OPERATING SYSTEM TUTORIAL

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Following are some of important functions of an operating System.

- Memory Management
- Processor Management
- Device Management
- File Management
- Security
- Control over system performance
- Job accounting
- Error detecting aids
- Coordination between other software and users

Memory Management

Memory management refers to management of Primary Memory or Main Memory. Main memory is a large array of words or bytes where each word or byte has its own address.

Main memory provides a fast storage that can be access directly by the CPU. So for a program to be executed, it must in the main memory. Operating System does the following activities for memory management.

- Keeps tracks of primary memory i.e. what part of it are in use by whom, what part are not in use.
- In multiprogramming, OS decides which process will get memory when and how much.
- Allocates the memory when the process requests it to do so.
- De-allocates the memory when the process no longer needs it or has been terminated.

Processor Management

In multiprogramming environment, OS decides which process gets the processor when and how much time. This function is called process scheduling. Operating System does the following activities for processor management.

- Keeps tracks of processor and status of process. Program responsible for this task is known as traffic controller.
- Allocates the processor (CPU) to a process.
- De-allocates processor when processor is no longer required.

File system manipulation

A file represents a collection of related information. Computer can store files on the disk (secondary storage), for long term storage purpose. Few examples of storage media are magnetic tape, magnetic disk and optical disk drives like CD, DVD. Each of these media has its own properties like speed, capacity, data transfer rate and data access methods.

A file system is normally organized into directories for easy navigation and usage. These directories may contain files and other directions. Following are the major activities of an operating system with respect to file management.

- Program needs to read a file or write a file.
- The operating system gives the permission to the program for operation on file.
- Permission varies from read-only, read-write, denied and so on.
- Operating System provides an interface to the user to create/delete files.
- Operating System provides an interface to the user to create/delete directories.
- Operating System provides an interface to create the backup of file system.

Communication

In case of distributed systems which are a collection of processors that do not share memory, peripheral devices, or a clock, operating system manages communications between processes. Multiple processes with one another through communication lines in the network.

OS handles routing and connection strategies, and the problems of contention and security. Following are the major activities of an operating system with respect to communication.

- Two processes often require data to be transferred between them.
- The both processes can be on the one computer or on different computer but are connected through computer network.
- Communication may be implemented by two methods either by Shared Memory or by Message Passing.

First Come First Serve (FCFS)

- Jobs are executed on first come, first serve basis.
- Easy to understand and implement.
- Poor in performance as average wait time is high.

Process	Arrival Time	Execute Time	Service Time
P0	0	5	0
P1	1	3	5
P2	2	8	8
P3	3	6	16

Wait time of each process is following

Process	Wait Time : Service Time - Arrival Time
P0	0 - 0 = 0
P1	5 - 1 = 4
P2	8 - 2 = 6
P3	16 - 3 = 13

Average Wait Time: (0+4+6+13) / 4 = 5.55

Shortest Job First (SJF)

- Best approach to minimize waiting time.
- Impossible to implement
- Processer should know in advance how much time process will take.

Process	Arrival Time	Execute Time	Service Time
P0	0	5	0
P1	1	3	3
P2	2	8	8
P3	3	6	16

Wait time of each process is following

Process	Wait Time : Service Time - Arrival Time
P0	3 - 0 = 3
P1	0 - 0 = 0
P2	16 - 2 = 14
P3	8 - 3 = 5

Average Wait Time: (3+0+14+5) / 4 = 5.50

Priority Based Scheduling

- Each process is assigned a priority. Process with highest priority is to be executed first and so on.
- Processes with same priority are executed on first come first serve basis.
- Priority can be decided based on memory requirements, time requirements or any other resource requirement.

