TABLE OF CONTENTS

Section 2

COMPUTER ORGANISATION

2.1 Computer Architecture

Central Processing Unit (CPU)

A hardware component of a computer system and can perform basic arithmetic, logical or input/output operations; essentially the 'brain' of the computer system. Also known as the 'Processor'.

The CPU contains the Control Unit (CU); Arithmetic Logic Unit (ALU); Memory Address Register (MAR); and Memory Data Register (MDR).

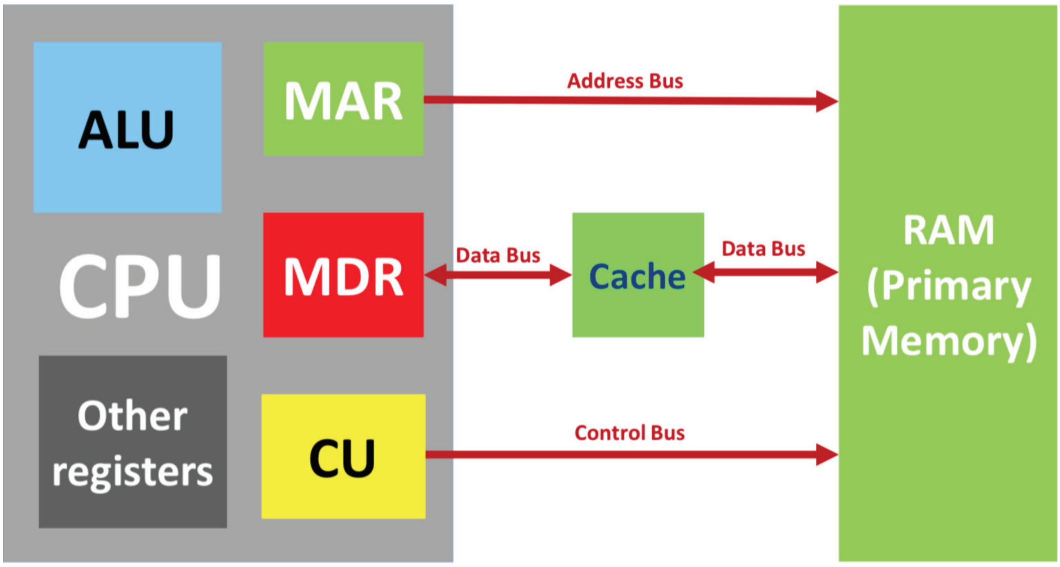
Control Unit (CU)

Fetches data or instruction from memory, decodes it into commands and controls transfer of among other units of the CPU (e.g. command to ALU for execution).

Part of the Processor which coordinates all activities within it.

Arithmetic Logic Unit (ALU)

Performs all basic Arithmetic and Logical and input/output Operations executes instructions.



Primary Memory (2.1.2)

Revised □

Primary Memory is the only storage that is directly accessible by the CPU; at any point in time, it may hold both data and instructions that are currently running on the computer system. These instructions are stored in Machine Code (1s and 0s).

It consists of Two Types of Memory:

Random Access Memory (RAM)

Stores executing data and instructions of program currently being run. Data is stored in Unique Memory Locations; each of these Locations has an Address as well as Content.

RAM is a 'General Purpose' storage area, since data stored can be overwritten and instructions executed whenever necessary.

However, RAM is Volatile; therefore the contents of Memory are wiped whenever Power is lost.

Read Only Memory (ROM)

Stores permanent instructions and data of programs, used to boot and operate the computer (e.g. Basic Input Output
System - BIOS).

Data can be Written-to not cannot be Overwritten; any ROM instructions are embedded. This makes ROM Non-Volatile — data and instructions remain even without Power.

By size, it is much smaller than RAM.

