

Cambridge IGCSE

Computer Science
Section 1

Methods of Data Transmission

Unit 2:
Data Transmission

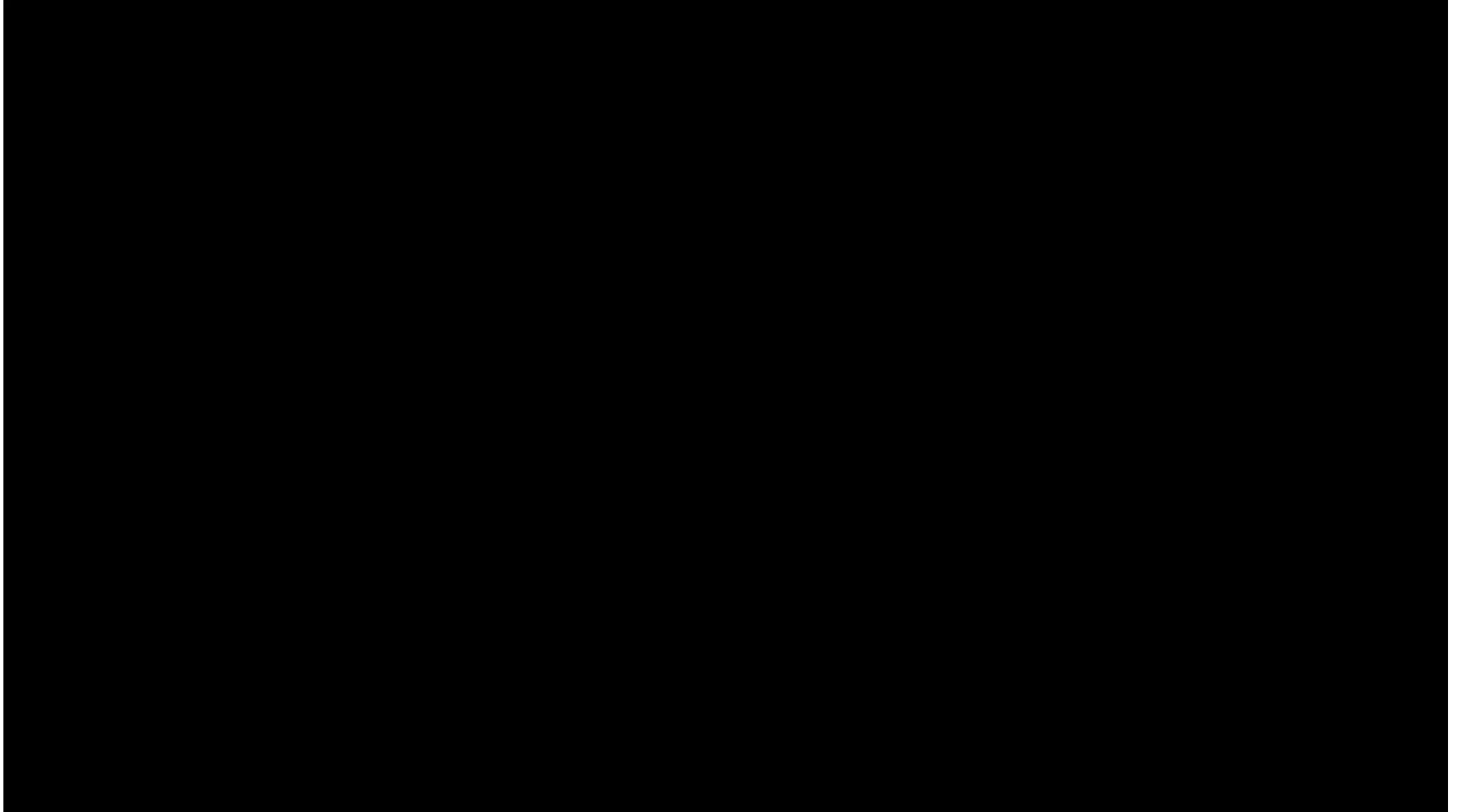
Objectives

- Distinguish between serial and parallel data transmission
- Distinguish between simplex, duplex and half-duplex data transmission
- Explain the advantages and disadvantages of each method of data transmission

Data transmission

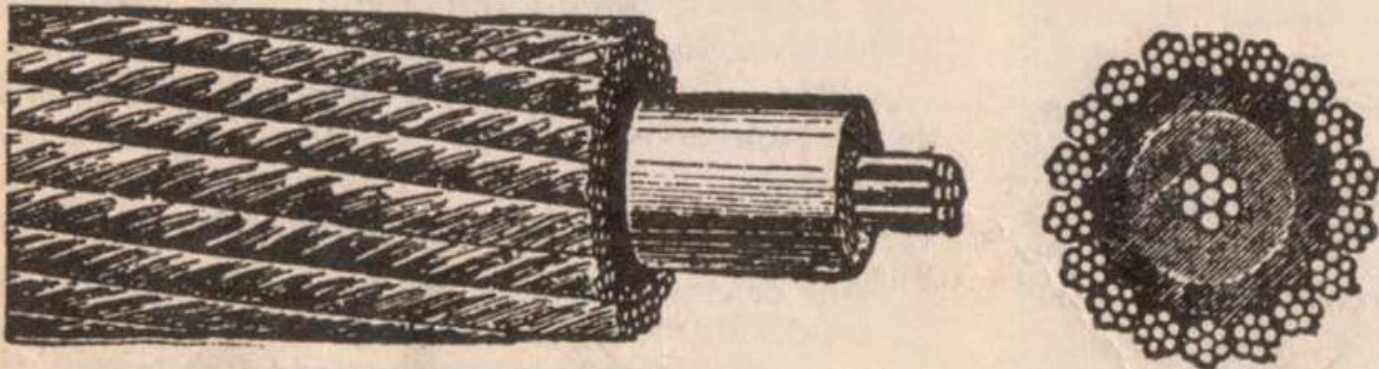
- The **transfer of data from one digital device to another**
- Data can be transferred from one point to another using various methods:
 - Copper cable using electrical pulses
 - Wirelessly using radio frequency
 - Optical fibre using light
 - Infra-red

