Advanced Microcontrollers & Applications (EC-506)

(Class: ECE- 5th Semester, Academic session: July-Dec, 2020)

Chapter 1

Introduction to Embedded System

Presented by:

Vijay Kumar

Assistant Professor

ECE, UIET, PU, CHD

1. Introduction to Embedded system

1.1 Define basic concept of embedded system

1.2 Characteristics of Embedded system

1.3 Operating system (O.S)

1.4 Types of operating system

1.5 Types of Mobile operating system

1.6 Characteristics of Real Time operating system

1.7 Comparison of different operating systems used for embedded system

1.1 Basic concept of Embedded System

Definition 1:

➤ An embedded system is a system that has software embedded into computer-hardware, which makes a system dedicated for an application(s) or specific part of an application or product or part of a larger system.

➤ An embedded system is one that has a dedicated purpose software embedded in a computer hardware.

➤ Examples : Printers, Home appliances (camcorders, TVs, Washing machines , Microwave Ovens etc.), Audio Video devices (Webcam, mic, speakers etc.)

Definition 2:

Embedded system is a dedicated computer based system for an application(s) or product. It may be an independent system or a part of large system. Its software usually embeds into a ROM (Read Only Memory) or flash.

Definition 3:

➢ An embedded system is a dedicated computer system, designed to work for single or few specific functions often within a larger system.

➢ Embedded Systems, therefore, are built to function with little or no human intervention.

➢ Specially designed keeping in consideration the tasks that need completion in the most efficient way.

➢ Most of our gadgets like washing machines, microwave ovens, ATMs and mobile phones have embedded-system in them.

Embedded System Development

Embedded System Development

Hardware Development

Software Development
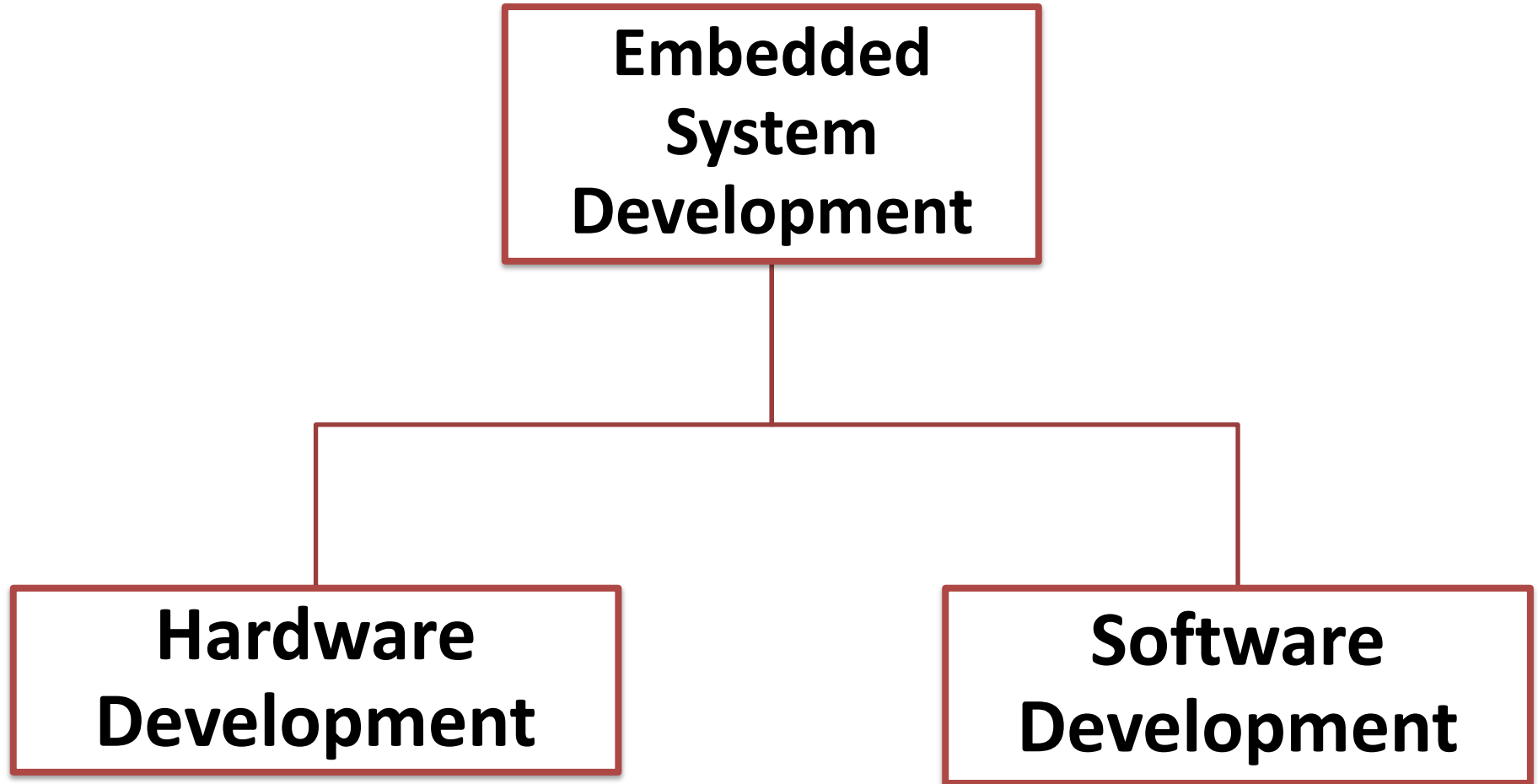
Microcontroller as core of Embedded System

