

## Recap

\_\_\_\_\_ is the maximum amount of data that can be transmitted over a connection per second. It is measured in bits per second (**bps**).

\_\_\_\_\_ is the time taken for a transmission to reach its destination.

| File size units | Equivalent to  |
|-----------------|----------------|
| bit             | 1 bit          |
| nibble          | 4 bits         |
| byte            | 8 bits         |
| Kibibyte(KiB)   | 1024 bytes     |
| Mebibyte (MiB)  | 1024 kibibytes |
| Gibibyte (GiB)  | 1024 mebibytes |
| Tebibyte (TiB)  | 1024 gibibytes |

| Speed Units | Equivalent to |
|-------------|---------------|
| 1 Kbps      | 1000 bps      |
| 1Mbps       | $1000^2$ bps  |
| 1 Gbps      | $1000^3$ bps  |

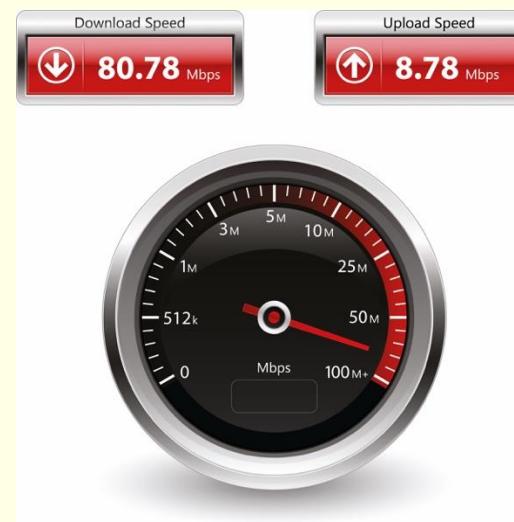
$$time = \frac{file\ size\ (in\ bits)}{network\ speed\ (in\ bps)}$$



# Learning Aims

In this lesson you will learn to:

- Define the meanings of the terms '**bandwidth**' and '**latency**'
- Explain how bandwidth and latency affect the performance of a network
- Use bits per second (bps) to describe network speed
- Construct expressions involving file size, transmission rate and time.

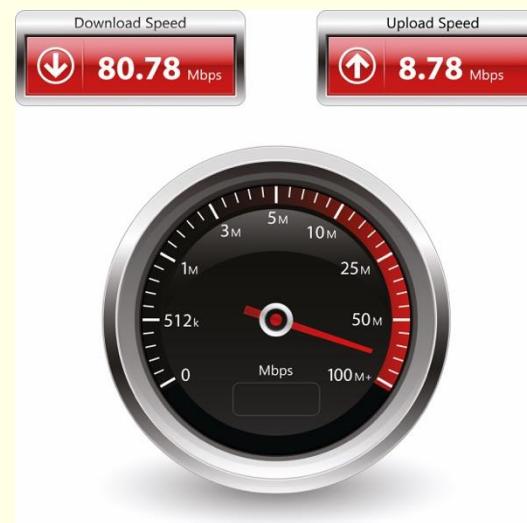


# What does speed mean?

The term '**download speed**' refers to how much data can be downloaded **per second** over a connection.

There are a number of factors that can affect the speed of a connection.

The two most important are the **bandwidth** and **latency**.



# Bandwidth and latency

**Bandwidth** is the maximum amount of data that can be transmitted over a connection per second. It is a measurement of capacity. It is measured in bits per second (**bps**).

**Latency** is the time taken for a transmission to reach its destination.

Gamers may be familiar with the term '**ping**'. This is a way of measuring latency. It times a single transmission as it travels to a server and back again.



# Measuring speed

We measure network speed in bits per second (bps).

Modern networks have high bandwidths, measured in millions of bits per second.

The following units are used to measure network speeds.

| Units               | Abbreviation | bits per second |
|---------------------|--------------|-----------------|
| bits per second     | bps          | 1               |
| kilobits per second | Kbps         | 1000 bps        |
| megabits per second | Mbps         | $1000^2$ bps    |
| gigabits per second | Gbps         | $1000^3$ bps    |

# File size

Edexcel require you to measure file size using the following:

| Unit     | Abbreviation | Equivalent to  |
|----------|--------------|----------------|
| bit      |              | 1 bit          |
| nibble   |              | 4 bits         |
| byte     |              | 8 bits         |
| kibibyte | KiB          | 1024 bytes     |
| mebibyte | MiB          | 1024 kibibytes |
| gibibyte | GiB          | 1024 mebibytes |
| tebibyte | TiB          | 1024 gibibytes |



## Calculating transmission times

$$time = \frac{file\ size\ (in\ bits)}{network\ speed\ (in\ bps)}$$



## Formulas for working out speed and size

$$\text{speed} = \text{size} / \text{time}$$
$$\text{size} = \text{time} * \text{speed}$$


# Worked example

How long will it take to download a **20MiB file** over a **12 Mbps connection?**

1. Convert the file size to bits

$$20 \times 8 \times 1024 \times 1024$$

2. Convert the speed to bits per second

$$12 \times 1000 \times 1000$$

3. Arrange the size and speed

$$\text{expressions} \quad \frac{20 \times 8 \times 1024 \times 1024}{\text{time}} = \frac{20 \times 8 \times 1024 \times 1024}{12 \times 1000 \times 1000}$$

$$\text{time} = \frac{20 \times 8 \times 1024^2}{12 \times 1000^2}$$

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$$\text{time} = \frac{\text{file size (in bits)}}{\text{network speed (in bps)}}$$



# Must know for exam

In an exam, you could be asked to construct an expression involving file size, transmission rate and time. This could include an expression for:

- how long it takes to transfer a file of a given size
- how many mebibytes or kibibytes can be transmitted per second
- how many files of a given size can be transmitted per second



You will find the following expressions useful:

## File Size

**one byte (B) = 8 bits (b)**

**file size in bits (b) = file size in bytes (B)  $\times$  8**

**one kibibyte (KiB) =  $1024 \times 8$  bits**

**one mebibyte (MiB) =  $1024^2 \times 8$  bits**

**one gibibyte (GiB) =  $1024^3 \times 8$  bits**

## Speed

**one kilobit per second (Kbps) = 1000 bits per second (bps)**

**one megabit per second (Mbps) = 1000 Kbps =  $1000^2$  (bps)**

**one gigabit per second (Gbps) = 1000 Mbps =  $1000^3$  (bps)**



## Practice Tasks

- 1** Anke plays cricket. She has made a video to promote women's cricket. The file size of the video is 22 GiB.

Construct an expression to calculate how long it will take to transmit the video across a network that has a transmission speed of 54 Mbps.
- 2** Erik uses the network to send a file to his colleague Jens. It takes 35 seconds for Jens to receive the file. The network transmits data at a rate of 40 Mbps.

Construct an expression to calculate the size of the file in mebibytes.
- 3** Marty plays multi-user games online with other gamers. How might a high latency internet connection affect her user experience?



Wrap up: you have learned how to...

- Define the meanings of the terms ‘bandwidth’ and ‘latency’
- Explain how bandwidth and latency affect the performance of a network
- Use bits per second (bps) to describe network speed
- Construct expressions involving file size, transmission rate and time.

