

The Computer system

This is a collection of components that operate logically together to process data into information.

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The major components of a computer system are:

- i) Computer hardware**
- ii) Computer software**
- iii) Computer users (live ware).**
- iv) Data.**

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- Computer software is used to control or manage the computer resources, guide computer operations, provide security to the data, manage errors in the system.**

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Computer users

These include the ordinary users and computer professionals such as software programmers, system analysts, and system administrators, Network administrators and Database administrators.

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- Computer users' role include entering data into the system to be processed, programming, instructing the computer system, administering the network, program the system, and administration of the computer system.**

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- Data is the basis for generating information**

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COMPUTER HARDWARE

Computer hardware is used for: input of data into the system, processing of data, storage of information, output of information, and communication between computers and networks. It Generally comprises of ;

- Input devices; e.g. mouse, keyboard, joystick, game pad,
- Output devices e.g. monitor, speakers, printers, plotters

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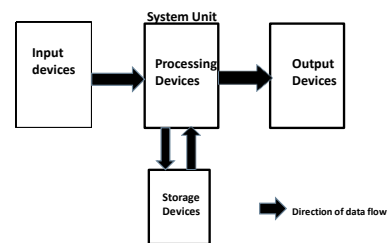
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- Processing devices e.g. the Central Processing unit
- Storage devices, e.g. Hard disk, flash disk, CD, DVD
- Communication devices e.g. MODEM, Network interface card, router, switch, etc.



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Computer System configuration



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Standalone computer



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Network computer



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The IBM system z9 mainframe

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Personal computers (PC)

- PCs are Computers designed to be used by a single user at a time usually for general purposes.
- For example desktop PC, a laptop, a netbook, tablet PC , and smartphones

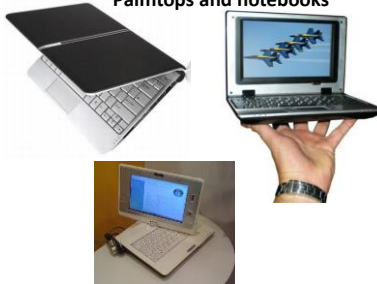
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What are the characteristics of personal computers?



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Palmtops and notebooks



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Tablet computers



Portable digital assistants (PDAs)



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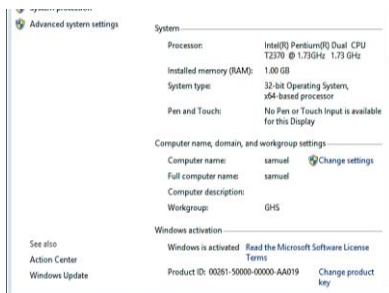
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Common PC specifications

These are the technical descriptions of the computer's components and capabilities, including:

- The hard disk capacity (usually in GBs).
- The (internal) memory capacity (GBs).
- The size of screen/monitor.
- The type of video adaptor, (determines image quality)
- The model, manufacturer, and speed of the processor (speed is measured in GHz).

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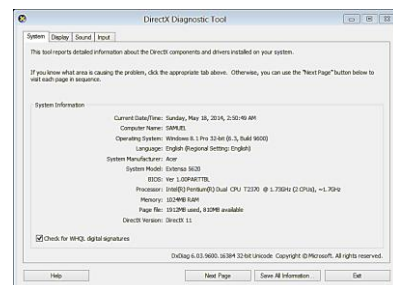
PCs are:

- Relatively small (portable-can fit in fairly small places) A small.
- Relatively inexpensive computer
- Designed for an individual user.
- General purpose. E.g. an individual can use a PC for word processing, accounting, desktop publishing, and for running spreadsheet and database

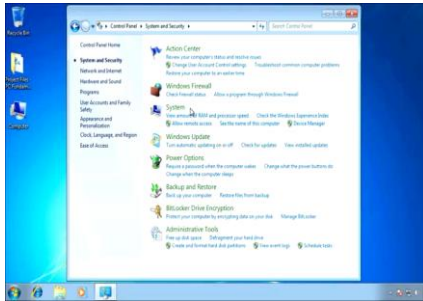
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- Available Network adaptor (wireless, 10/100 Ethernet, Gigabit Ethernet, or Bluetooth cards).
- The system infrastructure, e.g. 32-bit or 64-bit.
- The type or version of installed operating system (some are usually preferred).