- Microcontroller is an IC chip that takes input, process data according to program written in its memory and gives output as control signal for controlling other machines and devices.

- A microcontroller (sometimes abbreviated μC, uC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals.

Microcontroller Based Electronic Devices

- Example of electronic devices using microcontrollers are : Digital Watches, Washing Machines, Mobile Phones, Microwave Ovens etc.
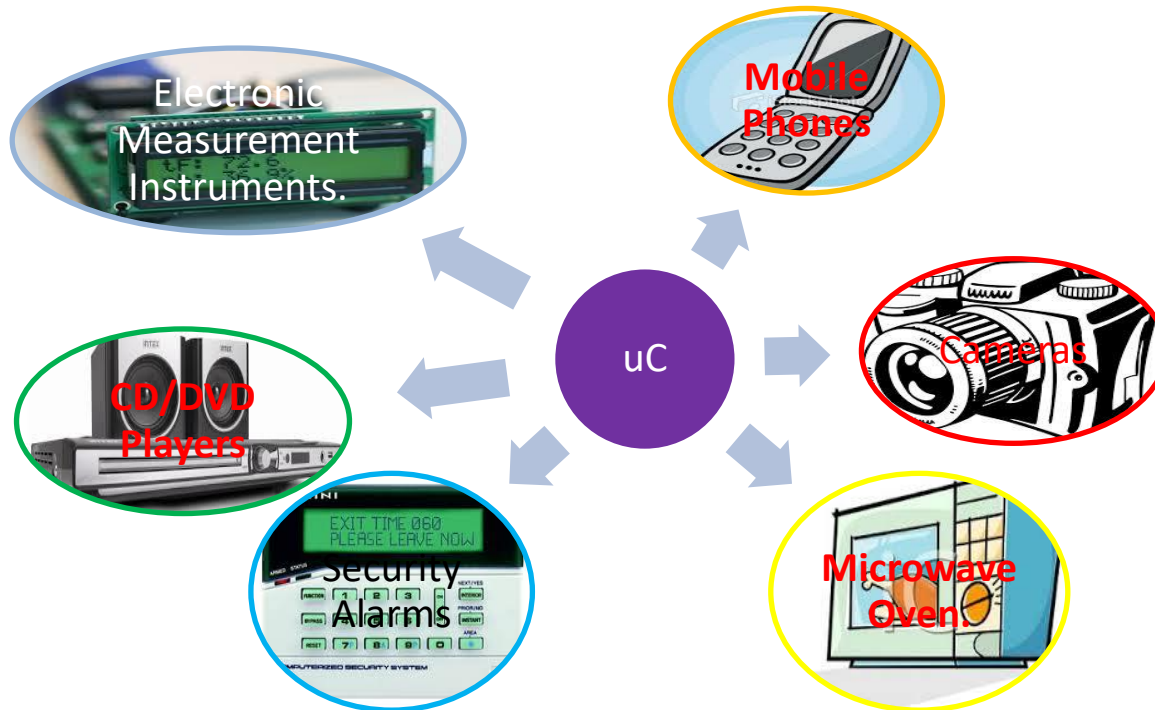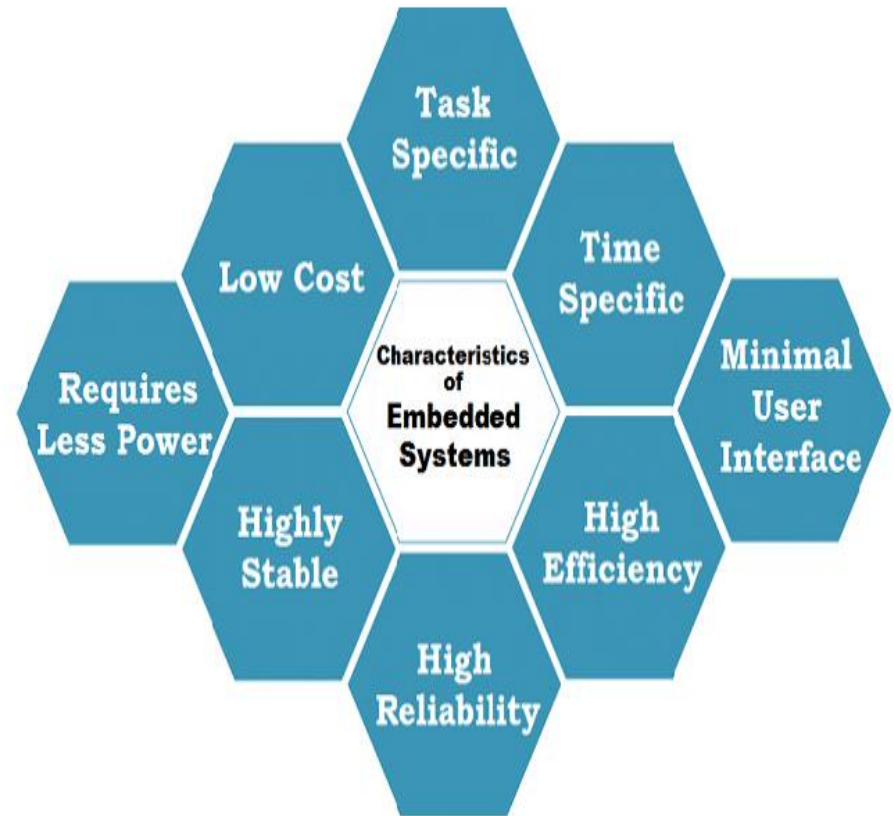
1.2 Characteristics of Embedded Systems

1.2.1 Task Specific:

All Embedded systems are task specific. They do the same task repeatedly /continuously over their lifetime.

Example: An mp3 player will function only as an mp3 player.

Fig 1: Key characteristics of embedded systems

1.2.2 Time Specific

Embedded systems are created to perform the task within a certain time frame. It must therefore perform the task fast enough.

Example: A car's brake system, if exceeds the time limit, may cause accidents.

1.2.3 Minimal User Interface

They have minimal or no user interface (UI). A fully automatic washing machine works on its own after the programme is set and stops once the task is over.

1.2.4 High Efficiency, Low cost and consume less power

Embedded systems are built to achieve certain efficiency levels. They are small sized, can work with less power and are not too expensive.

1.2.5 High reliability and stability

➢ Embedded systems cannot be changed or upgraded by the users. Hence, they must rank high on reliability and stability. They are expected to function for long durations without the user experiencing any difficulties.

➢ Microcontroller or microprocessors are used to design embedded systems.

➢ Embedded systems need connected peripherals to attach input & output devices.