Process	Arrival Time	Execute Time	Priority	Service Time
P0	0	5	1	0
P1	1	3	2	3
P2	2	8	1	8
P3	3	6	3	16

Wait time of each process is following

Process	Wait Time : Service Time - Arrival Time
P0	0 - 0 = 0
P1	3 - 1 = 2
P2	8 - 2 = 6
P3	16 - 3 = 13

Average Wait Time: (0+2+6+13) / 4 = 5.25

Polling

Polling is a process by which a host waits for controller response. It is a looping process, reading the status register over and over until the busy bit of status register becomes clear. The controller uses/sets the busy bit when it is busy working on a command, and clears the busy bit when it is ready to accept the next command. The host signals its wish via the command-ready bit in the command register. The host sets the command-ready bit when a command is available for the controller to execute.

In the following example, the host writes output through a port, coordinating with the controller by handshaking

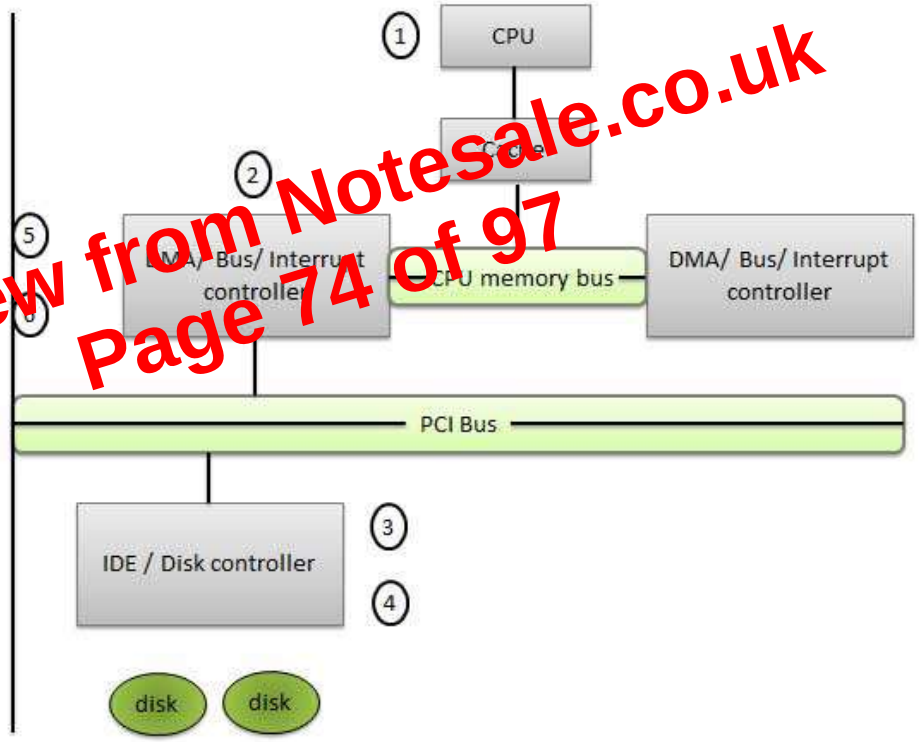
- The host repeatedly reads the busy bit until that bit becomes clear.
- The host sets the write bit in the command register and writes a byte into the data-out register.
- The host sets the command-ready bit.
- When the controller notices that the command-ready bit is set, it sets the busy bit.
- The controller reads the command register and sees the write command.
- It reads the data-out register to get the byte, and does the I/O to the device.
- The controller clears the command ready bit, clears the error bit in the status register to indicate that the device I/O succeeded, and clears the busy bit to indicate that it is finished.

Direct Memory Access (DMA)

Many computers avoid burdening the main CPU with programmed I/O by offloading some of this work to a special purpose processor. This type of processor is called, a Direct Memory Access (DMA) controller. A special control unit is used to transfer block of data directly between an external device and the main memory, without intervention by the processor. This approach is called Direct Memory Access (DMA).

DMA can be used with either polling or interrupt software. DMA is particularly useful on devices like disks, where many bytes of information can be transferred in single I/O operations. When used with an interrupt, the CPU is notified only after the entire block of data has been transferred. For each byte or word transferred, it must provide the memory address and all the bus signals controlling the data transfer. Interaction with a device controller is managed through a device driver.