Video - Data transmission



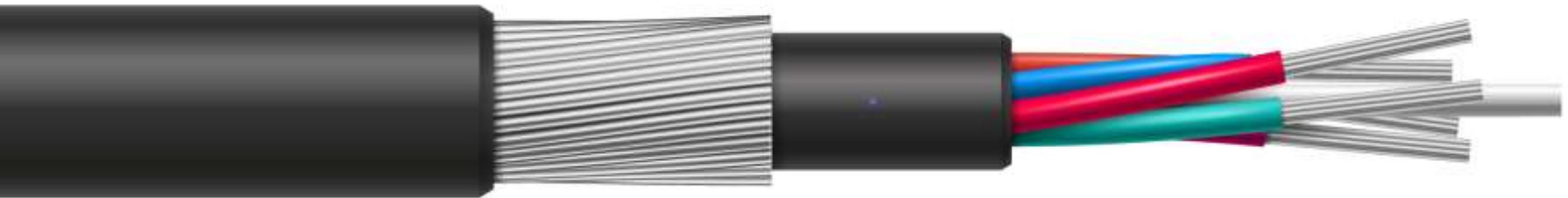
The history of connectivity

- The first cable, 2,500 miles long, was laid across the Atlantic in 1858, after many difficulties including storms and cable breakages
- For each mile of cable, 133 miles of copper and iron wire was needed
- Total weight was one ton per mile



Fibre-optic cables

- Today, fibre optic cables carry almost 100% of worldwide Internet and phone traffic
 - A fibre-optic cable is about 13-19mm in diameter

