


Network Fundamentals

GCSE student booster

Key Information

- 1) Remember this booster is here to **help you**. Please consider your behaviour in the chat.
- 2) If you are in a room with a teacher/group, please login to the meeting. This is so we can mark your attendance. This information goes into a **prize draw**.
- 3) Make sure the name on the meeting is the **SAME** as the name on your Isaac account. We can't mark you present if they don't match.



Network Fundamentals

GCSE Booster

Starter Question... in the **chat**:



List some of the things you can do when connected to a network, that you could **not** do if your device was not connected.

Isaac Computer Science

During this booster you may require access to the [Isaac Computer Science platform](#).

Accounts are free to create. You will be able to:


- use the platform to develop your subject knowledge
- use for GCSE for each exam board
- take part in Gameboards
- access self-marking questions



Intended learning outcomes

By the end of this session you will be able to:

- understand the **purpose** of networks and what **hardware** is needed for **LANs** and **WANs**
- understand **topologies**, **client-server**, **peer-to-peer**, **wired** and **wireless** networks
- know some effects on network **performance** and define **bandwidth**, **latency** and **congestion**




Why use a network?

Think about some of the things you do often:

- Email, messaging and social media
- Streaming video and music
- Making phone calls
- Printing cinema tickets
- Doing schoolwork

All these activities need your device to be connected to a network.

But what are the downsides of this?



Network Pros and Cons

Name some **advantages** and **disadvantages** of joining computers and other devices together

Advantages	Disadvantages

Answers in the chat...

Network Pros and Cons

Name some **advantages** and **disadvantages** of joining computers and other devices together

Advantages	Disadvantages
<div>communicate</div> <div>share hardware</div> <div>share files</div> <div>backup centrally</div> <div>update software</div> <div>multi-user systems</div>	<div>hardware cost</div> <div>staff cost</div> <div>security risks</div>

Types of network by size

Personal area network (PAN) – AQA only

- Enables communication between computer devices near a person
- Range typically is a few meters
- Typically uses bluetooth (but can use wifi or NFC)
 - Bluetooth speakers, headphones or earbuds
 - Computer peripherals (mouse, keyboard)
 - Tethering / hotspotting a smartphone and a laptop
 - Tapping a device to pay for something



Local area network (LAN)

- Local area networks use **devices connected** in a **small geographical area**
- Devices connected using their **own hardware**
- Examples could include a school, a small business, a museum







Wide area network (WAN)

- A WAN (wide area network) is created when **lans are connected together**
- A WAN covers a **large geographical area**
- The largest WAN is the **internet**
- Uses **third party infrastructure**



LAN, WAN or PAN?

In the chat, type LAN, WAN or PAN...

- A school network on one site 
- A bank network linking all ATMs across the country 
- A home network linking TVs, smartphones and printers 
- A Bluetooth connection between earbuds and a smartphone 



Network Hardware



Hardware: Network Interface Card / Controller (NIC)

- Usually now integrated into a PC, laptop or mobile device
- Connects a device wired or wirelessly **to a LAN**
- It uses a **protocol** to ensure successful communication with other devices
- Every NIC has a permanent, unique number, called the **MAC address** (or physical address)



Hardware: Switch

- A switch sends data between computers on a **local area network**.
- It can only route traffic on a **single network**
- It uses the **MAC address** on a device to route traffic



Hardware: Router

- A router connects **different networks**
- It reads the **IP address** and forward messages to the correct **network**
- A "home router" is not just a **router**, it contains a **WAP**, a **switch** and a **modem** too.




Hardware: Wireless access point (WAP)

- Wireless access points allow **wireless** devices to connect to a wired network
- Waps **convert** data they receive through cables into a wireless signal (& vice versa)
- They're commonly found in public places
- A "home router" also contains a WAP



Hardware: Transmission Media


Fibre Optic



Long-distance connections and **wide area networks** are usually connected with fibre optic cable

Fibre optic has a **higher bandwidth** than copper and suffers from **less interference**


Copper



Local area networks are usually made with unshielded twisted pair (UTP) copper cable

It is **cheap** and flexible which makes it easy to install

Wireless




Laptops, tablets and smartphones usually connect **wirelessly**. It's **cheaper** than installing lots of cables. Users can **work flexibly**. But is **less secure** and can be affected by **obstructions** and **congestion**

Activity 1: Match the Hardware

On the handout do Activity 2.

