are two different types of memory segments being used by the CPU. First is the ROM which stands for Read Only Memory while other is R/W which stands for Read and Write Memory or Random Access Memory (RAM).

a. **ROM:** From this memory unit, CPU can only read the stored data. No writing operations can be done in this part of memory. Thus it is used to store the programs that need no alteration or changes like Monitor Program or Keyboard driver etc.

b. **R/W:** As name indicates it is opposite to ROM and used for both reading and writing operations. In general User's program and instruction are stored in this segment of memory unit.

5. Input Devices: Input devices are used to enter input data to microprocessor from Keyboard or from ADC which receives data from sensors/signal conditioning systems.

6. Output Devices: These devices display the results/conclusions coming out from ALUs either in soft copy (Monitor) or in Hard Copy (Printer).

- **Advantages of a Microprocessor**

a) high speed high speed
b) high accuracy and reliability
c) data movement between memory locations
d) used to perform multitask operations
e) only require limited current and low voltages

- **Disadvantages of a Microprocessor**

a) Highly sensitive to thermal and electric variations
b) Do not have internal memory(RAM&ROM),input/output ports inside the microprocessor
c) No timers, interrupts inside the microprocessor
d) Make a system expensive
e) Need proper interfacing components for functioning

- **Applications**

a) Widely used in modern computer systems
b) Used in robotics
c) Used in telecommunication fields
d) Used in space systems

S.NO	RGPV QUESTIONS	Year	Marks
Q.1	What is a microprocessor? Explain the basic fundamentals blocks of a microprocessor?	JUNE 2014	7

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LECTURE -3

Evolution of Microprocessor

> **Moore's Law**
>
> In 1965, Intel co-founder Gordon Moore predicted that the number of transistors on a chip would double about every two years. Since then, Moore's Law has fueled a technology revolution as Intel has exponentially increased the number of transistors integrated into it processors for greater performance and energy efficiency.

Intel 4004* Microprocessor Chip

In 1969, Intel Corporation began work on a project to develop a set of chips for a series of high-performance programmable calculators for Busicom, a Japanese company. Marcian E. "Ted" Hoff, who had joined Intel in 1968, is assigned to the project. Ted Hoff, along with Federico Faggin, Stan Mazor and others developed a design that included four chips.

The four chip combination included a central processing unit chip (CPU), a read-only memory chip (ROM), and a random access memory chip (RAM), and a shift-register chip for input and output (IO). This design was the first microprocessor chip, which Intel named the 4004.

The Intel 4004 was one-eighth of an inch wide by one-sixteenth of an inch long and contained 2300 metal-oxide semiconductor transistors (MOS). Its computing power was equal to the giant 18,000 vacuum tube ENIAC built in 1946.

The Intel 4004 could execute 60,000 operations per second. Masatoshi Shima, of Busicom, designed the logic for the chip. Shima later joined Intel. Intel sold Busicom the processor design for $60,000, but later bought back the design rights when Stan Mazor and Ted Hoff lobbied for the many other potential uses of the 4004 chip.

Intel 8008* Chip and the Intel 8080* Chip

The 8008 was an 8-bit microprocessor chip and was introduced in April 1972. Designers were Ted Hoff, Federico Faggin, Stan Mazor and Hal Feeney.

An even greater achievement was the 8080 chip, introduced in 1974. The 8080 had 10 times the performance of the 8008 chip and could execute 290,000 instructions per second. It had 64 bytes of addressable memory, and sold for $360 per chip. It quickly became an industry standard. Designers included Mazor, Faggin and Masatoshi Shima.

Intel 8748* Microcontroller

Intel Corporation introduced the 8748 microcontroller in 1976. The 8748 is essentially a computer on a chip, containing its own central processor, EPROM, data memory, on-chip peripherals and input/output functions.

The 8748 "microcontroller" is designed to control events in real-time, while a "microprocessor" is designed to manipulate large amounts of data. The 8748 project team included Hank Blume, Gene Hill, Mark Holler, Mike Melloch, Dave Stamm, Dave Budde, Howard Raphael and Bob Wickersheim. The 8748 became the most widely accepted 8-bit microcontroller architecture in the world.

Intel 8086* Microprocessor

The 8086, announced by Intel Corporation in 1978, had 10 times the performance of the 8080 chip announced in 1974.

The 8086 established a new 16-bit software architecture. The project team included Bill Pohlman, Bob Koehler, John Bayliss, Jim Mckevitt, Chuck Wildman, Steve Morse and others. Motorola introduced the 68000 chip a year later, which directly competed with the 8086. By 1984, however, the 8086 chip was outselling the 68000 by approximately 9 to 1. The 8088 chip was released in 1981.