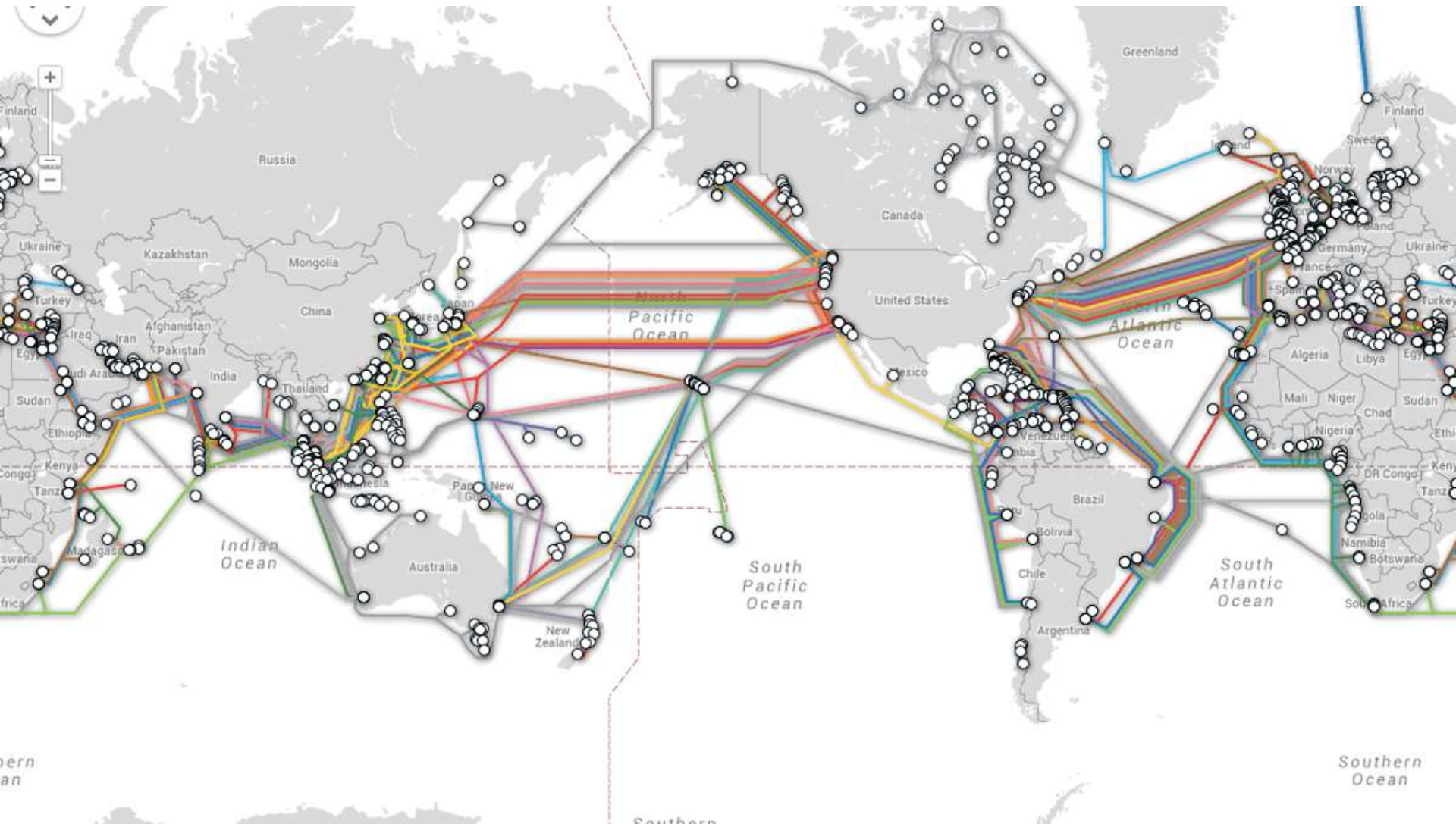


Across the oceans

- Cables are laid under the sea across the world
- Today, there are more than 420 submarine cables stretching over **700,000 miles (1.1 million km)** around the world



Undersea Internet cables



Bandwidth

- The maximum amount of data that can be transmitted over a network connection in a given amount of time



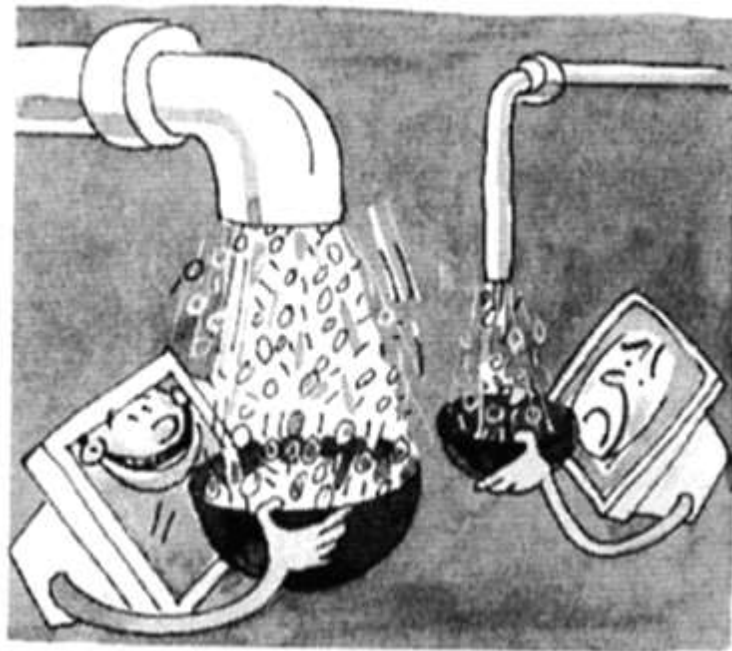
Bandwidth

- The maximum amount of data that can be transmitted over a network connection in a given amount of time

Large Bandwidth



Lots of data can be transferred in a short time.



Small Bandwidth



Not very much data can be transferred at a time.

Worksheet 1

- **Complete Task 1**

Transmission types

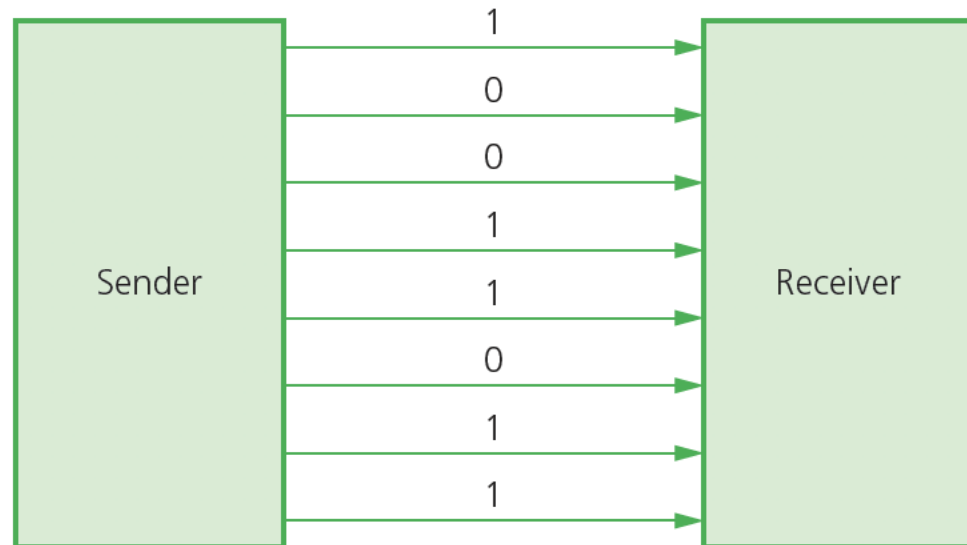
- Serial data transmission**

Data is sent one bit at a time over a single wire (channel).



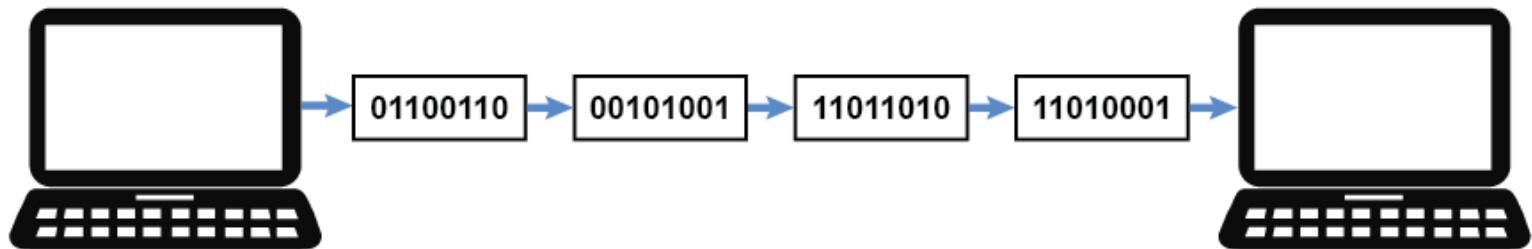
- Parallel data transmission**

Several bits of data are sent down several wires (channels) at the same time.



