



Network Fundamentals

GCSE 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.



Timing: 1 minute

Key outcome: Remind students on behaviour, checking all students are on the meeting, also checking they have the right name so we can track them.

Activity: Check names against register, check they are using preferred name, no nicknames

Background:

Questions:

Misconceptions/issues to note:



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.

Timing: 3 minutes

Key outcome:

Activity:

Background:

Questions:

Misconceptions/issues to note:

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



Timing: 1 minute

Key outcome: Introduce Isaac

Activity: Advise they create an account - platform is totally free.

Briefly share the benefits for teachers and students

Background: Isaac is a high-quality online textbook with short videos and practice questions. Can be used for self-study, homework and testing.

Teachers can set "gameboards" (quizzes) and track results by class/student.

Questions:

Misconceptions/issues to note:

Isaac platform link: <https://isaaccomputerscience.org/>

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
- understand **IP addresses, protocols, packet switching, DNS** and **URLs** and how the **internet** works
- know some effects on network **performance** and define **bandwidth, latency** and **congestion**



Timing: 1 minute

Key outcome: know the LOs

Activity: Discuss the slide

Background:

Questions:

Misconceptions/issues to note:

Slide 5

PRO I wonder how we could condense this into 4 LO's? Which are the most important as might overload students with 6 LOs.

Paul Robson, 2024-10-21T10:39:39.614

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?



Timing: 2 minutes

Key outcome: Begin to understand the purpose of a network

Activity: Discuss the slide, all of these things need a network

Background:

Questions: What are the downsides of being connected? A. cyberbullying, inappropriate content, hacking, scamming etc...

Next slide we will gather some pros and cons of being on a network

Misconceptions/issues to note: Not all of these things

need the **internet**, but they all need networks.
E.g. phone calls are usually made over the telephone companies' WANs, and printing uses your home LAN.

Images: Powerpoint icon set

Network Pros and Cons

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

Advantages	Disadvantages

Answers in the chat...



Timing: 2 minutes

Key outcome: Know some pros and cons of networks

Activity: Ask the question on the slide and get answers in the chat

Background:

Questions: What are some **advantages** and **disadvantages** of joining computers and other devices together?

Answers on next slide

Misconceptions/issues to note:

Network Pros and Cons

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

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

Timing: 2 minutes

Key outcome: Know some pros and cons of networks

Activity: Click to reveal some suggested answers

Background: More info, advantages:

- Communication includes email, social media, phones and VoIP etc
- Hardware e.g. printers and file storage can be shared, e.g. in school you might store your files on a file server or in the cloud (across the internet)
- Central backups can be done with backup software or by using cloud services (OneDrive, Google Drive, iCloud etc.)
- Software is automatically updated over the internet

e.g. Windows patching, auto update of apps from AppStore/Play Store

- Multi-user systems are common in the workplace, where staff all use a central computer system, e.g. helpdesk call logging, banking ledger systems, restaurant booking software

Disadvantages

- Hardware cost includes the routers, switches, WAPs and cables to make the network work
- Staff cost means extra IT experts to install and maintain the network
- Security risks include hacking, scamming, cyberbullying etc. that put the computers, software or people at risk

Questions: Why do we still do it? Save cost, enable business and personal objectives

Misconceptions/issues to note:

Types of network by size



Timing: 30 secs

Key outcome: This section deals with size of network (LAN v WAN v PAN)

Activity:

Background:

Questions:

Misconceptions/issues to note:

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



Timing: 2 minutes

Key outcome: Know what a PAN is

Activity: Discuss the slide

Background: AQA say "only Bluetooth needs to be considered" but for clarity you may wish to mention other technologies that create PANs:

Bluetooth headsets, earbuds and speakers all create a PAN. Also Bluetooth or WiFi keyboard and mouse.

Near-Field Communications (NFC) on a smartphone creates a brief PAN whenever you tap to pay with Google Pay or Apple Pay

"Tethering" is not common now, smartphones usually have a Wireless Hotspot feature, where the cellular network connection is shared via a Wireless hotspot through the phone's WiFi radio.

Multiple devices could connect this way but usually it's only one device, hence personal.