Cache Memory (2.1.3)

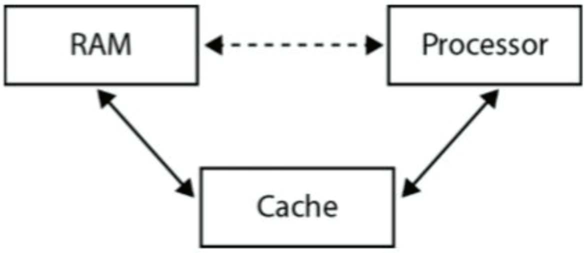
Revised □

RAM can be further distinguished into Two Types:

1. Dynamic RAM (DRAM)

2. Static RAM (SRAM)

DRAM is used as the primary source of RAM in a Computer System. However, SRAM is faster; and a small section of SRAM, known as the Cache Memory is placed between the main RAM and the Processor:



As such, Cache Memory is Smaller and Faster SRAM that temporarily stores the most frequently used data and instructions so that the processor does not need to access the slower primary DRAM. ‘Static’ means that the memory doesn’t need to be constantly refreshed.

When the processor (CPU) needs to read from the Primary Memory, it first checks if a copy of the data exists in the Cache; if so, it will read from the Cache instead of the DRAM. Cache Memory is located closer to the CPU providing faster access, and since the CPU accesses the slower DRAM less often, performance speeds up!

Therefore, Cache Memory is used to save time in accessing the RAM.

Control Unit (CU) Registers (2.1.1)

Revised □

The Control Unit (CU) contains various registers. In General, a Register is a small storage location that can hold data (in multiples of 8 bits) — a 64-bit Computer would have 64 bit Registers.

The basic registers in the CU are the *Memory Address Register* (MAR) and the *Memory Data Register* (MDR):

Memory Address Register (MAR)

Stores the Memory *Address* of next data/instruction to be decoded and executed by the ALU. In order for the MAR to communicate with the Primary Memory (RAM), it connects through the *Memory Address Bus*.

Memory Data Register (MDR)

Stores the *Data* Itself taken most recently from the RAM, which is then used by the ALU. This allows the Processor (CPU) and Memory (RAM) to act independently, with the CPU not affected by differences in the speed of operation.

The connection between the RAM and the MDR is accomplished by the *Memory Data Bus*.

Machine Instruction Cycle (2.1.4)

Revised □

Computer instructions are stored in the Primary Memory as a series of instructions in Machine Code (1s and 0s). These instructions/data have to be moved from the Primary Memory into the CPU in order for the Program to Operate.

The Basic Stages of Operation occur in a Cycle, known as the *Machine Instruction Cycle*:

1. **Fetching the Instruction**

   The CPU is responsible for knowing which instruction it needs to take from the Primary Memory. To achieve this, it sends the sends the instruction address through the *Memory Address Bus* (MAB) to the Primary Memory. The instruction inside the address is then copied into the *Memory Data Bus* (MDB) and sent to the Control Unit (CU).

2. **Decoding the Instruction**

   The instruction received by the CU is then decoded. Decoding an instruction allows the CPU to be aware of any additional data necessary for the execution of the instruction. Any additional data is appropriately fetched from the Primary Memory and delivered directly to the CPU through the same process as *Stage 1*.