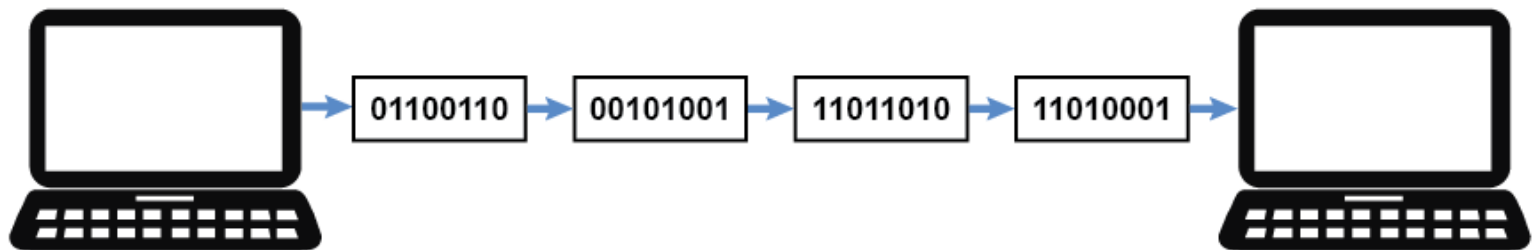
Serial transmission

- Bits are sent one signal at a time over a single wire
- Very high data transfer rates can be achieved
 - Using fibre-optic cable, data transfer rates ranging from around 50 Megabits per second (Mbps) to 100 Gigabits per second (Gbps) can be achieved
- Used with USB (Universal Serial Bus) cables



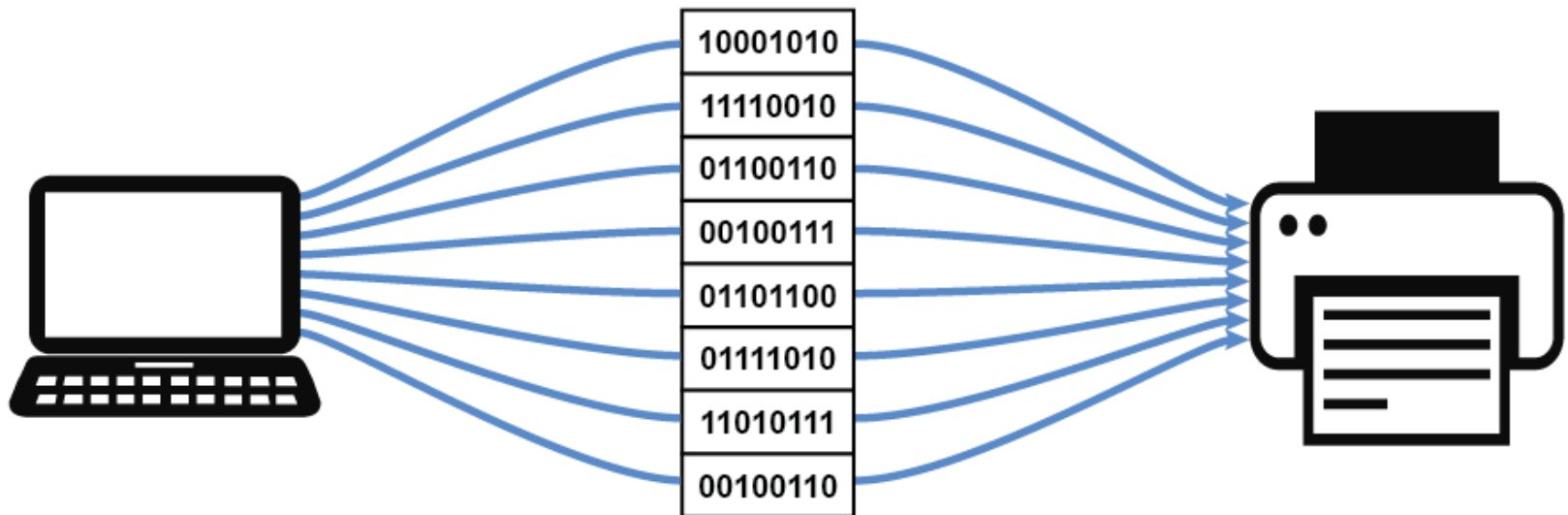
Serial transmission

- Bits are sent one signal at a time over a single wire
- Works well over long distances.
- Data is transmitted at a slower rate than parallel.
- Data arrives at its destination in the correct order (fully synchronised 同步), so no need for it to be reassembled.