You have 6 minutes!




Time's up!

Handout 1







Activity 1 – Match the Hardware

Read the descriptions in the final column of the table. Type the name of the component that matches this description in the Name column, drag the right image into the Image column, then complete the missing words in the Description column. Copper cable has been done for you.

Copper cable, Switch, NIC, WAP, Fibre optic cable, Router

Name	Image	Description
Copper cable		A transmission medium. Local area networks are usually made with unshielded twisted pair (UTP) copper cable. It is cheap and flexible which makes it easy to install
		Connects a device wired or wirelessly to a LAN. It uses a protocol to ensure successful communication with other devices. Has a permanent, unique number, called the MAC address

Activity 1 Answers

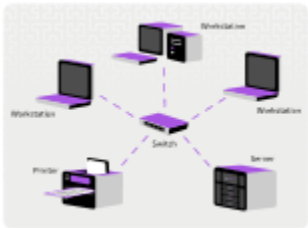
Name	Image	Description
Copper cable		A transmission medium. Local area networks are usually made with unshielded twisted pair (UTP) copper cable. It is cheap and flexible which makes it easy to install
NIC		Connects a device wired or wirelessly to a LAN. It uses a protocol to ensure successful communication with other devices. Has a permanent, unique number, called the MAC address
Switch		Sends data between computers on a local area network. It can only route traffic on a local network. It uses the MAC address on a device to route traffic
Router		Connects different networks. It reads the IP address and forward messages to the correct network
WAP		Allows wireless devices to connect to a wired network. Converts data it received through cables into a wireless signal (& vice versa)
Fibre optic cable		Long-distance connections and wide area networks are usually connected with this. It has a higher bandwidth than copper and suffers from less interference

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Topologies

Network Topologies – Star

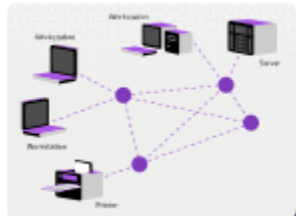
- Devices connect to a central **switch**.
- The switch directs each message to the intended recipient device



The diagram illustrates a star network topology. A central switch is connected to five other devices: two desktop computers, a laptop, a printer, and a server. All connections radiate from the central switch, showing that each device communicates through it.

Network Topologies – Mesh

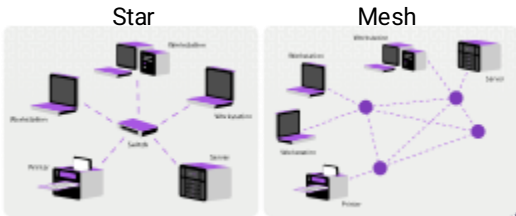
- No central switch. Instead, there are multiple paths between the **switches, WAPs and routers** that form the network.
- A **partial mesh** topology connects some devices directly and others through intermediary nodes, unlike a **full mesh** where each device connects to every other.



The diagram shows a partial mesh network topology. It includes five devices: two desktop computers, a laptop, a printer, and a server. The connections are not all direct to a central point; instead, some devices are connected to each other, and others are connected through intermediate nodes, creating multiple possible paths for data travel.

Activity 2: Hide and Draw!

Memorise the Star and Mesh diagrams, you will draw them in a moment... **1 minute**



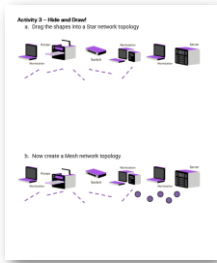
Activity 2: Hide and Draw!

Handout 1

Drag and drop to create a **Star** and **Mesh** topology.
You have **6 minutes!**

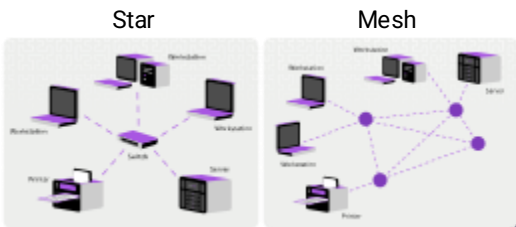


Time's up!



Activity 2: Hide and Draw!



Solutions, how did you do?



Wired v wireless

Wired vs Wireless

Network connections can be **wired** or **wireless**.