PAN is only AQA but useful to know as general knowledge / drawing upon comparisons of scale.

Questions:

Misconceptions/issues to note:

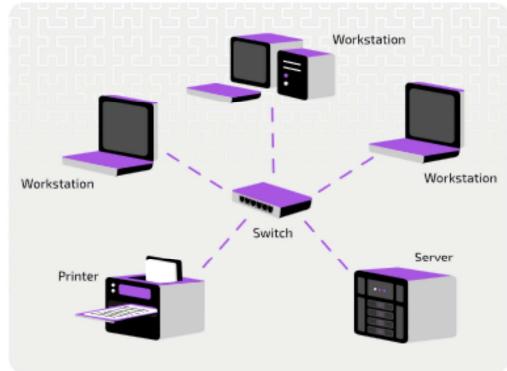
Key outcomes:

Image:

PAN: <https://vectorportal.com/vector/computer-technology-illustration/17475>

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



Timing: 2 minutes

Key outcome: Know what a LAN is

Activity: Discuss the slide

Relate to home networks which are likely to be a mixture of wired and wireless.

Background:

Important; if a question asks “State what is meant by a LAN” then students need to show knowledge of “local area” and also “network” hence the mark scheme will have “connected using their own hardware” and “in a small geographical area” underlined as required elements of the answer. Ideally they could give some examples of hardware such as transmission media, switches.

Questions: Why is your home network a LAN? A.
small geographic area, all hardware owned by you.

Misconceptions/issues to note:

“A LAN is in one building”. This is incorrect although many LANs **may be** within one building. More importantly all the hardware is usually **owned** by the organisation, where WANs usually use 3rd party connections and devices.

“A LAN is so that devices can connect to the Internet” – this may be the case but as a LAN may not necessarily be connected to the Internet this cannot be used to define a LAN, it is more an example of a likely purpose of a LAN.

Isaac Computer Science

https://isaaccomputerscience.org/concepts/net_network_network

Slide 11

PRO I would add to the notes about the owned hardware and add some examples for PDL to mention e.g. a switch, transmission media, WAP

Paul Robson, 2024-10-21T10:45:56.941

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



Timing: 2 minutes

Key outcome: know what a WAN is

Activity: Discuss the slide

Background:

A WAN is different to a LAN in size but also uses public or 3rd party hardware although:

Some corporations have their own global WAN on leased communications infrastructure (e.g. Shell)

Question: What are the benefits of a WAN for big organisations?

Answers: communicate between offices, work globally across many sites, work from home or remotely without cost of an office. share applications and storage

Misconceptions/issues to note:

Images:

WAN: https://freesvg.org/img/internet_schema.png

Slide 12

PRO The bold underline on last slide was useful. I am guessing you are doing the same on here?
Paul Robson, 2024-10-01T12:32:03.743

LAN, WAN or PAN?

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

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

PRO



Timing: 2 minutes

Key outcome: check understanding of LAN, WAN, PAN

Activity: ask each question in turn and click to reveal

For extra credit, why? (e.g. school network is a LAN because it is all on one site and uses only hardware owned by the school)

Background:

Questions:

Misconceptions/issues to note:

Background:

Slide 13

PRO Might be worth adding to the PDL notes EBI if you can say why.

Paul Robson, 2024-10-21T10:46:48.459

Network Hardware



Timing: 30 secs

Key outcome: Introduce new section on Hardware

Activity:

Background:

Questions:

Misconceptions/issues to note:

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)



Timing: 2 minutes

Key outcome: Know what a NIC is

Activity: Discuss the slide

Background:

C in NIC is either controller or card. Card is a throwback to when NICs were an additional purchase to most PCs and had to be installed and plugged into a slot on the motherboard.

The NIC is now a chip on the motherboard in modern devices.

The NIC will receive frames from the wire and inspect the destination MAC address, if this is the local address or the broadcast address the frame will be passed on to the CPU for further processing. If not the frame will be discarded.

Questions:

Misconceptions/issues to note:

Images:

<https://www.flickr.com/photos/51036506@N05/>

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



Timing: 2 minutes

Key outcome: Know what a switch does

Activity: Discuss the slide

Background:

A switch routes traffic on a local area network only. It uses MAC (physical) addresses of devices.