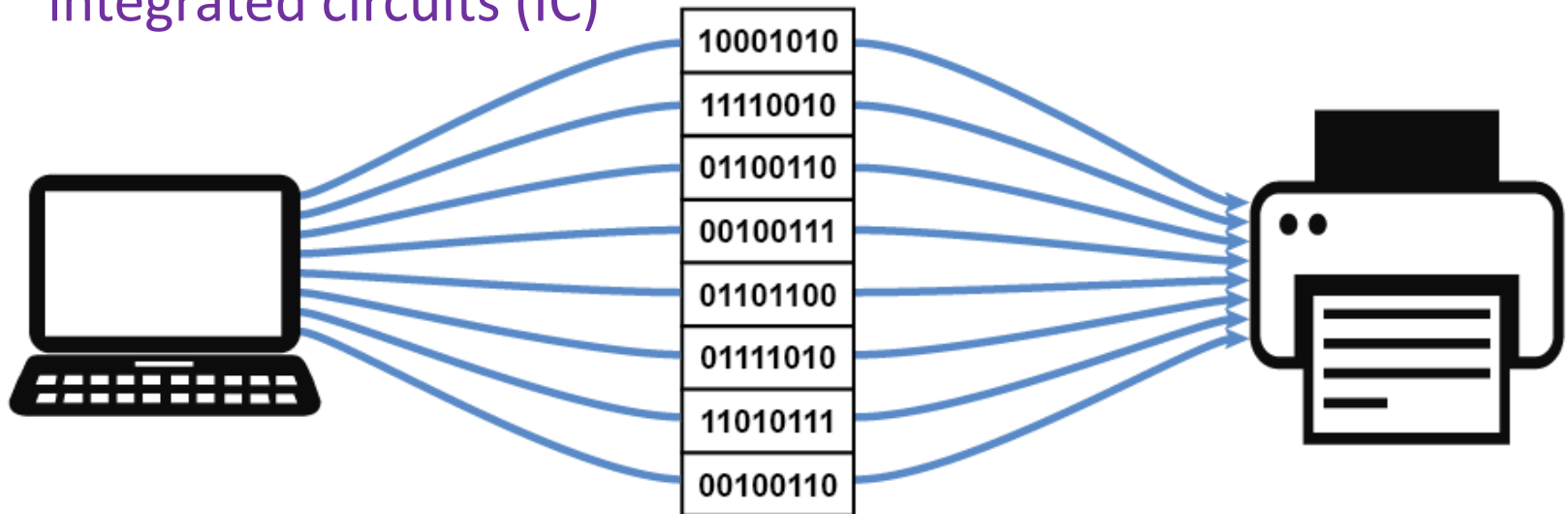
Parallel transmission

- Signals (bits) are sent simultaneously (at the same time) over a number of parallel wires
 - Why might parallel be faster than serial transmission?



Parallel transmission

- Works well over short distances, but over longer distances, data may become skewed 扭曲 and unsynchronised 未同步 when it arrives at its destination -> produces errors
- Used in the internal circuits (IC) of computers as only short distances are used and data can travel at high-speed - integrated circuits (IC)



Parallel transmission - use

Computer data ribbons

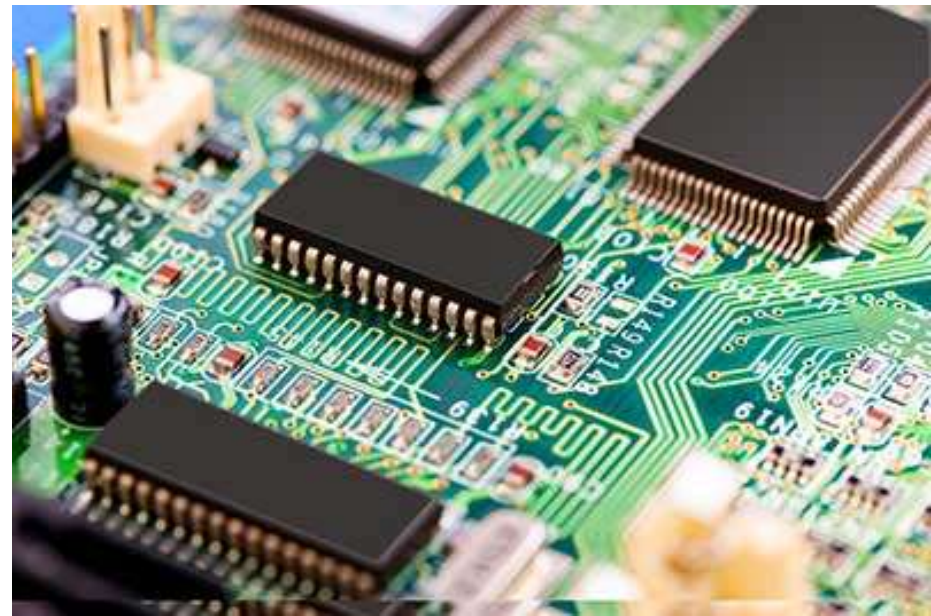
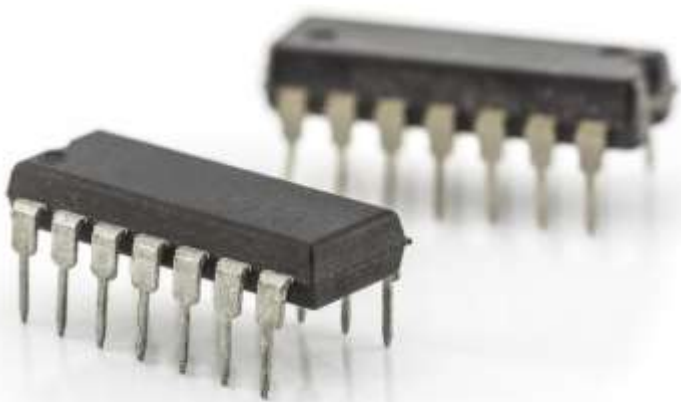
- Known as Parallel ATA cables
- Used to connect internal storage devices such as a hard disk drive or optical disk drive in a computer
 - The cables use 8, 16 or 32 bits sent down separate lines