Intel 80286* Microprocessor

In 1982, Intel Corporation released the 80286 microprocessor chip. At the time of its introduction, the 80286 microprocessor has three times the performance of any other 16-bit chip on the market. The 80286 offered on-chip memory management, making it suitable for multitasking operations. Intel's project leader for the 286 is Gene Hill. Intel also released the 80186 chip, which was an improvement over earlier Intel chips. The 80186 design team was lead by Dave Stamm.

Intel 80386* Microprocessor chip

The Intel 80386 is a 32-bit microprocessor containing over 275,000 transistors on a single chip. The 80386 (commonly known as the "386 chip") could handle four million operations per second and handle memory up to four gigabytes (4,294,967,296). The 386 was also compatible with Intel's earlier processor line for the IBM PC and compatibles and could run software designed for those processors as well. The 386 chip brought desktop personal computing power to a new level. John Crawford was the architecture manager for the Intel 386 and the Intel 486 microprocessors, and co-manager of Pentium microprocessor development.

Intel 80486* Microprocessor chip

In 1989, Intel Corporation announced the 80486 chip, a highly integrated 32-bit microprocessor combining 80386 compatibility, RISC-style CPU, 80387 math co-processor compatibility, 8-Kilobyte on-chip cache and built- in multiprocessing support. The 80486 has a reported capability of holding

1.16 million transistors and is about four times faster than the 80386 processor. Initial uses of the 80486 chip will be for LAN servers and high- end workstations.

John Crawford was the architecture manager for the Intel 386 and the Intel 486 microprocessors, and co-manager of the Pentium microprocessor development. The most common varieties of the 80486 chip are the 486SX (25Mhz), 486DX (33Mhz), and the 486DX2 (66Mhz).

Intel Pentium Microprocessor

In 1993, Intel announced the Pentium chip. The word "Pentium" comes from the Greek root word "pentas" meaning "five." The Pentium is the 80586 chip.

The Pentium is a 32-bit chip with superscalar design, and is estimated to be two times faster than the 486DX2 (66MHz) chip. The Pentium uses dual pipelines to allow it to process two separate instructions in a single cycle. The Pentium has a 64 bit bus interface, an eight bit code cache, an eight bit data cache, and branch prediction memory bank. Don Alpert was the architecture manager of the Pentium, John Crawford was co-manager. The Pentium is a CISC-based (complex instruction set computer) chip containing 3.3 million transistors.

In November 1995, Intel released new and faster Pentium Pro microprocessor, with speeds of over 150 MHz to 200 MHz

By 1996, 200 Mhz microcomputer systems were available on the market.

By 1999, 700 Mhz and above became available.

In March 2000, Intel announced the 1GHz microprocessor.

MICROPROCESSOR	YEAR	SPEED	WORD LENGTH	TRANSISTORS	MIPS
Intel 4004	1969	108 KHz	4-bit	2,300	.06
Intel 8008	1972	200 KHz	8-bit	3,500	.06
Intel 8080	1974	2 MHz	8-bit	6,000	.64
Intel 8086	1978	4.47 MHz	16-bit	29,000	.66
Intel 8088	1981	4.47 MHz	16-bit	29,000	.75
Intel 80286	1982	12 MHz	16-bit	134,000	2.66
Intel 80386	1985	16-33 MHz	32-bit	275,000	4
Intel 80486 (i486)	1989	20-100 MHz	32-bit	1.2 Million	70
Intel 80586 (Pentium)	1993	75-200 MHz	32-bit	3.3 Million	126 - 203
Intel Pentium Pro	1995	150-200 MHz	32-bit	5.5 Million	300
Intel Pentium MMX	1997	166-233 MHz	32-bit	4.5 Million	-
Intel Pentium II	1997	233-450 MHz	32-bit	7.5 Million	-
Intel Pentium III	1999	450-933 MHz	32-bit	Over 9.5 Million	-
Intel Itanium Processor (formerly Merced Processor)	2000	1 GHz	64-bit	15,000,000	1,200

Table 1 Evolution of Intel microprocessor

UNIT-I Microprocessor and Microprocessor Development System

LECTURE -4

Microprocessor architecture and its operations:-
All function performed by microprocessor can by classified in three general categories:-
1- Microprocessor initiated operations.
2- Internal data operations.
3- Peripheral (or externally) initiated operations.
To performed these operations, microprocessor needs [logic circuit and control signals].