More accurately it receives packets from machines via its ports, sends packets to destination via its ports, and in this way connects devices together on a LAN.

Note that you will find

contained within a home "router" which is really a multi-function device containing router, switch and WAP.

Additional info beyond GCSE A switch “learns” which machines are connected to which ports so that it can send data directly to the intended recipient rather than having to broadcast to all devices (like a Hub would).

Questions:

Misconceptions/issues to note:

Image:

Switch <https://pixabay.com/photos/it-switch-network-data-processing-1361846/>

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.



Timing: 2 minutes

Key outcome: Know what a router does

Activity: explain the slide, the top image are Cisco "core routers" that enable the internet backbone, and stand over a metre high!

Background:

A router often provides connectivity to the Internet but it does not always do so if it is connecting devices on a LAN for example. Students often use the term router synonymously with switch, hub, wifi, modem and so on. It is worth spending time telling students that a modern “Home Hub” is a box that performs a range of functions that separate pieces of hardware (as listed) would all do separately. It is a piece of hardware integrating several functions and actually when we refer to a router as an “internet router” this still performs the same function of forwarding data packets.

It is true to say though that the **main** purpose of a router is in fact to connect multiple networks and forward data packets.

Questions:

Misconceptions/issues to note:

Images:

Core routers by Cisco Systems, Inc. via [Wikimedia Commons](#), CC BY-SA 3.0 via Isaac website

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



Timing: 2 minutes

Key outcome: Know what a WAP is

Activity:

Explain to participants the role of a wireless access point (WAP), explain the fact it converts data that is received via a wired connection into a wireless connection and are commonly found in public places.

You may wish to touch upon the benefits / risks of using a wired / wireless network connection at this point – more detail on this topic is included in the media transmission PDE.

Background: A device like the image shown may be found on the ceiling of many classrooms or in the corridors, ask students to look out for them.

There is a WAP inside a home router also. Inside these devices are antennae (aerials) which are now usually concealed within the plastic case, but earlier devices had visible antennae sticking out.

Improvements in the WiFi protocols mean that they can function very effectively these days without the external antennae.

Questions: Where have you seen these? (School, shopping malls, public buildings)

Misconceptions/issues to note:

that your home "router" is a router. It is actually a multi-function device with a switch, WAP and router in one device.

Image:

http://www.linksys.com/images/productmt_aem/898d12ba-e1d2-4486-ad88-765b51151708/renditions/cq5dam.web.372.372.jpeg

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**



Timing: 3 minutes

Key outcome: Know types of transmission media

Activity: Discuss the slide

Background: This is the way signals travel between devices.

"Fibre broadband" means that the cables between your ISP and your house (or the cabinet in the street) are fibre-optic so you get higher bandwidth (higher Mbps speed)

If you're not on fibre broadband you're on copper cable. The wired LANs in school are probably copper UTP cable, of a standard called CAT5 (category 5), CAT6 or CAT7.

Once the internet arrives at your house over fibre or copper (or both, even in fibre broadband, usually the "last 100 yards" from the cabinet is copper) then

it will be the responsibility of the WAD

your internet streams usually travel over WiFi, then copper, then fibre!

Questions:

Misconceptions/issues to note:

Images:

Optic fibre: https://cdn.pixabay.com/photo/2014/10/25/18/46/fiber-optic-cable-502894_960_720.jpg

CAT5: <https://api.ndla.no/image-api/raw/mt8BmjS.jpg>

Wireless: author's own image made in Canva Pro – Alan Harrison

Slide 19

PRO I think it looks a bit odd that it's too realistic images then a icon?

Paul Robson, 2024-10-21T10:49:54.169

AHO 0 I made one

Alan Harrison, 2024-11-08T14:46:48.121

PR1

Activity 2: Match the Hardware

On the handout do
Activity 2.

You have 6 minutes!



Time's up!



Handout 1

Activity 2 – 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.*

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



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 ... to ensure successful communication with other devices. Has a permanent, unique number, called the ... address.
		Sends data between computers on a local area network. It can only route traffic on a ... network. It uses the ... address on a device to route traffic.