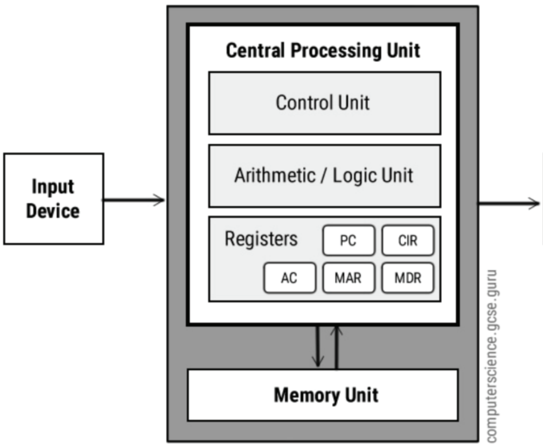
3. **Execute the Instruction**

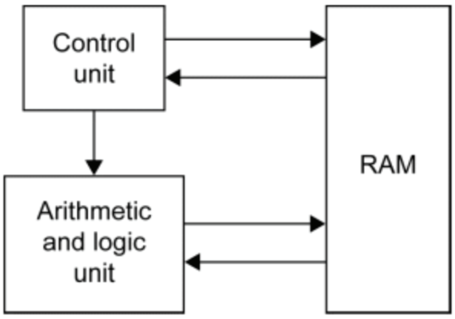
   The CPU executes the instruction using the loaded data and calculates its result. Depending on the result, additional data may be needed; and *Stage 1s* processes occur again.

4. **Store the Instruction, then Check for Instruction**

   After executing the instruction and computing the result, the CPU stores the result in the Primary Memory. This is achieved through specifying the address the data will be stored using the MAB and sends this data through the MDB.

   The CPU then checks for the next instruction and repeats *Steps 1 to 4*





‘Bus’

Simply, the Bus is a Set of Wires that connect to components in a computer system. Buses are used as physical connections to carry information to the CPU.

For example, the MDB transports data from/to the CPU, whereas the MAB states where the data is supposed to go/be.

Secondary Memory (2.1.5)

Revised □

The Primary Memory is the only form of storage that is accessible by the CPU. This means that any data that is stored elsewhere need to be first copied onto the RAM, since ROM cannot be written-to but only read-from!

RAM is a volatile; so whenever power is lost, the memory contents of RAM are wiped. Also, RAM is a relatively fast memory form (read/write outputs and inputs, process tasks quickly), but has a limited memory capacity.

When RAM is full, Data and Instructions need to be saved elsewhere.

Secondary Memory, also known as Auxiliary Storage, is a relatively slow memory form that can be written-to (like RAM) but also is non-volatile (like ROM); therefore the contents are not wiped when power is lost. This makes Secondary Memory a form of Persistent Storage.

In comparison to Primary Memory, Secondary Memory has a relatively high storage capacity.

When a computer system starts up, the RAM is empty. Instructions and Data (such as the Operating System) need to be copied into the RAM in order for the computer system to run. In most computer systems, these instructions are copied from the Secondary Memory.

Consequently, any computer systems that need to hold persistent data cannot function with Primary Memory alone (e.g. Editing a saved file).

Examples include: *HDD* (Hard Disk Drive), *USB* (Universal Serial Bus), *SD* (Secure Digital), *Magnetic Tape* (Cassette, Floppy Disk, VHS).

Operating and Application Systems (2.1.6)

Revised □

Operating System (OS) Set of software that controls computers hardware resources and provides services for computer programs.

The *OS* allocates (and de-allocates) specific sections of memory to each programs Process Module; this ensures that the memory assigned to one program is not overwritten. The *OS* uses Secondary Memory to allow more process to run simultaneously.

The *OS* is held in the either the Hard Disk; ROM or Solid-State Drive (SSD).

ROLES OF AN OPERATING SYSTEM

Peripheral Communication Peripheral Devices are all the hardware components of the computer system that exist outside the CPU. The OS is responsible for communicating directly with the hardware and providing an interface between hardware devices and applications.

Examples of Peripheral Devices:

- **Keyboard** (To type in data, or to type in a barcode if it doesn't scan).
- **Magnetic Card Reader** (used when a credit card is used).
- **Microphone** (to call the next customer, or to call the manager).
- **Monitor** (so the salesman can see the information/data on the screen).
- **Visual Display** (so the customer can read the information/data on the display).
- **Speakers** (for customers to hear information, for shop assistants to bring another item the customer may wish to buy).

Processor loading speed (efficiency) of OS functions need consideration, as does the graphics handling of the OS. The OS should be able handle input from appropriate devices (e.g. a developed video game application).

