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CAIE IGCSE

COMPUTER SCIENCE (0478)

THEORY

0.1. Operating Systems

- Operating Systems are designed to establish communication between the user and the computer
- Functions of a typical operating system -
  -managing files
  – handling interrupts
  – providing an interface
  – managing peripherals and drivers
  – managing memory
  – managing multitasking
  – providing a platform for running applications
  – providing system security
  – managing user accounts
- WIMP - Windows, Icons, Menu, and Pointing Devices

Advantages and Disadvantages of CLI and GUI

Interface	Advantages	Disadvantages
command line interface (CLI)	the user is in direct communication with the computer the user is not restricted to a number of pre-determined options it is possible to alter computer configuration settings uses a small amount of computer memory	the user needs to learn a number of commands to carry out basic operations all commands need to be typed in which takes time and can be error-prone each command must be typed in using the correct format, spelling, and so on
graphical user interface (GUI)	the user doesn't need to learn any commands it is more user-friendly; icons are used to represent applications a pointing device (such as a mouse) is used to click on an icon to launch the application – this is simpler than typing in commands or a touch screen can be used where applications are chosen by simply touching the icon on the screen	this type of interface uses up considerably more computer memory than a CLI interface the user is limited to the icons provided on the screen needs an operating system, such as Windows, to operate, which uses up considerable memory

Source: Cambridge IGCSE and O Level Computer Science - Second Edition (Hodder Education)

- Memory Management - Manages the RAM and the HDD/SSD during the execution of programs
- Security Management - Providing security features such as Anti-Virus, System updates and so on
- Hardware Peripheral Management - Managing the device drives, Inputs, Outputs, Queues and buffers
- File Management - Opening, Creating, Deleting, Renaming, and many more functions
- Multitasking - OS would share the hardware resources with each of the processes
- Management of User Accounts - OS would allow multiple users to customise their accounts individually.

Running of Applications

- The computer starts its OS (booting up the computer) through the bootstrap loader.
- The BIOS (Basic Input/Output System) tells the computer the location of the OS in the storage.
- BIOS is often referred to as the firmware

Hardware ↔ Firmware ← Firmware interface between OS and h/ware → Operating system

Interrupts

- Signal that causes the microprocessor to stop what it's doing and service the task
- Ensures important tasks are dealt with on a priority basis
- It can be a software or a hardware interrupt
- Peripherals like a keyboard & mouse can generate it
- Different interrupts have different levels of priority
- After interruption is dealt with, the previous process continues

0.2. Programming Languages, Translators and IDEs

- Computers can only understand **machine code;** therefore, translators are needed

High-Level Languages

- It is easier to read and understand as the language is closer to human language.
- Easier to write in a shorter time
- Easier to debug at the development stage
- Easier to maintain once in use

Low-Level Languages

- Refer to machine code
- Binary instructions that the computer understands

Language	Advantages	Disadvantages
High-level	independent of the type of computer being used easier to read, write and understand programs quicker to write programs programs are easier and quicker to debug easier to maintain programs in use	programs can be larger programs can take longer to execute programs may not be able make use of special hardware
Low-level	can make use of special hardware includes special machine-dependent instructions can write code that doesn't take up much space in primary memory can write code that performs a task very quickly	it takes a longer time to write and debug program programs are more difficult to understand

Source: Cambridge IGCSE and O Level Computer Science
- Second Edition (Hodder Education)

Assembly Language

- Few programmers use assembly language to -
  - Make use of special hardware
  - Write code that doesn't take up much space
  - Write code that runs very quickly
  - Assembly language must be translated into machine code using an assembler to run.