1- Mp Initiated Operations:-
Primarily microprocessor performs four operations:-
a) Memory read (Reads data from memory).
b) Memory writes (Write data into memory).
c) I/O read (Accept data to output device).
d) I/O writes (Sends data to output device).

These operations are part of communication process.
The microprocessor needs to perform the following steps:-
1- Identify the peripheral (memory location).
2- Transfer data.
3- Provide timing or synchronization signals.
Microprocessor performed these functions using sets of buses [Data bus, Address bus, Control bus].
1- Data bus: - is a group of 8 lines used for data flow, these lines are bidirectional from (00 – FF) =28 =256 numbers.
*The largest number = 1111 1111 = FF, thus 8085 Mp is called 8 bit Mp.
2- Address bus: - is a group of 16 lines, identified as A0 - A15. This bus is unidirectional (bit flow in one direction) from Mp to peripheral.
*Each memory location or peripheral identified with binary number called address. (216 =65536=64K).
3- Control bus: - the control is comprised of various single lines that carry synchronization signals.

- **Arithmetic and Logic Unit (ALU)**

ALU is one of the basic units of a microprocessor. All the computing functions are maintained in this unit. As the name shows, the ALU can perform all the arithmetic operations (+,-,*,/,%,etc) and all logical operations (AND, OR, NOT, XOR, etc).

- **Control Unit (CU)**

Control unit is another important part of a microprocessor. The CPU's control unit coordinates and times the CPU's functions, and it uses the program counter to locate and retrieve the next instruction from memory. Another purpose of control unit is, controlling the data flow between microprocessor and peripheral devices/peripheral chips.

- **Registers**

Registers are the important section of microprocessor chip. Registers are primarily used to store the data temporarily during the execution/runtime of the program. A microprocessor contains several kinds of registers that can be classified according to the instructions provided to the processor. These instructions are called instruction sets. The registers are basically 8bit, 16bit or 32 bit according to the type. Registers can easily accessible to the user by using various commands (instructions). Some registers are used to store address of memory locations that can be easily accessed by the microprocessor.

- **Memory**

As in the name shows, memory are used to store the information (data&instructios) as in the binary form. According to this binary information's, a microprocessor perform its operation during the execution period. A microprocessor can read the information from memory and perform the corresponding operations in its ALU. The result of each operation stored in a memory or given to any output unit associated with the system. The data stored in the memory can be use further use. But some memories used in a computer system are temporary memories or instantaneously fed to the any peripheral units. These type data can't be store in computer memory for later use. The memory unit of a microprocessor computer system consist of two types of memories. They are Read Only Memory (simply called as ROM) and Random Access Memory (simply called as RAM).

- **Read Only Memory (ROM)**

Read-only memory is one of the computer memories. ROM memory is used to store items that the computer needs to execute when it is first turned on. For example, the ROM memory on a PC contains a basic set of instructions, called the basic input-output system (BIOS). The PC uses BIOS to start up the operating system. BIOS is stored on computer chips in a way that causes the information to remain even when power is turned off.ROM is a non-volatile memory. The program stored in ROM can only read.

- **Random Access Memory (RAM)**

Random access memory is the other type of internal memory .RAM also called main memory because it is the primary memory that the CPU uses when processing information. The electronic circuits used to construct this main internal RAM can be classified as dynamic RAM (DRAM), synchronized dynamic RAM (SDRAM), or static RAM (SRAM).This memory is used to store user programs and data's temporarily. RAM is a volatile memory.

- **System Bus**

A bus is the set of hardware lines or circuit lines which help the communication between the processor and other input/output units. A system bus is a flat cable with numerous parallel wires. Each wire can carry one bit, so the bus can transmit many bits along the cable at the same time. For example, a 16-bit bus, with 16 parallel wires, allows the simultaneous transmission of 16 bits (2 bytes) of information from one component to another.

The system bus basically classified into three groups .

1) Control bus
2) Data bus
3) Address bus.

1) Control bus:-A control bus is a bi-directional bus which is used to transfer the control signals (read, write, interrupt) and timing signals(clock pulses) between microprocessor and other peripheral components.

2) Data Bus:-Data bus is also a bi-directional bus that used to transmit data bi-directionally between the microprocessor and peripherals devices.

3) Address Bus:-Address bus is a unidirectional bus which is used to send the address of a peripheral from microprocessor to the peripheral device.