Timing: 6 minutes

Key outcome: Apply knowledge of hardware devices

Activity: On the handout, students do activity 2. Click to start the timer. (The timer bar will fill up over 6 minutes)

They should drag and drop the icons and type the names of the devices, then fill in the missing words marked with underscores.

Background:

Questions:

Misconceptions/issues to note:

Slide 20

PR0 Would be useful to have a clock with timing on for student.

Paul Robson, 2024-11-11T10:27:36.431

PR1 I would add in answers for PDL to review?

Paul Robson, 2024-11-11T10:30:25.467

Activity 2 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.

Timing: 2 minutes

Key outcome: Check knowledge of hardware devices

Activity: Go through the answers and check for understanding.

Background:

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**.

Questions: Did you get everything? Any alternative answers?

Misconceptions/issues to note:

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**.

Topologies



Timing: 30 secs

Key outcome: Start new section on topologies

Activity:

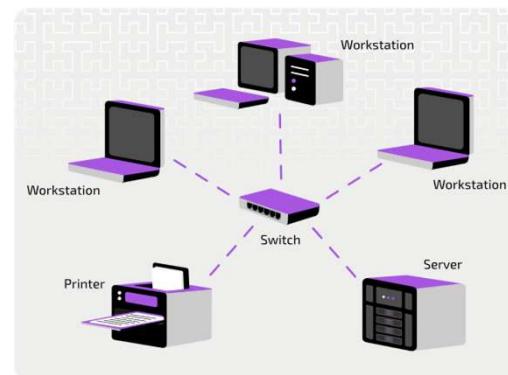
Background:

Questions:

Misconceptions/issues to note:

Network Topologies - Star

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



Time: 2 minutes

Key outcome: Know the Star topology basic features

Background information:

Advantages: More secure than bus or ring as packets are routed only to the authorized recipient.

Individual devices and cables are not critical and can fail leaving the network working, unlike bus or ring topologies.

Disadvantages: Central switch is a single point of failure.

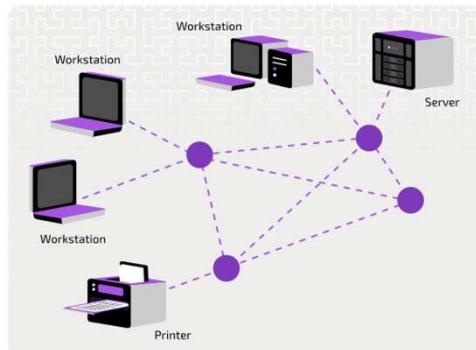
Misconception: A common misconception is that a **server** is at the centre of a star network, but as you can see a **switch** is at the centre with a server connected to it.

Image from Isaac comp sci

https://isaaccomputerscience.org/api/v3.5.0/api/images/content/computer_science/computer_networks/networking/figures/isaac_cs_net_network_star.svg

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.



Time: 2 minutes

Key outcome: Know the Mesh topology basic features

Background information:

The purple dots on the diagram are either **switches**, **WAPs**, or **routers**. Not shown is an internet connection, which would usually be provided as well.

Advantages: No critical point of failure (like the single switch in a Star network) as multiple pathways and switches.

Disadvantages: Expensive, complicated, hence a **full mesh topology**, where every device connects to every other, is often impractical due to cost and complexity, so a **partial mesh** is more common

Misconception: A mesh is sometimes shown with every client device connected to every other device. This is an over-simplification, and the diagram above where each node is a **switch** or **WAP** is more accurate. Think about a shopping mall with hundreds of wireless access points (WAPs) all meshed and connected to a big, fast router and on out to the internet. Every shopper with a mobile phone will connect to the nearest WAP but then get multiple routes out to the internet. Also home wireless mesh systems are now available such as Amazon Eero or BT Whole Home which create a mesh of WAPs in the home for greater coverage.