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Factors to consider before acquiring a Personal computer

- ❑ **Cost of the computer**
- ❑ **Whether it is network enabled.**
- ❑ **System requirements.**
- ❑ **Authenticity of hardware and software.**
- ❑ **The monitor size.**
- ❑ **User needs.**
- ❑ **Portability.**
- ❑ **Multimedia capability e.g. type of Video graphics card.**

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- ❑ **Available/installed software i.e. Operating system**
- ❑ **Memory capacity**
- ❑ **The processor type and capacity**
- ❑ **Hard disk capacity**
- ❑ **Warranty**

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Data

- ❑ **A warrant is an assurance to the user by the manufacturer/seller, that he will repair or replace in case of any problem relating to the product which is not of the buyer's making within a given time period.**

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- ❑ **The unprocessed (raw) facts, that have no particular meaning.**
- Common examples of data include symbols, numbers, music notes, letters, text etc.**

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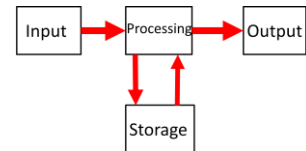
Information

- This is processed data into a meaningful and useful form to the person who receives it;
- for example, documents, reports, formula, a piece of music, and grades, date etc.

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The information processing cycle

The sequence of events that includes input, process, output and storage through which the computer system turns data into information.



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Data capture (data collection)

- The process of gathering data before it can be input into a system for processing. Including;
 - i) obtaining data from a given source(s)
 - ii) recording the data. e.g. using a camera or a note book.
- Data capture can be done using either manual methods or electronic methods.

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Manual methods of data capture

Obtaining the data using booklets, forms and questionnaires. It is relatively cheap due to absence of use of hardware and software.

Electronic methods

Collection of information using electronic devices like sensors, barcode readers, scanners and cameras.

- electronic methods are fast and accurate, but relatively expensive.

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Data logging

Collecting data over a period of time. Mostly done automatically under computer control, using sensors linked to a computer. The readings are stored in tables and can be displayed in graphs or passed to an application, such as a spreadsheet, for later analysis.

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Input of Data

Entering and sending the data into a computer system. Collected data is transformed into a form that the computer can accept as input i.e. into machine code.

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Encoding of data

Converting data into a form that can be accepted by the computer system via the available input devices.

Usually by assigning unique codes e.g. ASCII codes. Or reducing the size of files in case of audio and video files.

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Source data automation (Direct data entry methods)

The use of special equipment like scanners and digital cameras to collect data in digital format at the source and send directly to the computer system.

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Ways of automated data capture includes:

- i) Using document scanners like OMR, MICR, OCR.
- ii) Using barcode readers.
- iii) Scanning images.
- iv) Using sensors for data logging.

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Benefits of source data automation:

- It increases speed of data input process
- it reduces cost of data entry
- it reduces possibility of human errors.

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Garbage in Garbage out (GIGO)

- An expression in computing to mean that incorrect or poor quality input will always produce faulty output because the computer process data strictly basing on the data and instructions given since it has no capacity to judge what is correct or wrong.

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Data entry error types

1. Transcription (recording) errors usually as a result of typographical mistakes. These include errors of omission of characters and errors of substitution.
2. Errors of omission of characters or words e.g. "cmputer"
3. Errors of substitution e.g. "camputer" where wrong characters are used.