Activity 3:

Wired v wireless

On the handout, drag the wired and wireless icons to the right place on this scale in **4 mins!**

Handout 1

Speed

Security

Range

Flexibility

Cost

10

Activity 3 Answers



Performance of a network

Bit rate is the measure of the amount of data (in bits) that is transferred per second.

Standard unit	Common abbreviation	Bits per second
bits/s	bps	1
kbit/s	kbps	1,000
Mbit/s	Mbps	1,000,000
Gbit/s	Gbps	1,000,000,000

[Netflix](#) recommends a minimum bit rate of 3Mbps for HD and 15Mbps for 4K streaming. **Why?**

Bandwidth

Bandwidth is the theoretical **maximum** bit rate of a connection.

Some common bandwidths are:

- On a wired local area network (LAN):
- "Fast Ethernet" is 100 M bit/s
 - "Gigabit Ethernet" is 1 G bit/s
 - "10 Gigabit Ethernet" is 10 G bit/s
- On a wireless local area network (WLAN):
- Wi-Fi 4 (802.11n) is 600 Mbit/s
 - Wi-Fi 5 (802.11ac) is 3.5 Gbit/s
 - Wi-Fi 6 (802.11ax) will be 9.6 Gbit/s!

Question: which is faster, wired or wireless?

Answer: it depends on what standards we are on!

Factors that affect performance

Factor	Description
Range	Distance over which data can be reliably transmitted, this depends on transmission media , and is shortened by obstructions such as thick walls
Number of devices	Also known as congestion . All devices on a LAN must share its bandwidth , if users are streaming video, others will struggle for bandwidth.
Latency	The delay between transmit and receive. This depends on the journey the packets take and the speed of each hop, for example a satellite hop will add ¼ of a second.



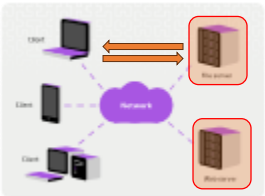
Client-server vs peer-to-peer



Client-server model

Client-server networks have **servers** and allow you to access your files and services from any **client** device.

- Centrally you can manage**
- Security
 - Software installation
 - Updates / patching
 - Backups
 - Authentication



Peer-to-peer model (P2P)

In a peer-to-peer network, there are no central servers. All computers are equal, and as **peers** they communicate directly with each other.

On **individual** computers you must:

- Manage security
- Install software
- Install updates / patches
- Backup files



Activity 4: Client/server v. peer to peer



On the handout do activity 5...
You have 6 minutes!



Time's up!

Activity 5 – Client-server v. Peer to Peer

Use Issue to complete this table by dragging and dropping the statements in to the correct empty cells. <https://www.cisco.com/it/learning/learning-path/peer-to-peer-networks>

	<div>On a peer-to-peer network, individual users may be responsible for backing up their own data.</div>	<div>On a peer-to-peer network, workstations may be at multiple different locations, including at home, and are difficult to oversee.</div>
	<div>Individual users are likely to be responsible for backing up their own data.</div>	
	<div>On a client-server network, servers may be located in secure rooms. They do not need to be physically accessible to every user. It is easier to monitor a server room (e.g. by CCTV) than to monitor every device on the network.</div>	
	<div>Servers can be located in secure rooms. They do not need to be physically accessible to every user. It is easier to monitor a server room (e.g. by CCTV) than to monitor every device on the network.</div>	
	<div>On a client-server network, servers will need to be set up and configured. These will generally be high-performance computers capable of supporting a large number of users.</div>	
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Factor	Client-server	Peer-to-peer
Setup cost	Servers will need to be set up and configured. These will generally be high-performance computers capable of supporting a large number of users.	No additional devices are needed.
Physical security	Servers can be located in secure rooms. They do not need to be physically accessible to every user. It is easier to monitor a server room (e.g. by CCTV) than to monitor every device on the network.	On peer-to-peer networks, workstations may be at multiple different locations, including at home, and are difficult to oversee.
Backups	most important files are stored on servers. It is therefore much easier to make sure that all of these files are backed up. In a large organisation, there is likely to be a network manager who will be responsible for the security and back up of the servers.	individual users are likely to be responsible for backing up their own data.
Points of failure	If a server fails, many users will be affected. For example, if a file server fails, no-one will be able to access the files.	If one device fails, it will have less impact. Most users will be able to carry on with their work.