Parallel transmission - use

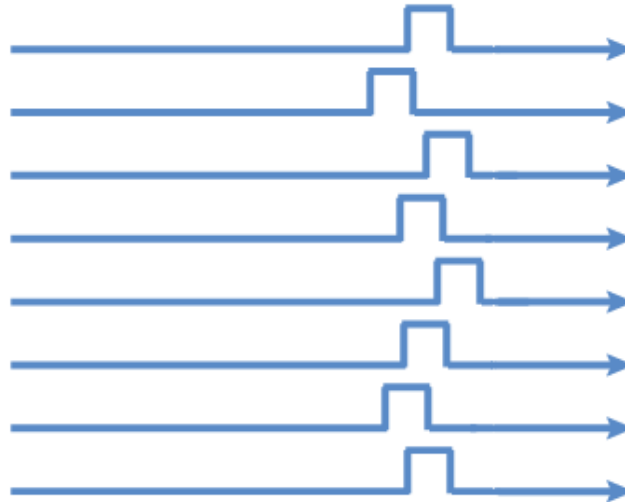
Integrated Circuits (IC)

- Known as a 'chip', an IC is made of a semiconductor material called silicon
 - The silicon layer assembles millions or billions of tiny resistors, transistors and resistors sending data in parallel



Parallel - problems – Skew 扭曲

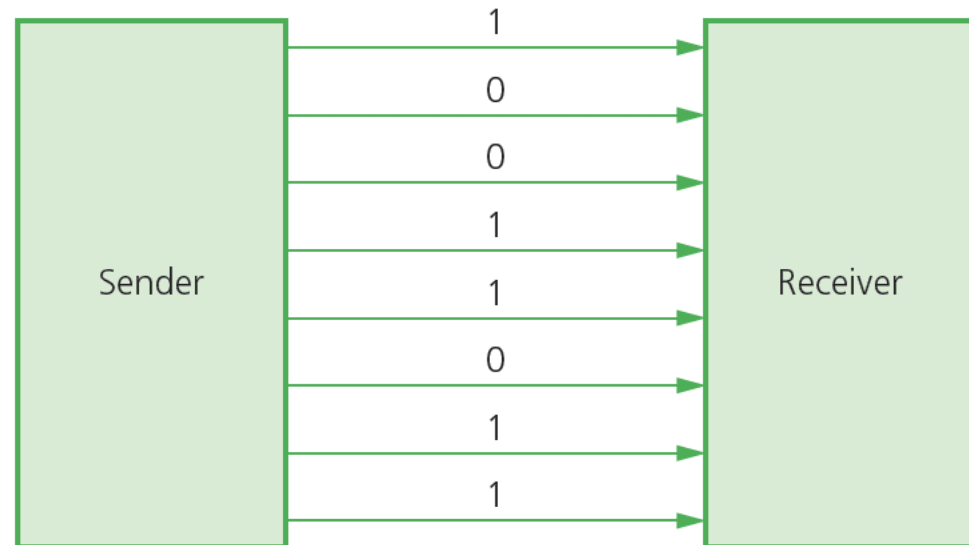
- Each wire in a parallel cable has slightly different properties
 - Signals travel down wires at different speeds



- Transmission must be over very short distances to reduce the problem

Parallel - problems - Crosstalk

- Crosstalk interference 干扰 occurs when a signal from one line gets transferred to another line and changes the data
 - A similar event can occur on a telephone landline when you can hear a different conversation on another circuit