Handshaking is a process between the DMA controller and the device controller. It is performed via wires using terms DMA request and DMA acknowledge.



Step	Description
1	Device driver is instructed to transfer disk data to a buffer address X.
2	Device driver then instruct disk controller to transfer data to buffer.
3	Disk controller starts DMA transfer.

File Type

File type refers to the ability of the operating system to distinguish different types of file such as text files source files and binary files etc. Many operating systems support many types of files. Operating system like MS-DOS and UNIX has the following types of files:

Ordinary files

- These are the files that contain user information.
- These may have text, databases or executable program.
- The user can apply various operations on such files like add, modify, delete or even remove the entire file.

Directory files

- These files contain list of file names and other information related to these files.

Special files:

- These files are also known as device files.
- These files represent physical device like disks, terminals, printers, networks, tape drive etc.

These files are of two types

- **Character special files** - data is handled character by character as in case of terminals or printers.
- **Block special files** - data is handled in blocks as in the case of disks and tapes.

Space Allocation

Files are allocated disk spaces by operating system. Operating systems deploy following three main ways to allocate disk space to files.

- Contiguous Allocation
- Linked Allocation
- Indexed Allocation

Contiguous Allocation

- Each file occupies a contiguous address space on disk.
- Assigned disk address is in linear order.
- Easy to implement.
- External fragmentation is a major issue with this type of allocation technique.

Linked Allocation

- Each file carries a list of links to disk blocks.
- Directory contains link / pointer to first block of a file.
- No external fragmentation
- Effectively used in sequential access file.
- Inefficient in case of direct access file.

Indexed Allocation

- Provides solutions to problems of contiguous and linked allocation.
- A index block is created having all pointers to files.
- Each file has its own index block which stores the addresses of disk space occupied by the file.
- Directory contains the addresses of index blocks of files.

Authentication

Authentication refers to identifying the each user of the system and associating the executing programs with those users. It is the responsibility of the Operating System to create a protection system which ensures that a user who is running a particular program is authentic. Operating Systems generally identifies/authenticates users using following three ways:

- **Username / Password** - User need to enter a registered username and password with Operating system to login into the system.

- **User card/key** - User need to punch card in card slot, or enter key generated by key generator in option provided by operating system to login into the system.

- **User attribute - fingerprint/ eye retina pattern/ signature** - User need to pass his/her attribute via designated input device used by operating system to login into the system.

One Time passwords

One time passwords provides additional security along with normal authentication. In One-Time Password system, a unique password is required every time user tries to login into the system. Once a one-time password is used then it cannot be used again. One time password are implemented in various ways.

- **Random numbers** - Users are provided cards having numbers printed along with corresponding alphabets. System asks for numbers corresponding to few alphabets randomly chosen.

- **Secret key** - User are provided a hardware device which can create a secret id mapped with user id. System asks for such secret id which is to be generated every time prior to login.

- **Network password** - Some commercial applications send one time password to user on registered mobile/ email which is required to be entered prior to login.

CHAPTER

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Linux Operating System

This section describes Linux operating system's component and its functioning.

Linux is one of popular version of UNIX operating System. It is open source as its source code is freely available. It is free to use. Linux was designed considering UNIX compatibility. Its functionality list is quite similar to that of UNIX.

Kernel Mode v/s User Mode

Kernel component code executes in a special privileged mode called **kernel mode** with full access to all resources of the computer. This code represents a single process, executes in single address space and do not require any context switch and hence is very efficient and fast. Kernel runs each process and provides system services to processes, provides protected access to hardware to processes.

Support code which is not required to run in kernel mode is in System Library. User programs and other system programs works in **User Mode** which has no access to system hardware and kernel code. User programs/ utilities use System libraries to access Kernel functions to get system's low level tasks.