Activity 4 Answers


Factor	Client-server	Peer-to-peer
Setup cost	Servers will need to be set up and configured. These will generally be high-performance computers capable of supporting a large number of users.	No additional devices are needed.
Physical security	Servers can be located in secure rooms. They do not need to be physically accessible to every user. It is easier to monitor a server room (e.g. by CCTV) than to monitor every device on the network.	On peer-to-peer networks, workstations may be at multiple different locations, including at home, and are difficult to oversee.
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Past Paper Style Questions

Activity 5: Past Paper Style Question

Now attempt the question in Activity 6
You have 6 minutes!



Handout 1

Activity 6 – Past Paper Style Questions

1. A school runs a LAN (Local Area Network). The Computing department and the Library have desktop computers connected by cable and all staff have laptops that connect wirelessly.

(a) Name two hardware devices that are needed in this network, and the purpose of each.

Device 1:
Purpose:
Device 2:
Purpose:

(b) Staff in the PE block report that their connection is very slow and unreliable. Give two reasons why this might be.

(c) Students in Computing lessons report that the network is sometimes slow. Give one reason why this might be.

Activity 5 Answers to a, b, c

1. A school runs a LAN (Local Area Network). The Computing department and the Library have desktop computers connected by cable and all staff have laptops that connect wirelessly.

(a) Name two hardware devices needed in this network, and the purpose of each. [2 marks]

Device 1: **Any of NIC, Hub, Switch, Router, WAP, cable**

Purpose: **Correct purpose (see activity 2) – both needed for a mark**

Device 2: **Any other device from NIC, Hub, Switch, Router, WAP, cable**

Purpose: **Correct purpose (see activity 2) – both needed for a mark**

(b) Staff in the PE block report that their connection is very slow and unreliable. Give two reasons why this might be. [2]

- **Too far / long distance from the WAP / wireless router**
- **Obstructions / walls in the way (reducing signal strength)**
- **Interference from other devices nearby**
- **Congestion / too many users on one WAP**

(c) Students in Computing lessons report that the network is slow when all computer labs are full of students. Give one reason why this might be. [1]

- **Congestion / too many users on a switch or the network at the same time**
- **Not enough bandwidth for all the users at once**

Activity 5 Answers d

(d) Students use the library computers to access the world wide web for homework. When a student types `bbc.co.uk/bitesize` into the browser address bar, the BBC Bitesize website is loaded. Fill in the missing terms to explain how this works. Choose from the following terms, two of which are not needed. [4]

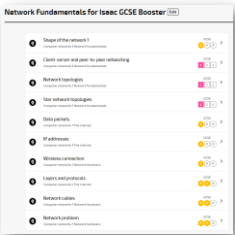
HTML, DNS server, MAC address, web server, SMTP, client, URL, address bar, IP address, HTTPS.

BBC Bitesize is hosted on a **web server**. The student computer is called a **client**. The string '`bbc.co.uk/bitesize`' is an example of an **URL**. The student types this into the browser **address bar**. The browser sends a request to a **DNS server** for the matching **IP address** for that URL. The client browser can then send a request to this IP address for the website content, which is written in **HTML** and sent using the application protocol **HTTPS**.



Isaac Gameboard practice

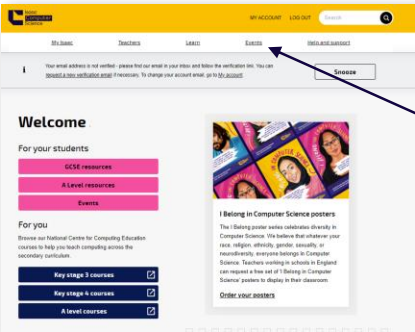
- Don't forget, if you want more networks practice, then try this gameboard.
- You will need to sign in to **Isaac Computer Science** or register for a free account if not done already.



ncce.io/isc-net1



Check for more ISAAC boosters




Keep an eye out for more student booster events



Intended learning outcomes

By the end of this session you will be able to:

- Understand the **purpose** of networks and what **hardware** is needed for **lans** and **wans**
- Understand **topologies**, **client-server**, **peer-to-peer**, **wired** and **wireless** networks
- Know some effects on network **performance** and define **bandwidth**, **latency** and **congestion**



Questions?



Thank You