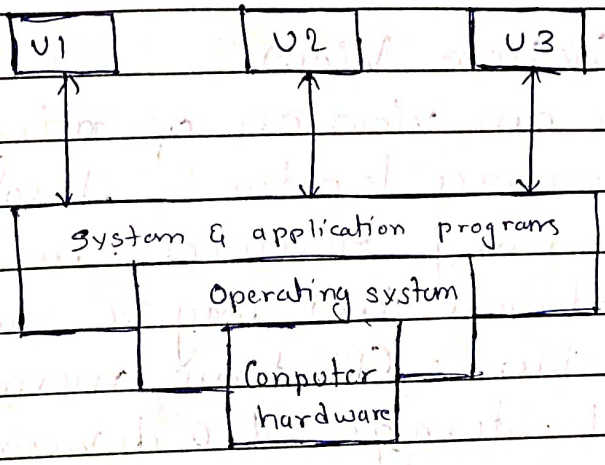
Operating System
Module - 1

An operating system is an important part of almost every computer. A computer system is roughly divided into four components : The hardware, The operating system, The application programs, and the users.



- The hardware - The Central processing unit (CPU) the memory and the I/O devices provides the basic computing resources. The application program such as word processors, spreadsheets, compilers and web browsers define the ways in which these resources are used to solve the computing problem of the user.

The operating controls ~~the~~ and co-ordinates the use of the hardware among the various application programs for the various users.

OS explored from two viewpoints : The user & The system.

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1) The User View.

The user view of the computer varies by the interface being used. Most computer user sit in front of a PC, Consisting of a monitor, Keyboard, mouse and system unit, such a ~~design~~ system is designed for one user to monopolize it's resources to maximize the work that the user is performing.

2) System View.

- We can view an operating system as a "Resource locator". A computer system has many resources - hardware and software that may be required to solve problems: CPU time, memory space, file storage, I/O devices and so on.
- The operating system acts as the manager of these resources, facing numerous and possibly conflicting requests for resources, the operating system must ~~be~~ decide how to allocate them to specific programs and users so that it can operate the computer system efficiently and fairly.

Date :
Page No :

* Mainframe system.

Mainframe computer systems were the first computers used to tackle many commercial and scientific applications.
The growth of mainframe system traces from simple batch systems, where the computer runs one and only one application, to time shared systems, which allows for user interaction with the computer system.

* Desktop systems

Personal computer PC's appeared in the 1970's. During their first decade, the CPU's in PC's lacked the features needed to protect an operating system from user programs. PC operating systems therefore were neither multiuser nor multitasking. However, the goals of these operating system have changed with time; instead of maximizing CPU and peripheral utilization, the systems opt for maximizing user convenience and responsiveness.

* Multi processor system:

Multi processor systems (also known as parallel systems or tightly coupled systems) are growing in importance. Such system have more than one processor in close

communication, sharing the computer bus, the clock, and sometimes memory and peripheral devices.

this systems have three main advantages.

1) Increased throughput.

By increasing the number of processors we hope to get more work in less time. the speed up ratio with n processors is not N; rather, it is less than N. when multiprocessors cooperate on a task a certain amount ~~amount~~ of overhead is incurred in keeping all the parts working properly.

Similarly a group of N programmers working closely together does not result in N times the amount of work being accomplished.

2) Economy scale.

Multi processor systems can save more money than multiple single-processor system because they share peripherals, mass storage and power supplies, if several programs operate on the same set of data, it is cheaper to store the data on one disk ~~to~~ and to have all the processors share them than to have many computers with local disks and many copies of the data.

3) Increased Reliability.

If functions can be distributed properly among the several processors, then the

failures of one processor will not halt the systems, only slow it down, if we have ten processors and one fails, then each of the remaining nine processors must pick up a share of work of the failed processors. Thus, The entire system runs only 10 persent slower, rather than failing altogether. this ability to continue providing service proportional to the level of surviving hardware is called graceful degradation. system designed for graceful degradation are also called fault tolerant.