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- **A Transposition error is one that occurs when characters are switched places.**
- **e.g. if "erro" is typed instead of: "error".**

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Data validation

- **This is the process of checking that the data being entered into the system is the right type. Ensuring that data is in line with the set rules. It can be performed automatically by the system while the data is being entered.**

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There are four main validation techniques:

- 1) **Range check.** To ensure that data is within a specified range. e.g. A person's month of birth should be between 1 and 12.
- 2) **Presence check.** To make sure that important information is entered. The system cannot allow the data field to be left empty.

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3) Check digit. Checking that numerical data is entered accurately.

4) Data type check. Checking that text is not put where numbers are needed or vice versa.

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Data verification

The process of ensuring that data entered is accurate.

- **There are two main verification techniques:**
 - 1) **Proof reading.** By comparing the entered into the system with the original.
 - 2) **Double entry.** To compare the two versions. Any errors found are then corrected.

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Processing of data stage

Data is converted into information at this stage. The computer calculates and manipulates or compares the input data using the instructions given.

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Data processing methods

- **Manual data processing.**
- **Mechanical data processing.**
- **Electronic data processing.**

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Manual data processing

Data is processed without using any machine or tool to get the required result.

Demerits:

- It is very slow,
- It is relatively more expensive,
- It is prone to errors due to human error.

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Mechanical data processing

In mechanical data processing, data is processed by using different mechanical devices such as the Typewriter.

Merits:

- It is faster
- It is more accurate than manual data processing.

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Electronic data processing

Automated measures using simple, repetitive actions, and computer technology to process data.

It is very fast and accurate.

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The CPU (Microprocessor)

The combination of components placed on a single silicon microchip that does all the processing activity of a computer system.

The type of CPU is defined basing: manufacturer, brand/model, code name and processor generation.



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Major CPU manufacturers and brands

Intel Corporation, Advanced Micro Devices (AMD), ARM, Motorola Corporation and IBM.

Common CPU brands include Pentium, Celeron, Athlon, Phenom, etc.

A CPU may contain more than one processing unit (Multi-core processors) each called a core.

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- Xeon : by Intel with multicores for High-performance workstations and servers.
- Duo core processors : e.g. AMD Phenom II X2 and Intel Core Duo
- Tri core processors: e.g. AMD Phenom II X3 and Intel i3



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- Quad-core CPUs, e.g., AMD Phenom II X4, Intel's i5 and i7 processors.
- hexa-core CPUs, e.g., AMD Phenom II X6 and Intel Core i7 Extreme Edition 980X.
- octa-core CPUs, e.g. Intel Core i7 5960X
- deca-core CPUs, e.g. Intel Xeon E7-2850



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- Atom: low power consumption chip for mobile devices to conserve battery life and generates less heat.
- ARM system-on-a-chip (SoC). on a single lightweight and compact chip for mobile devices.
- Itanium : by Intel for use in HP high – end servers.

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Major Components of the CPU

- It is made up of: the Control Unit, the Arithmetic and Logic unit, the Registers, and system Clock.

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The control unit(CU) coordinates the work of the whole computer system:

1. It directs the operation of the processor by telling other components how to respond to instructions received.
2. It controls the input and output of data so that all signals go to the right place at the right time.

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3. It controls the flow of data to and from the CPU.
4. It receives and decodes data and instruction from memory.

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The ALU (Arithmetic logic Unit) does the actual processing of data.

□ **It has two parts:**

1. **Arithmetic unit: where arithmetic calculations take place.**
2. **Logic unit: this makes decisions.**

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Registers

Memory location in the CPU it uses to quickly accept, store and transfer data being used to avoid wasting time fetching the data from RAM. Registers have a specific storage capacity based on computer bus size, for example, a 32-bit computer has a register of 32 bits in length.

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Types of Registers vary according to the CPU design. The most commonly used registers are:

(1) Program counter (PC). This stores the memory location of the next instruction that will be needed by the CPU.

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(2) Instruction registers or current instruction register (CIR). This stores the instruction currently being executed by the CPU which are being executed.

(3) The memory data register (MDR). This holds data that has just been read from or about to be written to main memory.