Image from Isaac

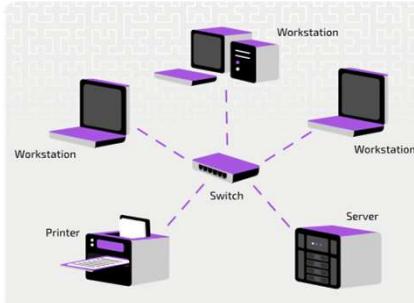
https://isaaccomputerscience.org/api/v3.5.0/api/images/content/computer_science/computer_networks/networking/figures/isaac_cs_net_network_mesh_topology.svg

Activity 4: Hide and Draw!

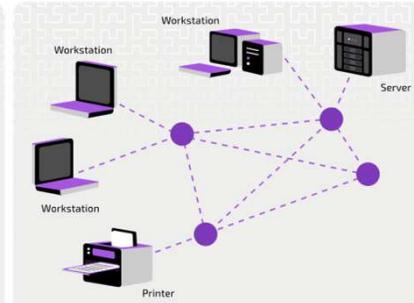
PRO

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

Star



Mesh



Timing: 1 minute

Key outcome: Memorise the topologies ready for the activity

Activity:

Background:

Questions:

Misconceptions/issues to note:

Slide 25

PRO No notes at all on the next 3 slides can we add.

Paul Robson, 2024-11-11T09:47:17.559

Activity 3: Hide and Draw!



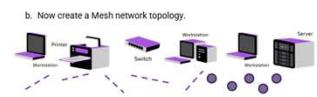
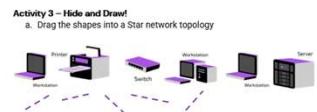
Handout 1

Drag and drop to create a
Star and **Mesh** topology.

You have **6 minutes!**



Time's up!



Timing: 6 minutes

Key outcome: Recall the star and mesh topologies

Activity: Activity 3 on the handout. Click to start the timer, the clock will pulse and the bar will animate until it's fully filled in.

Background:

Questions:

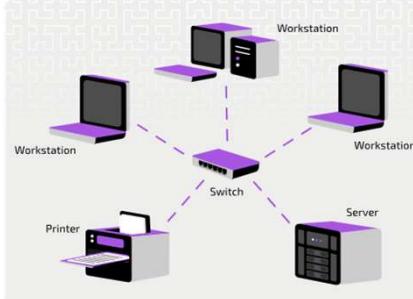
Misconceptions/issues to note:



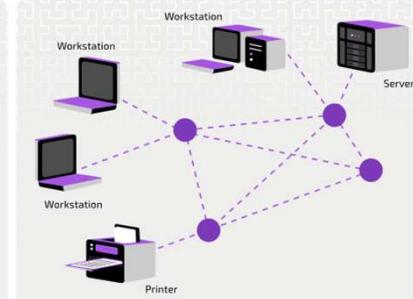
Activity 4: Hide and Draw!

Solutions, how did you do?

Star



Mesh



Timing: 2 minutes

Key outcome: Reveal and check the topologies

Activity: Discuss the solution, did they get it right?

Background: AQA also require they know a "logical

Questions:

Misconceptions/issues to note:

Wired v wireless



Timing: 30 secs

Key outcome: Introduce new section wired v wireless

Activity:

Background:

Questions:

Misconceptions/issues to note:

Wired vs Wireless

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



Timing: 1 minute

Key outcome: Know that network connections can be wired or wireless

Activity: Discuss the slide

Background:

Wireless connections use WiFi, Bluetooth or NFC and wired connections usually use an ethernet cable (although a PAN could be made over USB or Firewire).

Most consumer devices now make wireless connections (phone, tablet, laptop, smart TV, games console etc.)

Wired connections are still used by desktops in schools and offices, and by servers.

Questions:

Misconceptions/issues to note:

Images:

Tablet: <https://pixabay.com/vectors/tablet-pc-computer-technology-311350/>

Cable: <https://pixabay.com/vectors/cable-network-data-transfer-38382/>

PC: <https://pixabay.com/vectors/computer-hardware-monitor-tower-23232/>

WiFi: <https://pixabay.com/vectors/wifi-access-internet-logo-network-158401/>

Activity 5: Wired v wireless



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



Timing: 4 minutes

Key outcome: Compare properties of wired v wireless networks

Activity: On the handout, drag the wired and wireless icons onto the scale, for each of the properties shown.
Click to start the timer bar.