* Distributed Systems

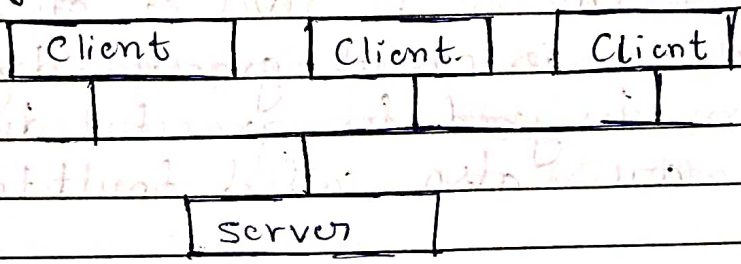
A. A network in the simplest form, is a communication path b/w two or more systems Distributed systems depends on networking for their functionality. by being able to communicate, distributed systems are able to share communicational tasks, and provide a rich set of features to users.

• Networks are typecast based on the distances b/w their nodes.

→ LAN
→ WAN
→ MAN
→ Client Server System.

• As PC's have become faster, more powerfull & cheaper, designers have shifted away from the centralized system architecture, Terminals

connected to centralized systems are now being supplanted by PC's. correspondingly, user interface functionality that used to be handled directly by the centralized system is increasingly handled by the PC's. As a general structure of a client-server system is



Server system can be broadly categorized as compute servers and file servers.

- Compute-Server systems: Provide an interface to which clients can send requests to platform an action, in response to which they execute the action and send back results to the client.
- File server system: it provides a file system interface where clients can create, update, read and delete files.

→ Peer-to-Peer System.

In contrast to the tightly coupled system, the computer networks used in these applications consists of a collection of processors that do not share memory or a clock. Instead each processor has it's own local memory. The processors communicate

with one another through various communication lines, such as high speed buses or telephone lines. These systems are usually referred to as loosely coupled systems (Distributed systems)

* Clustered Systems.
- Like parallel systems, clustered systems gather together CPUs to accomplish computational work. clustered systems differ from parallel systems, however in that they are composed of two or more individual systems coupled together.
- Clustering is usually performed to provide high availability. A layer of cluster software runs on the cluster nodes, Each node can monitor one or more of the others if the monitored machine fails, the monitoring machine can take ownership of it's storage and restart the application that were on the failed machine.

* Real-time System
A real time system is used when rigid time requirements have been placed on the operation of a processor or the flow of data. Thus, it is often used as a control device in a dedicated applications. Sensors bring data to the computer. The computer must analyse the data and possibly adjust controls to modify the sensors input. Systems

that control scientific experiments, medical imaging systems, industrial control systems, and certain display systems are real-time systems.

Real time system come in two flavors : hard & Soft
A hard real time system gaurantees that critical tasks be complete on time.
This goal requires that all delays in the system be bounded, from the retrieval of stored data to the time that it takes the operating system to finish any request made of it. such time constraints dictate the facilities that are available in hard real-time systems.

A Soft hard real time system, where a critical real time tasks gets priority over other tasks and retains that priority until it completes. As in hard real time systems, the operating system Kernal delays need to be bounded. A real time task cannot be kept waiting indefinitely for the Kernal to run it.
Soft real time is an achievable goal that can be mixed with other types of systems.

Date :
Page No :

* Handheld Systems

Handheld system include personal digital assistants, such as palm-pilots or cellular telephones with connectivity to a network such as the internet.

Virtual memory allows developers to write programs that behave as if the system has more memory than may be physically available. currently many handheld devices do not use virtual memory techniques thus forcing program developers to work within the confines of limited physical memory.

Some handheld devices may use wireless technology, such as bluetooth, allowing remote access to email & web browsing. cellular telephones with connectivity to the internet fall into this category.

* Computer Environments.

1) Traditional Computing.
2) Web based computing.
3) Embebbed computing.

1) Traditional computing

As computing matures, the lines among many of the traditional computing environments are blurring. Consider the "typical office network". Just a few years ago, this environment consisted of PC's connected to a network with servers providing file and print service.

Remote access awkward, and portability was achieved by laptop computers carrying some of the user's workspace. Terminals attached to mainframes were prevalent at many companies as well, with even fewer remote access and portability options.