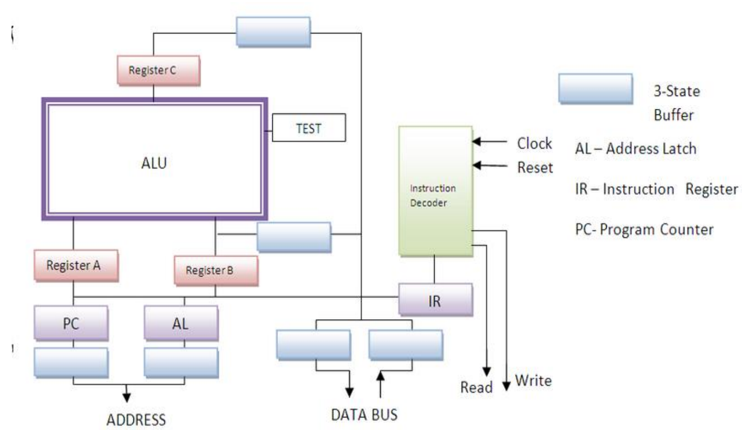


Fig 2 Microprocessor architecture

The internal logic design of the microprocessor called its "architecture", determine how and what various operations are performed by "Mp".
The microprocessor is programmable logic device designed with register, flip-flop and timing elements.

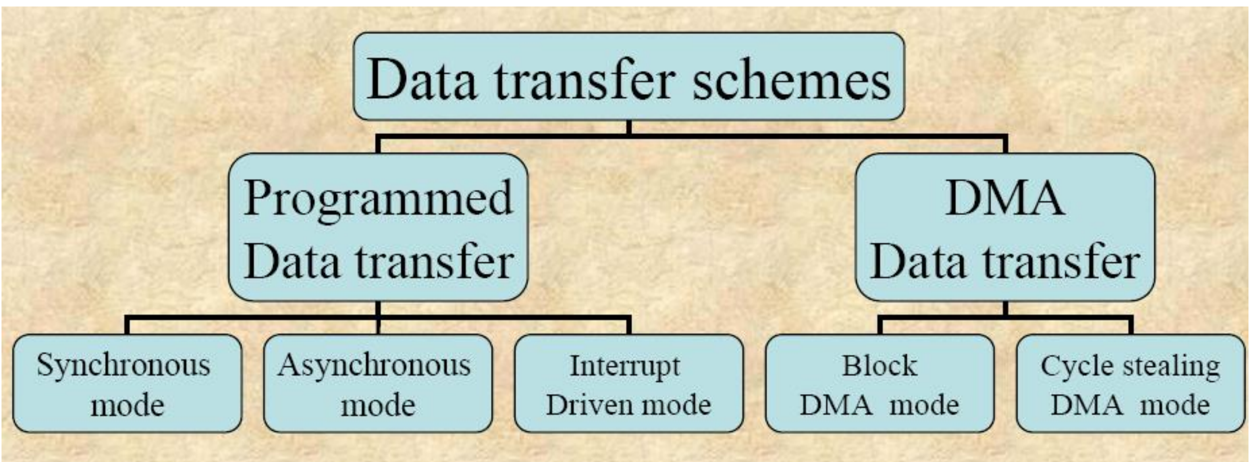
LECTURE -5

Data transfer schemes in a microprocessor

Why do we need data transfer schemes?

Availability of wide variety of I/O devices because of variations in manufacturing technologies e.g. electromechanical, electrical, mechanical, electronic etc. Enormous variation in the range of speed. Wide variation in the format of data.

Classification of Data Transfer Schemes



Programmed Data Transfer Scheme

The data transfer takes place under the control of a program residing in the main memory. These programs are executed by the CPU when an I/O device is ready to transfer data. To transfer one byte of data, it needs to execute several instructions. This scheme is very slow and thus suitable when small amount of data is to be transferred.

Synchronous Mode of Data Transfer

It's used for I/O devices whose timing characteristics are fast enough to be compatible in speed with the communicating MPU.In this case the status of the I/O device is not checked before data transfer. The data transfer is executed using IN and OUT instructions. Memory compatible with MPU is available. Hence this method is invariably used with compatible memory devices.

•The I/O devices compatible in speed with MPU are usually not available. Hence this technique is rarely used in practice.

Asynchronous Data Transfer

This method of data transfer is also called Handshaking mode.This scheme is used when speed of I/O device does not match with that of MPU and the timing characteristics are not predictable.The MPU fist sends a request to the device and then keeps on checking its status.The data transfer instructions are executed only when the I/O device is ready to accept or supply data.
•Each data transfer is preceded by a requesting signal sent by MPU and READY signal from the device.