Background:

Questions:

Misconceptions/issues to note:

Activity:

Images:

Green thumb: <https://pixabay.com/vectors/good-hand-up-green-thumb-thumb-up-157436/>

Red thumb: <https://pixabay.com/vectors/bad-hand-down-red-thumb-157437/>

Activity 5 Answers



Timing: 4 minutes

Key outcome: Compare properties of wired v wireless networks

Activity: Go through the answers using the advice below. Note that these are rough averages, because there are many standards with overlapping performances, and these are improving all the time.

Background:

Speed: Wired networks are usually faster than wireless, but this is changing as WiFi gets faster.

Security: Wired networks are more secure because an attacker needs a physical connection, wireless networks can be hacked from outside the building (if poorly

configured)

Range: Wired networks can run for hundreds of metres, but standard WiFi is only tens of metres.

Flexibility: Wireless networks are more flexible and easy to set up, users can work anywhere.

Cost: Wireless is usually cheaper than wired, because of the cost of all the cables and switches.

Questions: Do you disagree?

Misconceptions/issues to note: Be flexible on disagreements, as these are just rough rules of thumb and technology is always changing.

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?**



Timing: 2 minutes

Key outcome: Know some performance key terms

Activity: Discuss the slide

Background:

Questions: Question on slide

Answer: Video streams are a sequence of bitmaps, i.e. grids of binary values that represent the colour of pixels on the screen. A HD film contains a lot of data, so to watch without buffering we need a connection that supports 3Mbps.

4K contains about 4x the number of pixels of HD so needs at least 4 times the bit rate (plus a bit extra to cater for congestion).

Misconceptions/issues to note:

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!



Timing: 2 minutes

Key outcome: Understand bandwidth, and some common bandwidths

Activity: Discuss the slide

Background: connection standards get faster all the time. Beware of out-of-date textbooks, websites and exam questions!

Questions: On the slide...

Answer: Both technologies get faster all the time. Exam questions have previously insisted that wired connections are faster, but this is no longer simple!

BT's current home hubs run Wi-Fi 5 and Gigabit Ethernet, so its wireless connections are faster than its wired ones.

Misconceptions/issues to note:

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 $\frac{1}{4}$ of a second.

Timings: 2 mins

Key outcome: Know some factors that affect network performance. They can be error rates and transmission media as these affect the bandwidth of the device.

Activity: Discuss the slide contents

Background: Transmission media can be copper, fibre optic or wireless, and among wireless networks, later WiFi standards have better bandwidth and range.

Range issues can be solved by adding additional WAPs, creating a partial mesh network (e.g. using BT Whole Home or Amazon Eero products)

These performance factors can combine, e.g. in a busy network heavy congestion can reduce the effective range. Also network devices should be placed away from walls and not close to each other

Questions:

Misconceptions/issues to note:

Client-server vs peer-to-peer



Timing: 30 secs

Key outcome: Introduce new section CS/P2P

Activity:

Background:

Questions:

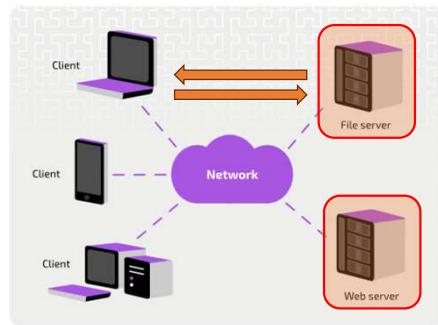
Misconceptions/issues to note:

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



Time: 3 minutes

Key outcome: Understand client-server model

Activity: Discuss the slide.

Emphasise the term **network model** refers to the relationship between computers and the way they interact, it is NOT related to topology.

That client-server is the first of two distinct network **models**, differing in several aspects, including security, software management (backup/install), and permissions.

Misconception: A common misconception is that a star network **must** be client-server and a mesh must be peer-to-peer. This comes from a misunderstanding of the diagrams of **logical** relationships found in some textbooks and on Wikipedia. Those diagrams show logical relationships (how computers share files etc.) and not physical ones.

Background:

Server

A **server** is a specialized computer or a program on a computer that shares resources with, or provides services to, any authorised client. Most servers will run 24 hours a day, 7 days a week, so that a client can send a request for resources at any time.