2) Web-based computing
web computing has increased the emphasis on networking. Devices that not previously networked now have wired or wireless access. Devices that were networked now have faster network connectivity, either by improved networking technology, optimized network implementation code or both.
The implementation of web based computing has given rise to new categories of devices, such as load balancers which distribute network connections among a pool of similar servers.

3) Embedded computing
Embedded computers are the most prevalent form of computers in existance. They run embedded real time operating systems. These devices are found everywhere from car engines and manufacturing robots to VCR's and microwave ovens. They tend to have very specific tasks.

Date :
Page No :

* System Components
1. Process management
- Main memory management
- File management
- I/o System management
- Secondary story management
- Networking
- Protection system
- Command interpreter system.

→ Process management.
A program does nothing unless it's instructions are executed by a CPU. A process can be thought of as a program in execution, but it's definition will broaden as we explore it further. A time shared user program such as a compiler is a process. A word processing program being run by an individual user on a PC is a process. A system task, such as sending output to a printer is also a process.

→ The operating system is responsible for the following activities in connection with process management.
- Creating & deleting both user & system processes
- Suspending & resuming processes
- Providing mechanisms for process synchronizati
- Providing mechanisms for process communication
- Providing mechanisms for deadlock handling.

Date :
Page No :

→ Main memory management:
Main memory is a large array of words or bytes ranging in size from hundreds of thousands to billions. Each word or byte has it's own address. Main memory is a repository of quickly accessible data shared by the CPU and I/O devices. The central processor reads instructions from main memory during the instruction fetch cycle and it both reads and writes data from main memory during the data-fetch cycle. The I/O operations implemented via DMA also read and write data in main memory.

→ Operating system is responsible for the following activities in connection with memory management.
- Keep track of which parts of memory are currently being used and by whom
- Deciding which processes are to be loaded ~~to be~~ into memory when memory space becomes available.
- Allocating and deallocating memory space as needed.

→ File management:
File management is one of the most visible components of an operating system. Computers can store information on several different types of physical media. magnetic type.

magnetic disk, and optical disk are the most common ~~tide~~ media. each of these media has its own characterstics and physical organization. each medium is controlled by a device, such as a disk drive or tape drive, that also has unique characterstics.

→ The operating system is responsible for the following activities in connection with the file management.

- Creating & deleting files
- Creating & deleting directories
- Supporting primitives for manipulating files and directories
- Mapping files onto secondary storage
- Backing up files on stable storage medium.

→ I/O Operating System Managemcint

One of the purposes of an operating system is to hide the peculiarities of specific hardware devices from the user.

→ The operating system is responsible for the following activities in connection with disk management.

- Free space management
- Storage allocation
- Disk scheduling.

→ Networking

- A distributed system is a collection of processors that do not share memory, peripheral devices, or a clock. Instead each processor has it's own local memory and clock, and the processors communicate with one another through various communication lines, such as high speed busses or networks.
- The processors in a distributed system vary in size and function.

* Operating system Services.

- An operating system provides an environment for the execution of programs, it provides certain services to program and to the users of those programs. The specific services provided of course differ from one operating system to another but we can identify common classes.

1) Program execution :-
The system must be able to load a program into memory and to run that program. The program must be able to end it's executing, either normally or abnormally

2) I/O operations
A running program may require I/O. This I/O may involve a file or an I/O device for specific devices, special functions may

be desired. For efficiency and protection, users usually cannot control I/O devices directly. Therefore, the operating system must provide a means to do I/O.

3) File system manipulation :-
The file system is of particular interest. Obviously, programs need to read and write files. Programs also need to create and delete files by name.

4) Communication :-
In many circumstances, one process needs to exchange information with another process. Such communication can occur in two major ways. The first takes place b/w processes that are executing on different computer systems that are tied together by a ~~computer~~ computer network.

5) Error detection
The operating system constantly needs to be aware of possible errors. Error may occur in the CPU and memory hardware, in I/O devices, and in the user program. For each type of error, the operating system should take the appropriate action to ensure correct and consistent computing.

6) Resource allocation:
When multiple users are logged on the system or multiple jobs are running at the same time, resources must be allocated to each of them. Many different types of resources are managed by the operating system.