➢ The hardware of an embedded-system is used for security and performance. The Software is used for features
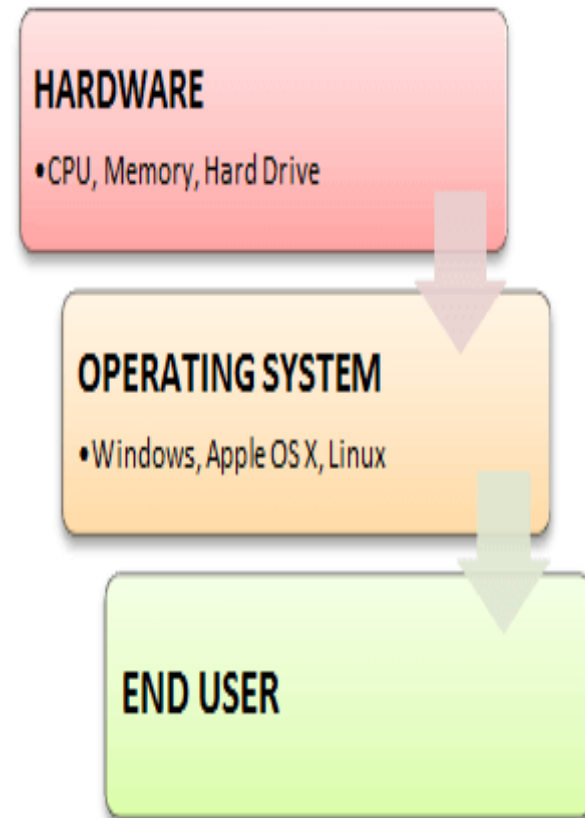
1.3 Operating system (OS)

- **Operating System (OS)** is one of the core software program that runs on the hardware and makes it usable for the user to interact with the hardware so that they can send commands (input) and receive results (output).

- It provides a consistent environment for other software to execute commands. It acts at the center through which the system hardware, other softwares, and the user communicate.
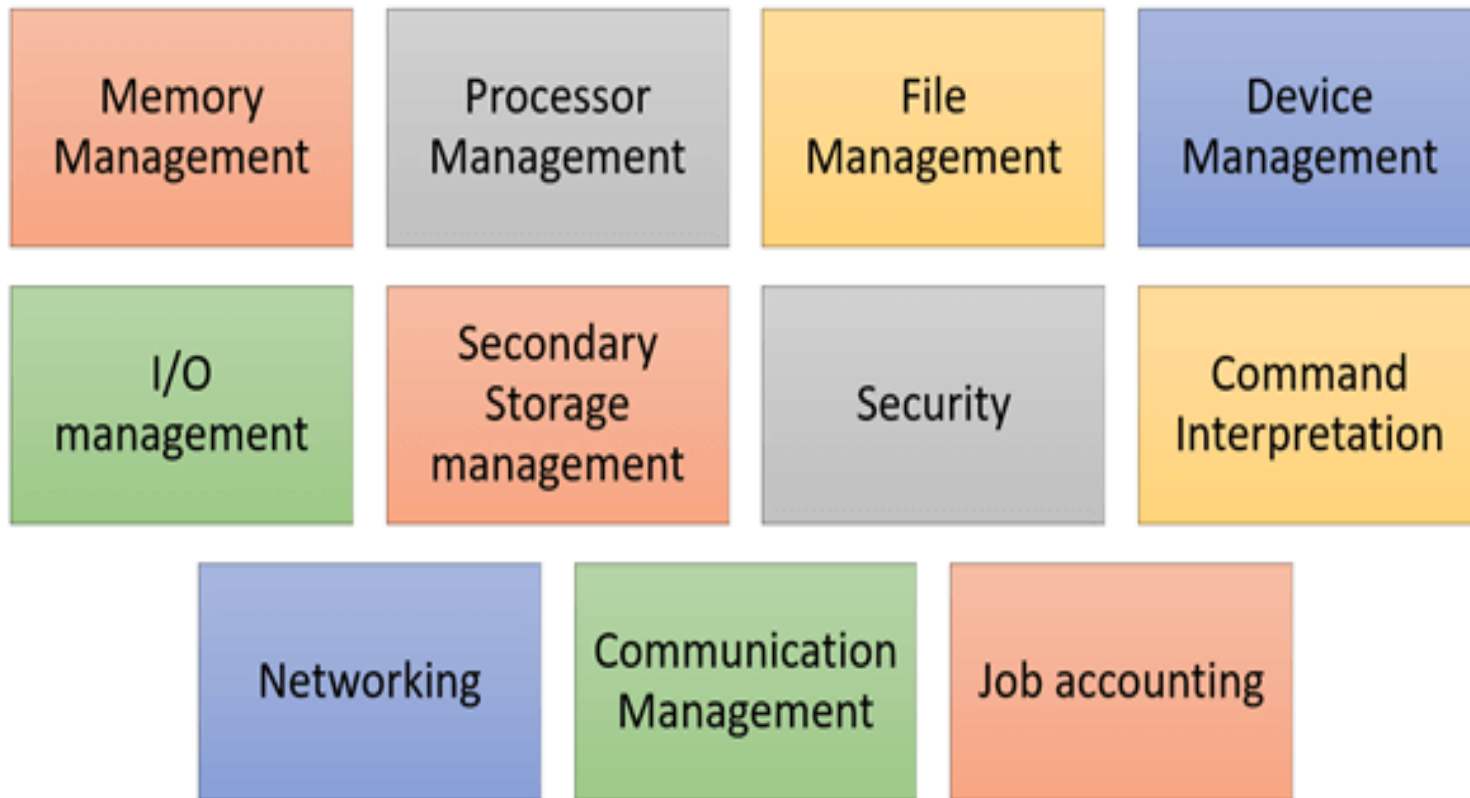