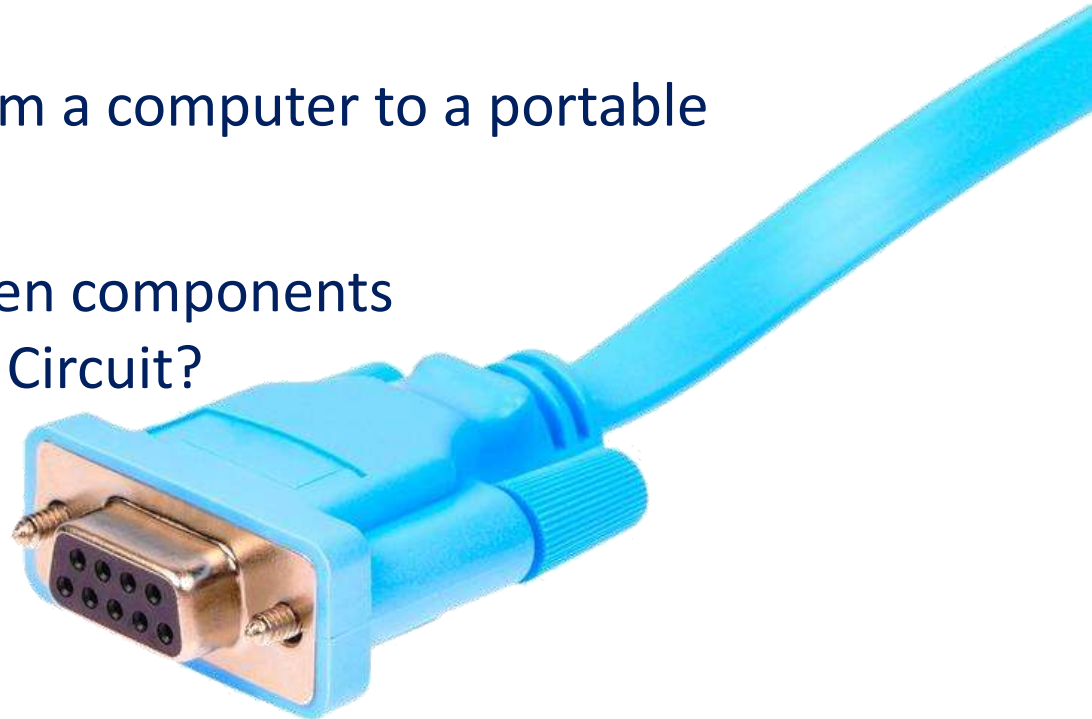


Comparison of serial and parallel transmission

Serial	Parallel
less risk of external interference than with parallel (due to fewer wires)	faster rate of data transmission than serial
more reliable transmission over longer distances	works well over shorter distances (for example, used in internal pathways on computer circuit boards)
transmitted bits won't have the risk of being skewed (that is, out of synchronisation)	since several channels/wires used to transmit data, the bits can arrive out of synchronisation (skewed)
used if the amount of data being sent is relatively small since transmission rate is slower than parallel (for example, USB uses this method of data transmission)	preferred method when speed is important
used to send data over long distances (for example, telephone lines)	if data is time-sensitive, parallel is the most appropriate transmission method
less expensive than parallel due to fewer hardware requirements	parallel ports require more hardware, making them more expensive to implement than serial ports
	easier to program input/output operations when parallel used

Transmission types

- Which type of transmission would you use for:
 - Connecting to a local printer on the same desk?
 - Downloading data from a rooftop weather station to a computer?
 - Transferring files from a computer to a portable hard drive?
 - Sending data between components inside an Integrated Circuit?



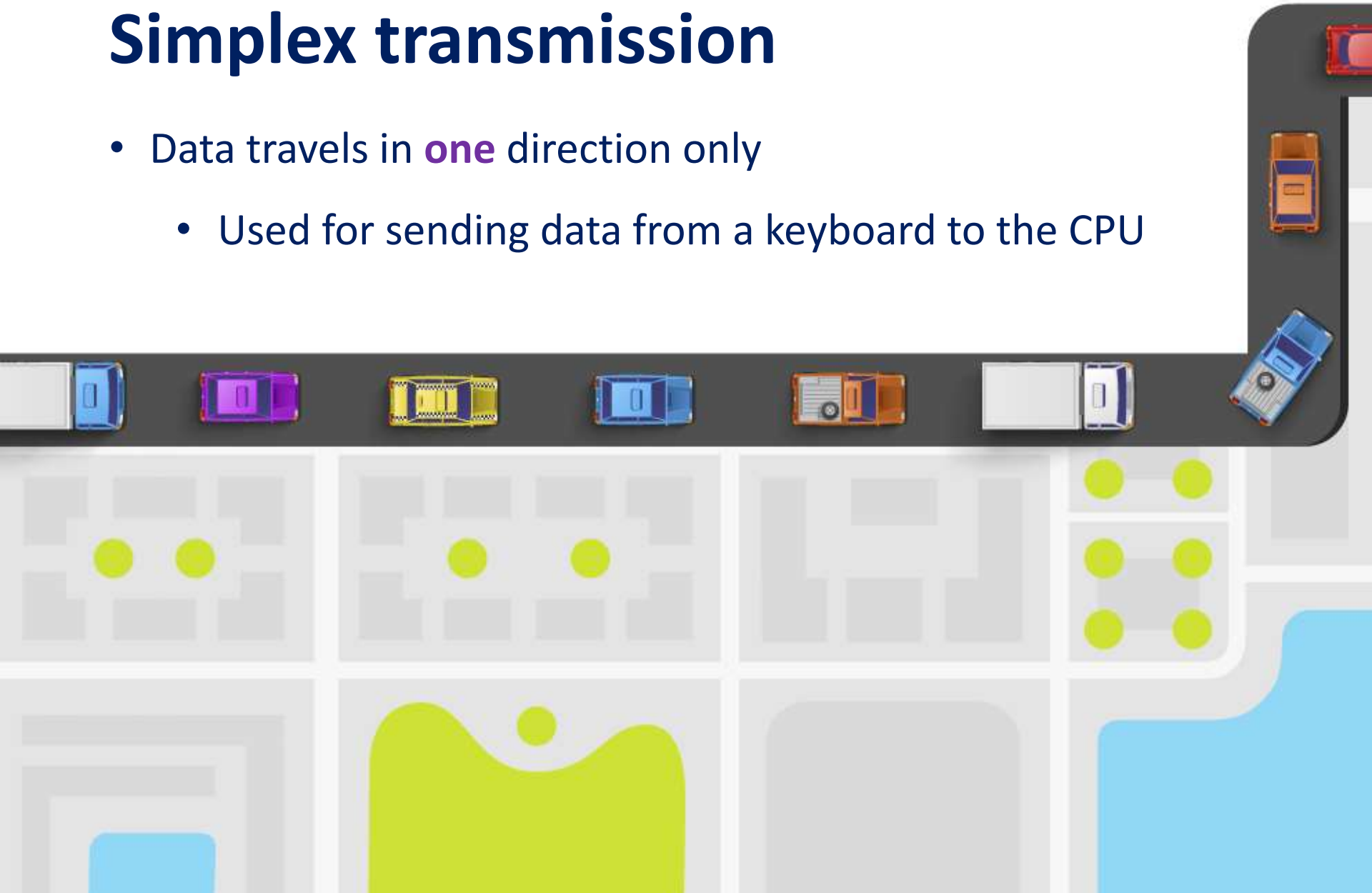
Transmission direction

- Simplex, duplex and half-duplex are terms referring to the direction of data during transmission.
- These terms can be used in conjunction with serial and parallel transmission terminology.