7) Protection
The owners of information stored in a multiuser computer system may want to control use of the information. When several disjointed processes execute concurrently, it should not be possible for one process to interfere with the others, or with operating system itself. protection involves ensuring that all access to system resources is controlled.

* System Calls
- System calls provide the interface between a process and the operating system. These calls are generally available as assembly-language instructions.
- System calls can be grouped roughly into five major categories:

1) Process control
2) File management
3) device management
4) Information maintainance
5) Communication.

Date :
Page No :

1) Process Control.
- end, abort
- load, execute
- create process, terminate process
- get process attributes, set process attributes
- Wait for time
- wait event, Signal event
- Allocate and free memory

2) File management
- create file, delete file
- open, close
- read, write, reposition
- get file attributes, set file attributes.

3) Device management
- Request device, Release device
- read, write, reposition
- get device attributes, set device attributes
- logically attach or detach devices.

4) Information maintainance
- get time or date, set time or date
- get system data, set system data
- get process, file or device attributes
- Set process file or device attributes.

5) Communication
- create, delete communication connection
- Send, receive message
- transfer status information
- attach or detach remote devices.

Date :
Page No :

* System programs.

A. System programs provide a convenient environment for program development and execution they can be divided into these categories:

1) File management:
These programs create, delete, copy, rename, print, dump, list, and generally manipulate files and directories.

2) Status information:
some programs simply ask the system for the date, time, account of available memory or disk space, number or users or similar status

3) File modification:
Several text editors may be available to create and modify the content of files stored on disk or or take.

4) Programming-language support:
Compilers, assemblers, and interpreters for common programming languages are often provided to the user with the operating system, some of these programs are now priced are provided separately.

5) Program loading & execution.
Once a program is assembled or compiled, it must be loaded into memory to be executed. The system may provide absolute loaders, relocatable loaders, linkage editors and overlay loaders. Debugging system for either higher-level language or machine language are needed also

6) Communication.
These programs provide the mechanism for creating virtual connections among processes, users and different computer system, they allow users to send messages to one another's screen's, to browse web pages to send electronic-mail messages, to log in remotely or to transfer files from one machine to another.

* System structure
1) Simple Structure - MS DOS
2) Layered structure / Approach - Unix
3) Micro Kernals - Mac OS
4) Modular approach - Solaris.

- Operating system can be implemented with the help of various structures
- The structure of the OS depends mainly on

how the various components are interconnected and put inside the Kernel Depending on this we have the following structures.

1) Simple Structures
Such operating system donot have a well defined structure & They are small simple & limited system, they interfaces and the levels of functionality are not well seperated
ex:- MS-DOS in MS-DOS application programs are able to access the I/O routines this can cause the entire OS to crash if the user program fails.

Advantages:
1. It gives Better application performance because of the few interfaces b/w application program & hardware
2. Easy for development

Dis advantages
The structure is very complicated as there is the clear Boundaries b/w the modules.

2) Layered Approach

The OS can be broken downed into no of layers or levels, the bottom most layer or lower layer is the hardware and the top most layer is the user interface, these layers are designed in such a way that each layer uses the functions of the lowers layer only, this eases the process the debugging.

ex:- Unix

Advantages

1) Implementation of a layer can be changed without effect the other layers.
2) It is easy to perform debugging & error verification

Dis-advantage

It requires carefull planning as to which functionals should be implemented in which layer as each layer can only make use of the service provided by the lower levels.

3) Micro Kernels :-

This structure designs the OS by removing all non-essential components from the Kernel and implementing them a system and user program. this results in a smaller Kernel called the micro Kernel, any new service can be added as the system program or user program and does not require the Kernel to be modified, This is more reliable bcoz even if a service fails the OS remains untouched.

ex:- MAE OS

Advantages:

It makes OS portable to various platform.

Disadvantages:

Performs may be degraded due to it's simpler structure.

ii) Modular approach

It is one of the best approach for designing the OS it involves designing of a modular kernel, the kernel has only the set of core components and the other services or components are added as dynamically loadable modules to the kernel, it is more flexible than the layered approach as one module can communicate with another module ex:- Solaris.

* System programes