Fig 2: OS working as core part

Operating system

- OS is Interface between end user and computer hardware.

- An application like Chrome, MS Word, Games, etc needs some environment in which it will run and perform its task.

HARDWARE
- CPU, Memory, Hard Drive

OPERATING SYSTEM
- Windows, Apple OS X, Linux

END USER

Functions of an operating system

Memory Management	Processor Management	File Management	Device Management
I/O management	Secondary Storage management	Security	Command Interpretation
	Networking	Communication Management	Job accounting

Function of an Operating System

Functions of operating system

- **Process management**:- Process management helps OS to create and delete processes. It also provides mechanisms for synchronization and communication among processes.

- **Memory management:-** Memory management module performs the task of allocation and de-allocation of memory space to programs in need of this resources.

- **File management**:- It manages all the file-related activities such as organization storage, retrieval, naming, sharing, and protection of files.

Secondary-Storage Management: Systems have several levels of storage which includes primary storage, secondary storage, and cache storage. Instructions and data must be stored in primary storage or cache so that a running program can reference it.

Security:- Security module protects the data and information of a computer system against malware threat and authorized access.

Command interpretation: This module is interpreting commands given by the and acting system resources to process that commands.

Networking: A distributed system is a group of processors which do not share memory, hardware devices, or a clock. The processors communicate with one another through the network.

- **Device Management**: Device management keeps tracks of all devices. This module also responsible for this task is known as the I/O controller. It also performs the task of allocation and de-allocation of the devices.

- **I/O System Management:** One of the main objects of any OS is to hide the peculiarities of that hardware devices from the user.

- **Job accounting**: Keeping track of time & resource used by various job and users.

- **Communication management**: Coordination and assignment of compilers, interpreters, and another software resource of the various users of the computer systems.
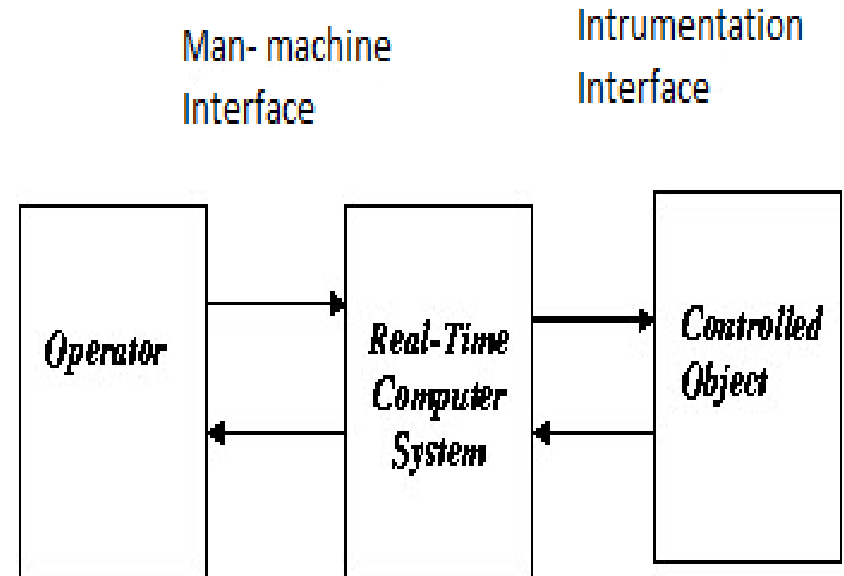
1.4 Types of Operating System