Disadvantages

1. A lot of MPU time is wasted during looping to check the device status which may be prohibitive in many situations.
2. Some simple devices may not have status signals. In such a case MPU goes on checking whether data is available on the port or not

Interrupt Driven Data Transfer

In this scheme the MPU initiates an I/O device to get ready and then it executes its main program instead of remaining in the loop to check the status of the device. When the device gets ready, it sends a signal to the MPU through a special input line called an interrupt line. The MPU answers the interrupt signal after executing the current instruction. The MPU saves the contents of the PC on the stack first and then takes up a subroutine called ISS (Interrupt Service Subroutine).

•After returning from ISS the MPU again loads the PC with the address that is just loaded in the stack and thus returns to the main program.

•It is efficient because precious time of MPU is not wasted while the I/O device gets ready.

•In this scheme the data transfer may also be initiated by the I/O device.

DMA Data Transfer scheme

Data transfer from I/O device to memory or vice-versa is controlled by a DMA controller. This scheme is employed when large amount of data is to be transferred. The DMA requests the control of buses through the HOLD signal and the MPU acknowledges the request through HLDA signal and releases the control of buses to DMA.It’s a faster scheme and hence used for high speed printers.

Block mode of data transfer
In this scheme the I/O device withdraws the DMA request only after all the data bytes have been transferred.

Cycle stealing technique
In this scheme the bytes are divided into several parts and after transferring every part the control of buses is given back to MPU and later stolen back when MPU does not need it.

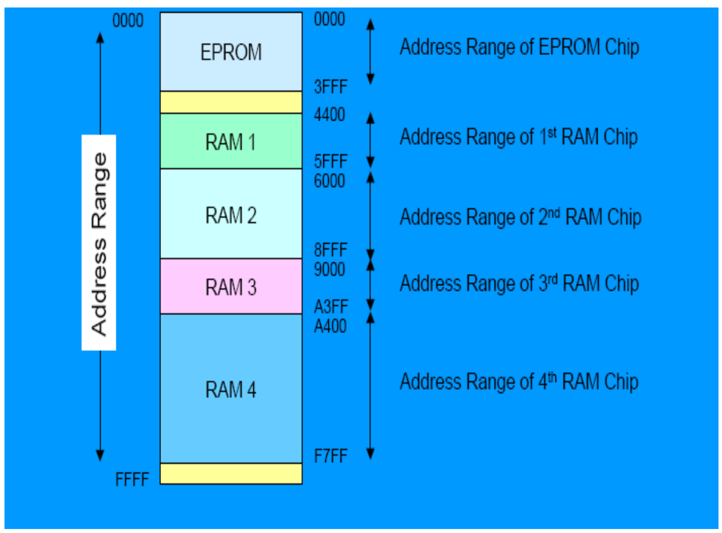
LECTURE -6

Memory

Memory stores information such as instructions and data in binary format (0 and 1). It provides this information to the microprocessor whenever it is needed. Usually, there is a memory "sub-system" in a microprocessor-based system. This sub-system includes: The registers inside the microprocessor Read Only Memory (ROM) used to store information that does not change. Random Access Memory (RAM) (also known as Read/Write Memory).used to store information supplied by the user. Such as programs and data.

Memory Map and Addresses

The memory map is a picture representation of the address range and shows where the different memory chips are located within the address range.



Memory

To execute a program: the user enters its instructions in binary format into the memory. The microprocessor then reads these instructions and whatever data is needed from memory, executes the instructions and places the results either in memory or produces it on an output device.

UNIT-I **Microprocessor and Microprocessor Development Systems**
LECTURE -7

Inputs-outputs (I/Os)

- In a typical computer system, the user communicates with the computer via standard peripheral devices such as the keyboard, mouse, display, printer etc.
- Furthermore computers and microprocessor based systems are used in instrumentation or automatic control applications. In such cases it is necessary that the microprocessor reads the state of input devices (switches, sensors) and activate some output devices (motors, heaters, lights).
- The I/O interface is required to enable the interface between the microprocessor and the peripheral devices.
- The peripheral devices are connected on a microprocessor system through the Input/output ports.
- The I/O interface provides the following:
  – Isolation between the buses and the peripheral devices.
  – Address decoding.
  – Synchronization/Latching.

TYPES OF INPUT/OUTPUT

- **Isolated I/O**
  – I/O locations are separate from memory locations
  – Special I/O instructions are used
  – The most common technique for Intel microprocessors
  – Advantage: More space for memory
  – Disadvantage: Additional control signals (IO/M) and instructions increase complexity
- **Memory-mapped I/O**
  – I/O devices are treated as memory locations in the memory map
  – Any memory transfer instruction can be used (MOV, LDR, STR etc)
  – Advantages: Simpler decoding circuitry, no special instructions required
  – Disadvantage: A portion of the memory system is used as the I/O map, reducing the memory available to applications