AQA Computer Science A-Level

4.9.1 Communication

Advanced Notes

Specification:

4.9.1.1 Communication methods:

Define serial and parallel transmission methods and discuss the advantages of serial over parallel transmission.

Define and compare synchronous and asynchronous data transmission.

Describe the purpose of start and stop bits in asynchronous data transmission.

4.9.1.2 Communication basics:

Define:

- baud rate
- bit rate
- bandwidth
- latency
- protocol

Differentiate between baud rate and bit rate.

Understand the relationship between bit rate and bandwidth.

Communication basics

Before understanding different methods of communication, it helps to understand some key concepts in communication.

Symbol
A symbol is a particular pattern of bits represented by a signal. For example, a symbol of four bits might be 1101.

Baud rate
A communication system's Baud rate is the number of signal changes in the medium per second. 1 Baud (or 1Bd) is equal to 1 symbol change per second.

Bit rate
A communication medium's bit rate refers to the number of bits that are transmitted over the medium per second. This is often measured in bits per second (bps).

Therefore, a communication system's bit rate is equal to its Baud rate multiplied by the number of bits per signal in the communication medium.

$$\text{Bit rate} = \text{Baud rate} \times \text{№ of bits per signal}$$

A communication medium's bit rate will be higher than its Baud rate if there is more than one bit sent per signal.

Bandwidth
Bandwidth, expressed in Hertz, relates to the range of frequencies that a communication medium is capable of transmitting. There is a direct relationship between bandwidth and bit rate. Higher bandwidth results in a higher bit rate.

Latency
Latency in a communication medium, often measured in milliseconds, is the difference in time between an action being initiated and its effect being noticed. For example, if you press the "R" key on your keyboard and the letter R appears on screen 26ms later, the latency in the link between your keyboard and the application you are using is 26ms. Latency usually increases with distance.

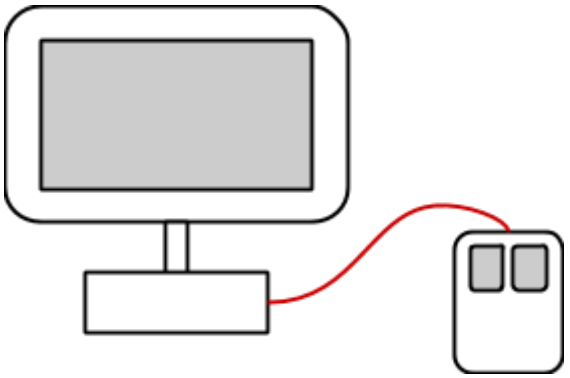
Protocol
A protocol is a set of rules relating to communication between devices. International organisations decide upon and publish protocols which allow devices made by different manufacturers in opposite ends of the world to communicate seamlessly.

Serial and parallel data transmission

Computers can transmit data between their different components in two ways: serially or in parallel.

Serial data transmission

In serial data transmission, data is sent one bit at a time over one communication line (this is usually a metal wire, but could also be an optical fibre or a wireless channel).



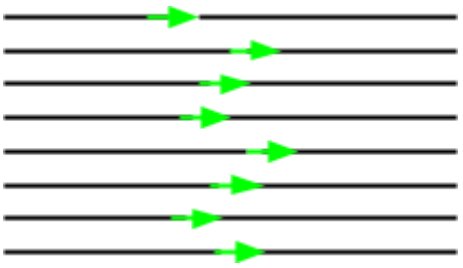
Serial data transmission is frequently used for transmitting data over medium to long distances (computationally speaking), such as from wired peripherals like mice and keyboards to your computer.

Parallel data transmission

Parallel data transmission uses numerous parallel communication lines in order to send multiple bits between components in a computer simultaneously.

The more lines that a parallel communication medium uses, the more data can be transferred simultaneously.

Each of the communication lines that forms part of a parallel communication medium will have slightly different electrical properties, meaning that the time taken for one bit to be transferred will differ slightly from line to line. This means that bits sent together may not be received together, a problem referred to as skew.



Skew is worst over long distances and, in extreme cases, can lead to bits from different pulses overlapping, causing corruption of data. Furthermore, parallel communication mediums are more expensive than their serial counterparts because of their use of multiple lines. For these reasons, parallel data transmission is most often used over short distances, such as between parts of the processor and within RAM.

Another issue, referred to as crosstalk, can occur with parallel data transmission. When communication lines are tightly packed, signals from one line can "leak" into another, another cause of data corruption.

The advantages of serial over parallel

Serial data transmission doesn't suffer from skew or crosstalk making it a more reliable communication method, especially over long distances. Serial communication mediums, which use just one line, are cheaper to install than parallel mediums which use more than one line.

Synchronous and asynchronous data transmission

Synchronous transmission

When data is transmitted using synchronous transmission, a clock signal (which is shared by both the sender and the receiver) is used to time when signals are sent. Synchronous data transmission is used within the busses of a computer's processor in the fetch-execute cycle.

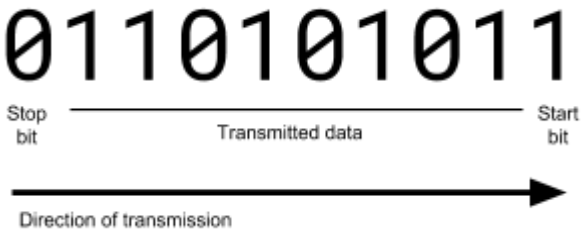
Synoptic Link

The **fetch-execute cycle** is covered in detail in the notes for **structure and role of the processor and its components** under **fundamentals of computer organisation and architecture**.

The signals, which are sent at regular intervals, will be received in the same order that they were sent. This makes synchronous data transmission suitable for transmitting information in real-time systems.

Asynchronous transmission

In asynchronous data transmission, the requirement for a shared clock signal is done away with by using start and stop bits to indicate the duration of a transmission.



The start bit can be either a 0 or a 1 and the stop bit is always the opposite of the start bit.

The sender and receiver must use the same Baud rate and need only synchronise their clocks for the duration of data transmission.