AQA Computer Science A-Level

4.7.1 Internal hardware components of a computer

Advanced Notes

Specification:

4.7.1.1 Internal hardware components of a computer:

Have an understanding and knowledge of the basic internal components of a computer system.

Understand the role of the following components and how they relate to each other:

- processor
- main memory
- address bus
- data bus
- control bus
- I/O controllers

Understand the need for, and means of, communication between components. In particular, understand the concept of a bus and how address, data and control buses are used.

Be able to explain the difference between von Neumann and Harvard architectures and describe where each is typically used

Understand the concept of addressable memory.

Components of a computer

The processor

A computer's processor executes program instructions in order to run applications. The internal components of the processor are covered in much more detail in the notes for 4.7.3 structure and role of the processor and its components.

Main memory

A computer uses its main memory, which includes RAM (random access memory) and ROM (read only memory), to store program instructions and frequently used data. Main memory is usually much faster than secondary storage so storing frequently used data in RAM or ROM helps the processor to execute instructions quickly.

Synoptic Link

Types of **secondary storage** include **hard disk drives**, **solid state drives** and **optical disks**.

Secondary storage devices are covered under **external hardware devices**.

Buses

A number of buses can be found inside a computer. A bus is a series of parallel wires that connects internal components of a computer system, allowing signals to be passed between them.

Synoptic Link

Buses transmit data using **parallel data transmission**.

Parallel data transmission is covered under **communication** in **fundamentals of communication and networking**.

The number of parallel wires in a bus is called its width and has a direct relationship to the number of bits can be transferred simultaneously by the bus.

The three buses that you need to know about are the address bus, the data bus and the control bus.

Address bus

The address bus is used to transport memory addresses, specifying where data is to be sent to or retrieved from. Increasing the width of the address bus increases the range of addresses that it can specify, hence increasing the computer's amount of addressable memory. Adding a single wire doubles the number of addressable memory locations.

Number of parallel wires in address bus	Number of addressable memory locations
1	$2^1 = 2$
2	$2^2 = 4$
3	$2^3 = 8$

An addressable memory location is a portion of memory that can be accessed by its address.

If there are not enough addresses available, some portions memory may go unused.

Data bus

A computer's data bus sends data and instructions to and from the different components of the computer system. Increasing the width of the data bus increases the volume of data that can be transferred over the bus at any one time.

Control bus

The control bus is used to carry control signals that regulate the operation of the computer system. The control bus also carries the computer's clock signal.

I/O Controllers

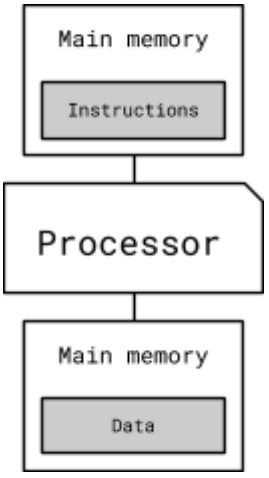
I/O controllers (input/output controllers) are pieces of hardware that control the communication of data between the processor and external hardware devices such as keyboards, mice and monitors.

Von Neumann and Harvard architectures

Harvard architecture and von Neumann architecture are two different ways of setting up a processor's access to main memory.

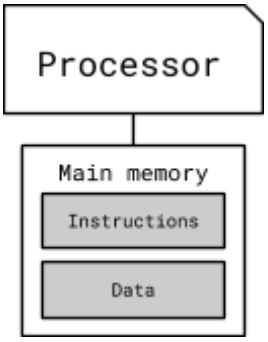
Harvard architecture

If a computer system is set up to use Harvard architecture, the processor will use two separate main memory locations. One for instructions and another for data.



Thanks to Harvard architecture's use of separate pieces of main memory, it can take advantage of giving each piece of main memory different characteristics. For example, the memory used for instructions could be read-only so that instructions cannot be altered.

Harvard architecture is extensively used in embedded systems such as digital signal processing.



Von Neumann architecture

In von Neumann architecture, both instructions and data are stored together in the same memory. Because of this, systems based on von Neumann architecture often perform worse than those based on Harvard architecture as the same buses have to be shared for fetching both instructions and data.

Von Neumann architecture is used in everyday general-purpose computer systems like laptops and smartphones.