0.3. Translators

Compiler

- Translates a program written in a high-level language into machine code
- Used without compiler
- Executable file of machine code produced
- One high-level language translated into several machine code instructions
- Used for general use

Interpreter

- Executes a high-language program a statement at a time
- No executable file of machine code produced
- One high-level language program statement may require several machine code instructions to be executed.
- Interpreted programs cannot be used without an interpreter
- Used when the program is being developed

Assembler

- Translates a low-level language program into machine code
- Executable file of machine code produced
- One low-level language translated into one machine code instructions
- It can be used without an assembler
- Used for general use

Compiler	Interpreter	Assembler
Translates a high-level language program into machine code.	Executes a high-level language program one statement at a time.	Translates a low-level assembly language program into machine code.
An executable file of machine code is produced.	No executable file of machine code is produced.	An executable file of machine code is produced.
One high-level language statement can be translated into several machine code instructions.	One high-level language program statement may require several machine code instructions to be executed.	One low-level language statement is usually translated into one machine code instruction.
Compiled programs are run without the compiler.	Interpreted programs cannot be run without the interpreter.	Assembled programs are used without the assembler.
A compiled program is usually distributed for general use.	An interpreter is often used when a program is being developed.	An assembled program is usually distributed for general use.

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Integrated Development Environments (IDEs)

- An IDE would usually have these features -
  - Code Editor
  - Translator
  - Debugger
  - Error Reports
  - Auto-Completion and Auto-Correction
  - Auto-Documenter
  - Pretty Printing

1. Software

1.1. Types of Software and Interrupts

Types of Software

1. **System Software** e.g. Operating System, Utility programs and device drivers
2. **Application Software** e.g. spreadsheet, word processor, etc.

System Software:

- these are a set of programs which control and manage the operations of hardware
- gives a platform for other software to run
- it is required to allow hardware and software to run without problems
- provides a human-computer interface (HCI) to the user
- controls the allocation and usage of hardware resources

Application Software:

- allows a user to perform specific tasks using the computer's resources
- maybe a single program (for example, NotePad) or a suite of programs (for example, Microsoft Office)
- user can execute the software when they require, and it is mostly not automatic

Examples

System Software:

- Compiler: Translates high-level language into machine code, allowing for direct use by a computer to perform tasks without re-compilation.
- Linker: Combines object files produced by a compiler into a single program, allowing the use of separately written code modules in the final program.
- Device driver: Software that enables hardware devices to communicate with a computer's operating system, without which a device like a printer would be unable to work.
- Operating system: Software that manages basic computer functions such as input/output operations, program loading and running, and security management, making computers more user-friendly.
- Utility programs: Software that manages, maintains, and controls computer resources by carrying out specific tasks, such as virus checking, disk repair and analysis, file management, and security.
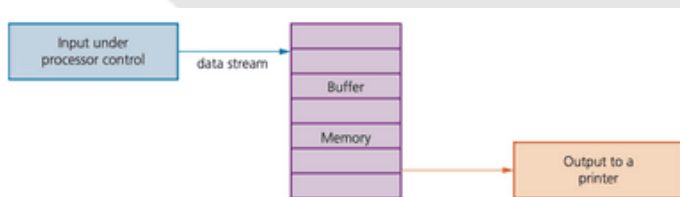
Application Software:

- Word Processor: Software used for manipulating text documents, including creating, editing, and formatting text with tools for copying, deleting, spell-checking, and importing images.
- Spreadsheet: Organizes and manipulates numerical data using a grid of lettered columns and numbered rows, with each cell identified using a unique combination of columns and rows. It can calculate using formulas, produce graphs, and do modelling and "what if" calculations.
- Database: Software used to organize, analyze, and manipulate data consisting of one or more tables that hold records and fields. It provides the ability to query and report on data and add, delete, and modify records in a table.
- Control and Measuring Software: A program designed to interface with sensors and allow a computer or microprocessor to measure physical quantities and control applications by comparing sensor data with stored data and altering process parameters accordingly.
- Apps: Software designed to run on mobile phones or tablets, downloaded from an "App Store" and ranging from games to sophisticated software such as phone banking. Common examples include video and music streaming, GPS, and camera facilities.
- Photo and Video Editing Software: Software that allows users to manipulate digital photographs or videos, including changing colour, brightness, and contrast, applying filters and other enhancements, and creating transitions between clips.
- Graphics Manipulation Software: Software that allows the manipulation of bitmap and vector images, with bitmap graphics editors changing pixels to produce a different image, while vector graphics editors manipulate lines, curves, and text to alter the stored image as required.