Memory Management An OS is responsible for all the memory that is available in a computer system, therefore it must Manage how Memory is used by applications, and ensures that one application does not interfere with memory that is being used by some other application.

The *OS* will allocate and de-allocate blocks of Memory to each Program being run, and keeps track of what data is in which location. This ensures that a Program has sufficient memory to run, and if there are too many processes for the RAM, the OS will use Secondary Memory (also known as *Virtual Memory*) to run programs simultaneously (e.g. Video Game applications use a lot of memory and require constant refreshing); this avoids overwriting or clashing of programs, and consequently optimises system performance and maximises memory usage.

Resource Allocation An application running on a computer system uses up Resources (including the amount of memory the application is occupying, or how much processing time is required). The OS is responsible for the efficient allocation of resources so that an application can run as effectively as possible.

Multiple applications may run on a computer system at once, and appear that they are performing tasks simultaneously. However, most computer systems only have a single *CPU* meaning that applications must share the CPU time in order to accomplish their process — this is known as computer *Multitasking*.

Networking The OS manages connections with networks of other computer systems to allow the sharing of Network Resources (e.g. digital files, printers).

Data Management The OS must have the ability to access data stored in Memory. Data is stored using files, and the OS must keep track of files and their location in order to make the best use of memory available, provide fast access times, and ensure that an application does not overwrite another applications files.

Security Provides measures such as password authentication, magnetic cards, access rights to prevent unauthorised access (e.g. Log files keep track of activity).

Software Application (2.1.7)

Revised □

The main software applications that may be installed on a computer system include:

SOFTWARE APPLICATION	FEATURES
Word Processors (e.g. Microsoft Word, Google Docs)	Used for the production of documentation; Includes tools for composition, editing, formatting and printing of documents; Useful Autosave features mean that if power goes off, only data after the last (automatic) save is lost;
Spreadsheets (e.g. Microsoft Excel)	Data is represented as Cells, organised into Rows and Columns; can perform calculations through formulae to process data and present it in visual charts to analyse.
Database Management Systems DBMS (e.g. Microsoft Access)	Manages and provides interface for users to use database organised into records, and the user can create or modify these records, or query and extract data from them.
Web Browsers (e.g. Internet Explorer, Safari)	Used to access, retrieved and present content on the World-wide Web (WWW). Connects to web servers to request information.

Computer Aided Design CAD (e.g. Google Sketchup)	Often used in engineering, manufacturing and architecture to create, modify and analyse a design. Can convert info like shape, materials, dimensions, etc with changeable values. Supports the design/development of rapid prototyping in manufacturing a System solution; Saves time/costs associated to drawing and development; Photorealistic rendering/photo simulation in various industries (architecture/video games/ simulators/ etc) by using shading, radiosity, reflection, etc.
Graphic Processing (e.g. Adobe Photoshop)	Manipulate visual images with functions such as move, erase, crop, colour, etc.
Email (e.g. Microsoft Outlook)	Allows exchange of digital messages from a single author to one or more recipients

Common Features of Applications (2.1.8)

Revised □

Graphical User Interface (GUI)	Allow users to interact with software in different ways.
Command Line Interface (CLI)	Where the user types in commands. Used in early software applications.

FEATURES OF AN OPERATING SYSTEM

Toolbar	Buttons, icons, menus, etc.
Menu	List of commands you can choose.
Dialogue Box	Communicates information to the user and allows option choice.

These are common elements provided by the OS to improve usability as they're usually in the same place and used in the same way, while others may be provided by the software. Built in commands for inputting from touch screens; Predicted text so that typing a class name followed by a full stop will bring up a list of methods/attributes.

Automatically use colour to represent keywords/variables and improve readability.

GUIs provide ways that allows users to understand and interact with computer systems in a more natural and direct fashion. The common features of a GUI can be remembered using the acronym *WIMP* which stands for Windows, Icons, Menus and Pointers.