Simplex transmission

- Data travels in **one** direction only
 - Used for sending data from a keyboard to the CPU



Half-duplex transmission

- Data can travel in **both directions** along a single cable, but **not simultaneously** (not at the same time)
 - Used in parallel printer cables: data is sent to a printer, and the printer can send 'Out of paper' messages back, but only when the computer has finished sending data



Full duplex transmission

- Data can travel in **both directions simultaneously** (at the same time)
 - Used in fibre optical networking or Internet cables for upload and download



Vocabulary

- **transmission**
- **serial**
- **parallel**
- **network**
- **simplex**
- **half-duplex**
- **full-duplex**

Past paper question examples ...

- 3 Blair writes a paragraph about data transmission in her Computer Science examination.

Use the list given to complete Blair's paragraph by inserting the correct **five** missing terms. Not all terms will be used. Terms can be used more than once.

- duplex
- half-duplex
- parallel
- serial
- simplex

..... data transmission is when data is transmitted a single bit at a time. data transmission is when multiple bits of data are sent all at once. If a user wants to transmit data over a long distance, with the highest chance of accuracy, data transmission should be used. If data needs to be transmitted in one direction only, for example from a computer to a printer, data transmission should be used. If a user has a large amount of data to transmit and this needs to be done as quickly as possible data transmission should be used.

Past paper question examples ...

- 9 Maisey purchases a new router and attaches it to her computer. The connection she sets up uses duplex data transmission.

(a) Five statements are given about duplex data transmission.

Tick (✓) to show if the statement is **True** or **False**.

Statement	True (✓)	False (✓)
Duplex data transmission can be either serial or parallel		
Duplex data transmission is when data is transmitted both ways, but only one way at a time		
Duplex data transmission is always used to connect a device to a computer		
Duplex data transmission is when data is transmitted both ways at the same time		
Duplex data transmission automatically detects any errors in data		

[5]

- (b) Maisey's computer uses an integrated circuit (IC) for data transmission that sends multiple bits at the same time.

State whether the IC uses **serial** or **parallel** data transmission.

Past paper question examples ...

5 Sonia shares files with her friends. The method of data transmission she uses is half-duplex serial transmission.

(a) Describe how data is transmitted using half-duplex serial data transmission.

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..... [4]

Past paper question examples ...

(ii) MIDI uses serial data transmission.

Explain **two** advantages of using serial transmission rather than parallel transmission.

Advantage 1

.....

.....

.....

Advantage 2

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.....

Worksheet 1

- Complete Task 2

Bit rate and Baud rate

- The speed of data is measured in bits per second (bps)
- The Baud rate is the rate at which the signal changes
- Baseband means one signal (bit) is sent at a time down a serial connection
- In standard baseband, bit rate = baud rate

Bit rate and Baud rate

- The speed of data is measured in bits per second (bps).
- If you have a 5 MB file and your internet connection is 10 mbps (megabits per second) connection how long will it take to download?

10 mbps = 10 000 000 bps (bits per second)

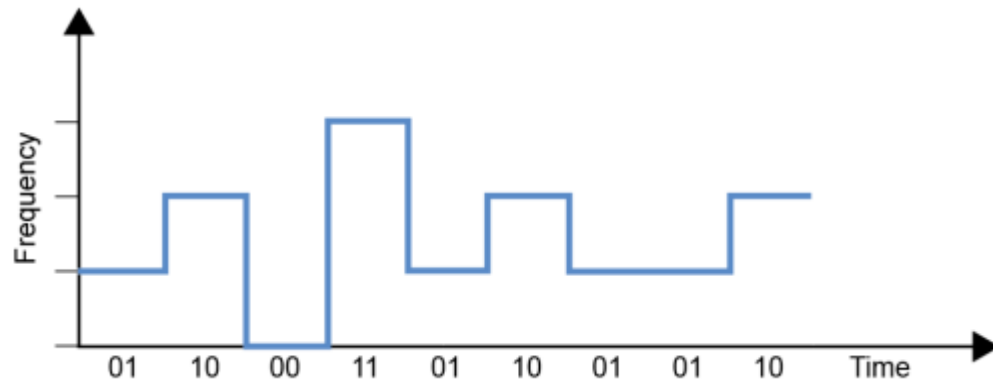
10 000 000 = 1 250 000 bytes per second (Bps)

1 250 000 = 1.25 megabytes per second (MBps)

5 megabytes / 1.25 megabytes ps = 4 seconds

Why serial transmission can be faster than parallel

- With higher bandwidths, more than one bit can be coded in a signal, increasing the bit rate
 - Bit rate of channel = (baud rate) x (number of bits per signal)



- Each signal has four frequencies meaning two bits can be encoded at a time. How many bits can be encoded with eight frequencies?

Plenary

For your exam, you need to be able to:

- Understand the difference between serial and parallel data transmission
- Understand the difference between simplex, duplex and half-duplex data transmission
- Explain the advantages and disadvantages of each method of data transmission