1.4.1 Real-time Operating System (RTOS)

- The real time operating system performs real-time applications i.e. response to inputs immediately.

- Task will be completed in specified time and RTOS responses in a predictable way to unpredictable events.

- RTOS is of two types :
  - Soft real time operating system
  - Hard real time operating system

Types of Real Time Operating System (RTOS)

Soft RTOS:

- It has certain deadlines, may be missed and they will take action at t=0+.

- Does not constrained to extreme rules.

- Critical time of this OS is delayed to some extent.

- Examples of soft RTOS are Digital camera, Mobile phones and online data etc.

Man- machine Interface

Intrumentation Interface

Operator

Real-Time Computer System

Controlled Object

Types of Real Time Operating System (RTOS)

<u>Hard RTOS:</u>

- It is predicted by a deadline.

- The predicted deadline will start at time t=0.

- Examples of Hard RTOS are: Air bag control in cars, anti-lock brakes and engine control system etc.

1.4.2: Multitasking Operating system

- OS can work on more than one task at a time by switching between the tasks very rapidly. Tasks may pertain to single user or multiple users.

- A multitasking OS can save the current state of each user and task so that it does not lose its place when it comes back to a task to resume its work.

- Examples : open and operate web browser and MS word at same time.

- The multitasking OS is of two types they are preemptive and cooperative.

  – Cooperative: OS will not interrupt a process with a context switch while the process is running but will instead wait for the process to finish.

  – Preemptive: Preemption will automatically switch between processes at defined intervals. This allocates resources evenly among all processes.

1.4.3: Network Operating system (NOS)

- It allows several multiple computers connected to a LAN (Local Area Network).

- There is two type of network OS they are:

  Peer to Peer: allow users to share resources and files located on their computers and to access shared resources found on other computers. However, they do not have a file server or a centralized management source.

Peer to Peer Network "Workgroup"

Computer A | Computer B | Computer C | Laptop A | Hub

22

Network Operating system Types

Client/Server:

