

Operating Systems SEC Notes

What is an OS?

The operating system is the manager of the computer. It manages programs and resources.

The resources of the computer are the CPU, memory, secondary storage, input devices, output devices and anything else that forms part of the computer system. Some resources are shareable (more than one program can use them at the same time) and non-shareable.

Examples of shareable resources are:

- Program code (more than one user on a network can run the same program)
- Parts of RAM that are read-only e.g. database tables.

Examples of non-shareable information are:

- CPU
- Printer, keyboard etc.

Types of OS

Batch OS

- Executing a sequence of non-interactive jobs sequentially.
- Today such programs are executed in the background.
- Uses JCL (Job Control Language) e.g. to indicate the files that must be inputted with the job.

Multiprogramming OS

- A computer running more than one program at a time.
- The main idea of multi programming is to maximize the CPU time.
- As soon as one job is involved in an I/O task (therefore the CPU is idle), the Operating System interrupts that job, chooses another job from the job pool (waiting queue) and assigns to it the CPU (this is called context switching).

Multiprocessing OS

- A computer using more than one CPU at a time.
- Therefore, multiple processes can be executed in parallel.
- The multi processors share the computer bus, memory and peripheral devices.

Multi-tasking OS

- Slots of time slices (quanta), to use the CPU. are allocated to different programs in succession.
- Provides interaction of simultaneous programs with the system.
- The time-shared systems are more complex than the multi-programming systems. The latter only assigns the CPU to a different process only when a process is idly waiting for an event.
- Very common
- Two kinds:
 - Pre-emptive multitasking: processor use is regulated by OS
 - Collaborative multitasking: it is the processes that decide when they stop using the processor.
- Used to be called time-sharing OS.
- Permits programs like a browser, a word processor and streaming music program to be run at the same time.
- Multitasking is a logical extension of multi programming. Both use context switching but multi-tasking works also on time-sharing.

Real time OS

- Immediate replies (time-limit set between input and output)
- Two types:
 - Hard real-time (critical): time limit has to be respected e.g. nuclear plant, autopilot etc.
 - Soft real-time (non-critical): time limit can be eased e.g. airline reservations

Network OS (NOS)

- It includes special functions for connecting computers and devices.
- Some features:

- It allows multiple computers to connect so that they can share data, files and hardware devices.
- Supports multi-processing of applications.
- Provides communication protocols.
- Provides security features such as authentication, logon restrictions and access control.
- Provides file, print, web services and back-up services.
- Supports Internetworking such as routing and WAN ports.
- Supports auditing tools with graphical interfaces.
- Types of NOSs
 - Peer-to-peer (P2P):
 - Allows users to share resources and files located on their computers and to access shared resources found on other computers.
 - In P2P all computers are considered equal; they all have the same privileges to use the resources available on the network.
 - Are designed primarily for small to medium local area networks.
 - Windows for Workgroups is an example of the program that can function as peer-to-peer network operating systems.
 - Client/server network:
 - Most computers are Clients i.e. asking for a service and some computers are Servers i.e. providing the service.
 - Examples of servers are File Server, Database server etc.
 - Novell Netware and Windows 2000 Server are examples of client/ server network operating systems.

Online OS

- Runs on a computer (or server) that is accessible to the Internet.
- It can support online applications i.e. applications that run on the web e.g. online spreadsheet, online word processor, online image processing, emails etc.

Single-user OS

- can be split into two types:
 - single user, single application operating systems e.g. mobile phone
 - single user, multi-tasking operating systems e.g. personal computer

Multi-user OS

- More than one user is logged on and can use the computer at the same time.
- Each user runs more than one application at a time, so it needs to be multi-tasking as well.
- Also called multi-access.

Multithreading OS

- A thread is a part of a program that can run concurrently and independently of other parts of the program.
- Allows different parts of a single program to run concurrently.
- It is an extension of multitasking.
- An example of a program with threads is a media player, where one thread is used for playing a particular song and another thread for adding new songs to the playlist.
- Another example: a web server which processes client requests. Each request is a thread.

Interactive OS

- It allows the user to directly interact with the operating system whilst one or more programs are running.
- Most operating systems are of this type

Device drivers

- A device driver is a program that acts as an intermediary (interface) between the operating system and hardware.

- Sound cards, graphics cards, network cards and peripherals such as printer, scanner, digital camera, mp3 player all have a device driver.
- If you are using a word processor and want to print a document, the printing progresses on the following steps:
 1. The user instructs the application program to print the document.
 2. The application program instructs the operating system to do it.
 3. The operating system passes the instruction to the device driver.
 4. The device driver messages the printer to do the required work.
 5. The printer performs the work and then messages the device driver that the work has been done.
 6. The device driver informs the operating system.
 7. The operating system informs the application program.
- The operating system is usually pre-loaded with drivers for all of the hardware it needs to control.
- New devices connected to the computer must have their drivers installed before being used.