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(4) Memory buffer registers (MBR). The data read from the memory location is stored in these registers.

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CPU Cache

□ **A smaller, fast memory that stores copies of the data from frequently used main memory locations to save time the CPU would take to access data from the main memory.**

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System clock

The internal clock that generates a signal to match and set the speed of all operations of the CPU and the movement of data around the other components of the computer.

Each phase in the processing cycle takes one pulse of the clock to be executed.

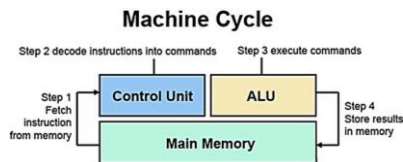
□ Hertz is the unit of measure of the clock speed (clock rate). e.g. megahertz (MHz, millions of cycles per second) or gigahertz (GHz, 1000 million cycles per second).

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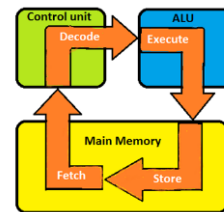
The machine cycle

□ The sequence in which the CPU processes a single instruction through successive steps of Fetch, decode, Execute and store.



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The machine cycle

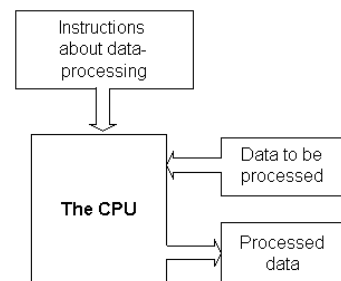


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Fetch is when the Control Unit obtains the next program instruction from memory before it can be executed.

The CPU receives at least two types of data:

1. **Data to process** (e.g. a document for printing or to save or format).
2. **The Instructions on how to handle the data** (e.g. to save or to print).



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Decode is translating the program instructions into commands the computer can process done by the Control unit.

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□ **Execute is the stage where the ALU carries out arithmetic, comparison and logical operations.**

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Store/Writeback is Sending data to memory such as the internal CPU register for quick access by subsequent instructions.

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The factors that influence the processing capacity of a CPU

1. The instruction set of the CPU. The processor's built-in code that determines how many cycles are needed to execute a given instruction.
2. The size of On-Board Cache (Level 1). The more cache there is, the more data can be stored closer to the CPU, and the faster the CPU.

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- 3) **Clock rate (clock cycles or clock speed).**
Determines how fast it processes data. The higher the clock cycles, measured in hertz, the faster is the processor;
A megaHertz equals one million instruction per second, a gigahertz equals one billion instructions per second.
- 3) **The number of CPU cores on the processor.** the more the number, the more powerful because the computer can execute more instructions at a time.

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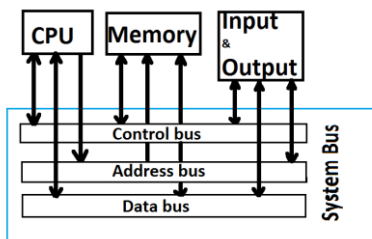
- 5) **Word size/Bus capacity.** The higher the word size, the more data a computer can process at a go. The number of bits that the CPU can process at a time measured in bits. A CPU with 32-bit word size can manipulate 32 bits at a time.

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6) The size and number of registers. The larger the register, the greater the processing power

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Control bus + Address bus + Data bus = System Bus



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The Data bus

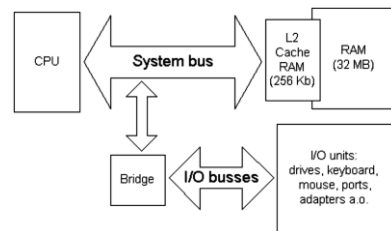
- What carries data to and from memory and between the CPU and input/output controller(Bridge). (I/O controller is an interface that manages data entering and leaving the CPU to and from I/O).
- The wider the data bus the more the amount of data it transmits.

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The system Bus

The electronic pathway through which data is transmitted between the CPU and the various computer components in the computer system. It is a combination of three separate kinds of buses: the data bus, the address bus, and the control bus.