There is a file server and a directory server which is used to manage user accounts and access controls. Every user account is created on the directory server and then each computer, laptop and other servers are joined to a domain where authentication is centralized for logins and resource permissions.
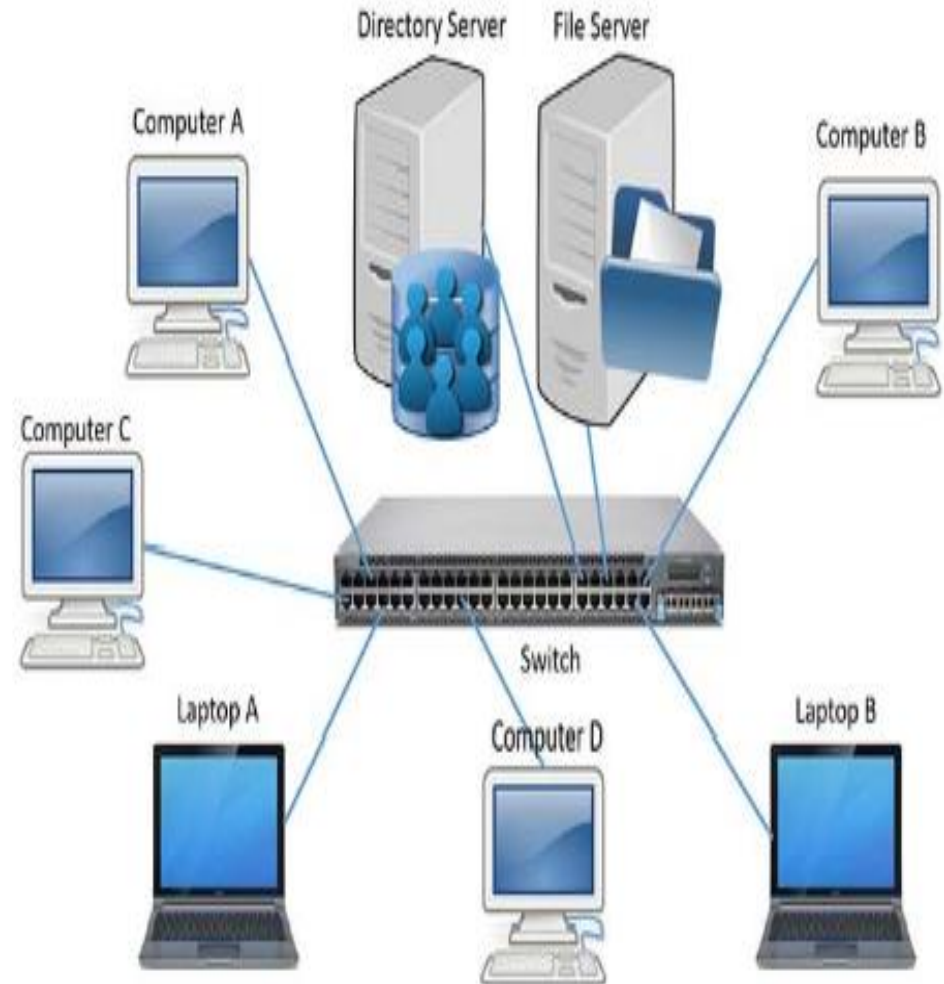
1.4.4: Distributed Operating system

- The distributed operating system is defined as a collection of independent computers that are used to perform a single task jointly.

- Examples of distributed OS: intranets, the internet, sensors networks, etc.

1.4.5: Batch Operating system

- It collects the input data into batches and each batch is processed as a unit.

- Examples of the batch operating system: transactions, payroll system, bank statements, reporting, integration, etc.

1.5 Mobile Operating system and types

- A mobile operating system, also called a *mobile OS*, is an operating system that is specifically designed to run on mobile devices such as mobile phones, smartphones, PDAs, tablet computers and other handheld devices.

- **Types of Mobile OS:**

➢ **Android OS (Google Inc.):**

  ▪ Google's open and free software .

  ▪ includes an operating system, middleware and also key applications for use on mobile devices, including smartphones.

  ▪ Updates have been developed under "**dessert-inspired**" version names (Cupcake, Donut, Eclair, Gingerbread, Honeycomb, Ice Cream Sandwich, Jelly Bean, KitKat, Lollipop, Marshmallow, Nougat, Oreo, Android 9 Pie, Android 10 (no dessert name)) with each new version arriving in alphabetical order with new enhancements and improvements.

➢ **iPhone OS / iOS (Apple):**

▪ Apple's iPhone OS was originally developed for use on its iPhone devices.

▪ Supported on a number of Apple devices including the iPhone, iPad, iPad 2 and iPod Touch.

▪ iOS mobile operating system is available only on Apple's own manufactured devices as the company does not license the OS for third-party hardware.

Symbian OS (Nokia):

- Symbian was **Nokia's operating system**, developed and sold by Symbian Ltd.

- Targeted at mobile phones that offers a high-level of integration with communication and personal information management functionality.

- Fast texting, taking pictures, voice control, quick dialing, some PDA features and thousands of different apps.

- Nokia does not maintain Symbian as an open source development project.

- **Palm OS:**

  - Palm OS is the mobile operating system developed by Palm Inc. in 1996.

  - It was designed to make the touchscreen-based interface easier in usage. It is one of the really simple mobile phone operating systems to master but the platforms multitask inability may cause some users to refuse it.

- **Windows Mobile:**

  - Windows Mobile is Microsoft's mobile operating system used in smartphones and mobile devices – with or without touchscreens.

  - Provides a lot of large text and a simple interface.

- **Web OS:**

  - Also known as LG web OS and Open web OS

  - Web OS is a Linux-based operating system for smartphones.

  - Supports multitasking