The main functions of an OS

1. Programs control
2. Memory management
3. Protection and security
4. User interface
5. File Management
6. Interrupts Handling

1. Program control

A process is a program during execution.

The OS follows a policy of which program should be assigned the CPU. This is called 'scheduling'.

Some examples of scheduling:

- First come first served (FCFS): Programs are held in a queue.
- Priority scheduling: Programs have a priority index and the ones with the highest priority are executed first.
- Round robin: Choosing programs one after the other giving them a time-slice each. Then repeat again.

2. Memory Management

Memory management refers to main memory management. Memory is a sequence of locations (memory cells). Each cell has a unique address. It has direct (random) access.

The OS manages RAM and decides where programs should be placed. It may use swapping i.e. removes a program (or part of it) from RAM and loads another program from secondary storage.

Uni-programming: 1 program in RAM.

Multiprogramming: 2 or more programs in RAM

3. Protection and Security

Protection and security are very similar terms. But

- Protection: against non-malicious attacks
- Security: against malicious attacks
- They are often used interchangeably

Goals of Protection and Security

- To prevent misuse (malicious or not). Examples of misuse:
 - theft of private or confidential information;
 - unauthorised access;

- unauthorised modification or destruction of data;
- denial of service;
- virus;
- worm;
- social engineering (i.e. means fooling trustworthy people into accidentally breaching security);
- phishing (i.e. sending an innocent-looking e-mail or web site designed to fool people into revealing confidential information);
- Measures:
 - passwords,
 - antivirus,
 - firewalls,
 - encryption,
 - authentication (involves verifying the identity of the entity who transmitted a message),
 - digital certificate (An attachment to an electronic message used for security purposes. The most common use of a digital certificate is to verify that a user sending a message is who he or she claims to be),
 - biometrics (Fingerprint scanners, Palm readers, Retinal scanners, Voiceprint analysers, etc.);
 - auditing, accounting etc.;
 - To ensure that each shared resource is used only in accordance with system policies
 - Implemented by access rights (no-access, execute, read, write, print) etc.
 - To ensure that errant programs cause the minimal amount of damage possible
 - To ensure that the system is kept in the best environment (e.g. right temperature)
 - To be prepared in case of disasters
 - Backups in a remote place

4. User Interfaces

User interface (UI):

- junction between the user and the computer
- most commonly UIs:
 - Command-Driven Interface (CLI): user types commands from the keyboard
 - Menu-driven interface: user selects option from menu
 - Graphical User Interface (GUI): also called WIMP. Stands for windows, icons, mouse (or menus), pointer.
 - Touch user interface
 - Gesture interface
 - Voice user interface

5. File Management

File management system:

- provides support to help users and applications create, delete, and use files

File:

- can be looked at as:
 - a sequence of bits (low-level perspective)
 - a stream of bytes (low-level perspective)
 - a structure of (high-level perspective):
 - words (e.g. a story)
 - pixels (e.g. photos)
 - records (e.g. a database table)
- file organisation and access (file of records)
 - sequential: records must be read from the start
 - direct (random access)
 - advantages:
 - faster if one needs to access one or few records
 - if a new record needs to be inserted only the index would need to be modified
 - disadvantage
 - index

Files are organised in folders in a tree structure. A pathname describes where a file is found by going inside folders.

File Sharing - Two issues:

- Determining access rights
- Managing simultaneous access

The most common access rights (also called attributes) are:

- read: user can read and use the file, but can't change it
- write: user can modify, delete or add to the file
- execute: user can load and run the program, cannot change or copy it
- others:
 - append
 - delete

Access can be granted to different classes of users:

- individuals
- groups (a set of users, such as class members)
- all (includes everybody with access to the system - e.g., public files)

Unauthorised Access

- Some system administrators set up alerts to let them know when there is an unauthorized access attempt.
- Many secure systems may also lock an account that has had too many failed login attempts.
- A firewall is designed to prevent unauthorized access to or from a private network.
 - Firewalls can be implemented in both hardware and software, or a combination of both.
 - Firewalls are frequently used to prevent unauthorized Internet users from accessing private networks connected to the Internet, especially intranets.

- An intranet is a private network based on TCP/IP protocols i.e. it is a small private internet
- All messages entering or leaving the intranet pass through the firewall, which examines each message and blocks those that do not meet the specified security criteria.

6. Interrupts Handling (not in syllabus)

An interrupt comes from a program or a device that requires immediate attention. The OS will see whether the CPU will switch its attention from the current program to the interrupt.