Interrupts

An interrupt is a signal sent to the microprocessor, either from a device or software, prompting the microprocessor to pause its ongoing tasks and handle the interrupt temporarily. Various factors can trigger interrupts, including:

- **Timing signals:** Scheduled signals prompt the microprocessor to pause and handle tasks at specific intervals.
- **Input/Output processes:** Events such as a disk drive or printer requiring additional data cause an interruption in the microprocessor's activities.
- **Hardware faults:** Issues like a paper jam in a printer, signalling the microprocessor to halt its operations and address the hardware problem.
- **User interaction:** Instances like a user pressing specific keys on a keyboard (e.g.,), leading to an interrupt in the system's operation.
- **Software errors:** Problems such as missing .exe files needed to initiate a program, conflicts like two processes accessing the exact memory location, or attempts to divide by zero. These errors trigger interrupts, prompting the microprocessor to handle the issues.

Source: Cambridge IGCSE and O Level Computer Science - Second Edition (Hodder Education)

1.2. Utility Software

- Computer users have access to utility programs as part of system software
- Utility programs can be initiated by the user or run in the background without user input
- Common utility programs include virus checkers, defragmentation software, disk analysis and repair tools, file compression and management software, backup software, security tools, and screensavers.

Virus Checkers & Anti-Virus Software

- Virus checkers or anti-virus software are important for protecting computers from malware.
- They should be kept up to date and run in the background to maintain their effectiveness.
- Anti-virus software checks files before they are run or loaded and compares possible viruses against a database of known viruses.
- Heuristic checking is used to identify possible viruses that are not yet on the database.
- Infected files are put into quarantine for automatic deletion or for the user to decide.
- Anti-virus software must be updated as new viruses are constantly discovered.
- Full system scans should be carried out regularly to detect dormant viruses.

Disk Defragmentation Software

- Defragmentation software rearranges the data blocks on a hard disk drive (HDD) to store files in contiguous sectors, reducing head movements and improving data access time.
- As an HDD becomes full, blocks used for files become scattered all over the disk surface, making it slower to retrieve data as the HDD read-write head needs several movements to find the data.
- When a file is deleted or extended, new data does not fill the vacant sectors immediately, causing the files to become more scattered throughout the disk surfaces.
- A disk defragmenter rearranges the data blocks to store files in contiguous sectors wherever possible, allowing for faster data access and retrieval.
- The defragmentation process can free up previously occupied sectors and empty some tracks.

Backup Software

- Backup software is a utility software that helps create and manage backup copies of data files and programs.
- Manual backups using memory sticks or portable hard drives are good practices, but operating system backup utilities are also recommended.
- Backup utilities allow scheduling backups and only backup files if changes have been made to them.
- There could be three file versions for total security: the current version stored on the internal HDD/SSD, a locally backed-up copy on a portable SSD, and a remote backup on cloud storage.

Security Software

- Security software is a utility software that manages access control, user accounts, and links to other utilities such as virus and spyware checkers.
- It also protects network interfaces using firewalls to prevent unauthorized access.
- Security software uses encryption and decryption to ensure intercepted data is unreadable without a decryption key.
- It oversees software updates to verify legitimate sources and prevent malicious software from being installed.
- Access control and user accounts use IDs and passwords to secure user data and prevent unauthorized access.

Screensavers

- Screensavers display moving and still images on the monitor screen after computer inactivity.
- They were originally developed to protect CRT monitors from 'phosphor burn'.
- Screensavers are now mostly used for customizing a device and as a part of computer security systems.
- They automatically log out of the user after a certain period of inactivity.
- Some screensavers activate useful background tasks like virus scans and distributed computing applications.

Device Drivers

- Device drivers translate data into a format that can be understood by the hardware device they are associated with.
- Without the appropriate device driver, a hardware device cannot work with a computer and may not be recognised by the operating system.
- USB device drivers contain descriptors, which include a vendor ID (VID), product ID (PID) and unique serial number that allow the operating system to identify the device.
- Serial numbers must be unique to avoid confusion if two devices with the same serial number are plugged into a computer simultaneously.

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