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The address bus

It sends information from the CPU to main memory about the location in memory where data will be placed.

The width of the address bus determines the amount of primary memory that can be directly addressed.

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The control bus

The pathway that carries control signals between the CPU and other devices and signals that report the status of various devices. For example, to indicate whether the CPU is currently reading from or writing to main memory.

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Types of computer processing

These include batch, and real time processing, time sharing, and other processing types.

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Real time/reactive processing is where Data processing takes place on constantly changing input and provides immediate output to enable immediate response to output event.

- Examples include anti-missile defense systems, airplane landing control system, electronic fund transfer systems, ATM transactions, Traffic control, Heart rate monitoring, Computer games, Controlling Robots, etc.

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Advantages of real time processing

- It is fast because there is no significant delay between data input and output.
- Information is always up to date, which prompts immediate action where need arises.
- Instant results from data input.

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Disadvantages of real time processing

- It is expensive.
- It is tedious.
- It requires more frequent data backup.

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Batch processing is where data is collected in a bunch and accumulated before processing it all at once at a later time when it is necessary or efficient to do so or until a certain number have occurred or a set time has passed.

Once a batch job starts, it continues until it is done or until an error occurs.

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batch processing is usually done where:

- i) **There is large amount of data to be processed.**
- ii) **The output is not urgently needed.**
- iii) **Where there is no need of human intervention during processing.**
- iv) **Where processing is periodical or repetitive. e.g. salaries or monthly bills.**

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- **There is no need of special hardware to support data input.**
- **Batch processing can take place off-line which reduces cost.**
- **Can easily and quickly handle large amount of data processing at lower processing cost.**

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Time-sharing processing (multi-user processing): Processing method where the CPU allocates slices of time to different users on a computer system to enable them independently run different or the same program on the same computer during the same time.

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Advantages of batch processing over real-time processing

- **It is usually done during less busy times, when computer resources are less needed.**
- **Jobs are queued in order to share computer resources fairly.**
- **Repetitive jobs are done quickly due to absence of interruptions once batch processing starts.**

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Disadvantages of Batch processing

- **There is delay between data collection of data and output.**
- **Data is not always up to date.**
- **It may be too late to rectify an error once a batch run is in process.**
- **It is not possible to correct errors during the processing.**
- **Sorting data is time consuming.**

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- **It provides many users the opportunity to use the system.**
- **All users get the equal amount of processing time.**
- **It is possible to interact with the running program.**

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Interactive(transactional) processing is a two-way communication between the user and computer system, involving continual exchange of responses between the computer and the user during processing. Once the transaction is accepted, the database will be updated. Examples include electronic fund transfer systems, tickets reservation systems, and point-of-sales systems.

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On-line transaction processing (OLTP) uses a terminal (input) that is remote from the CPU. The user is linked directly to a computer for the purpose of data input or receiving output.

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Centralised processing is where all data processing operations are executed by the central computer and the access to the central computer is via dumb terminals from which the user sends input and receives output

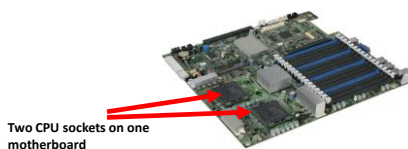
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Distributed processing is carried out by more than one computer where the system consists of independent computers installed at different sites, and inter-connected by a network, each of the computers performing independent data processing.

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Multiprocessing(parallel processing)

is the simultaneous execution of data using two or more central processing units (CPUs) within a single computer system.



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Pipelining (pipeline processing). A computer processing technique where the CPU executes more than one instruction at a time by beginning to execute another instruction before the previous is completed.

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□ **Several instructions are in the pipeline, each at a different processing stage to produce a steady stream of information and increase productivity of the processor.**

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Multitasking/Multiprogramming is The apparent simultaneous performance of two or more tasks by a computer's central processing unit.



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