There are many types of server:

- **File servers** store and provide files.
- **Web servers** store and provide webpages.

- **Email servers** store and forward emails. Some email servers filter out spam.
- **Database servers** store databases, run queries, and allow data to be manipulated.
- **Print servers** provide printing services across the network and manage print queues.

Client

A **client** is a program that typically runs on a device used by an end-user such as a laptop or mobile phone.

A client sends a **request** to the server. The server **processes** the request and then sends a **response** back to the client. For example, when you want to view a webpage, you will use a web browser (which is a web client). The browser will request the page from a web server. The server will send the page back to the browser and the page will be displayed.

Image from Isaac

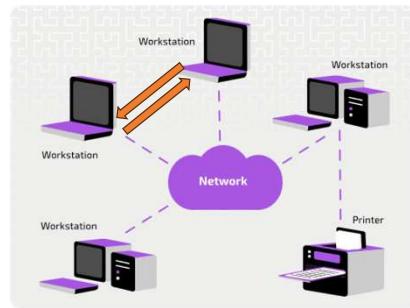
https://isaaccomputerscience.org/api/v3.5.0/api/images/content/computer_science/computer_networks/networking/figures/isaac_cs_net_network_client_server.svg

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



Timing: 3 minutes

Key outcome: Understand the peer-to-peer model

Activity: Discuss the slide

Explain that peers communicate directly with each other. The owner of each device gives permission to access some or all of the device's resources.

This needs to be done with care; if you give someone write-access to your disk drive, they would be able to delete all of your files.

Background information:

This model is cheaper because no server is needed, but has many downsides (see slide)

Image from Isaac computing

https://isaaccomputerscience.org/api/v3.5.0/api/images/content/computer_science/computer_networks/networking/figures/isaac_cs_net_network_p2p.svg

<https://pixabay.com/vectors/group-people-members-team-business-42917/>

<https://pixabay.com/vectors/speech-bubble-shape-text-chat-35342/>

Activity 5: 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 Isaac to complete this table by dragging and dropping the statements in to the correct empty cells. https://isaaccomputerscience.org/concepts/net_network_network

Factor	Client-server	Peer-to-peer
Setup cost		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.	



Timing: 6 minutes

Key outcome: Know the difference between client-server and peer to peer

Activity: They drag and drop the missing paragraphs into the correct places on the table.

Background:

Questions:

Misconceptions/issues to note:

More Background:

Advantages of client-server model:

1. **Centralized control** for efficient data management and resource sharing.
2. **Scalability** to accommodate more clients or requests as needed.
3. **Simplified maintenance** due to centralized updates and management.
4. **Enhanced security** with centralized security policies.
5. **Remote accessibility** for clients to access services from anywhere.

Disadvantages of client-server model:

1. **Single point of failure** risking service availability if the server fails.
2. **Scalability limits** that can be reached, affecting performance.
3. **Potential for traffic congestion** with many client requests.

4. Higher costs for server hardware and maintenance.

5. Network dependency where connectivity issues can disrupt services.

Advantages of Peer-to-Peer (P2P) model:

- **Simple Setup:** Easy to start and connect devices directly.
- **No Single Failure Point:** If one device fails, the network can still work.
- **Direct Sharing:** Files can be shared directly between devices.
- **Easy to Add More Devices:** New devices can join without much trouble.

Disadvantages of Peer-to-Peer (P2P) model:

- **Less Secure:** More open to risks as all devices are potential targets.
- **Hard to Backup:** Difficult to keep track of and backup data properly.
- **Variable Speeds:** Performance depends on the devices' own power.
- **Harder to Control:** No central place to manage the network or data.
- **Relies on Devices Being On:** If a device is off, its files can't be accessed.

Activity 5 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.
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	If one device fails, it will have less impact. Most users will be able to carry on with their work.

Timing: 2 minutes

Key outcome: Check for understanding of the difference between client-server and peer to peer

Activity: Go through the answers

Background: below

Questions: Do you agree?

Misconceptions/issues to note:

More Background:

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5. Network dependency where connectivity issues can disrupt services.

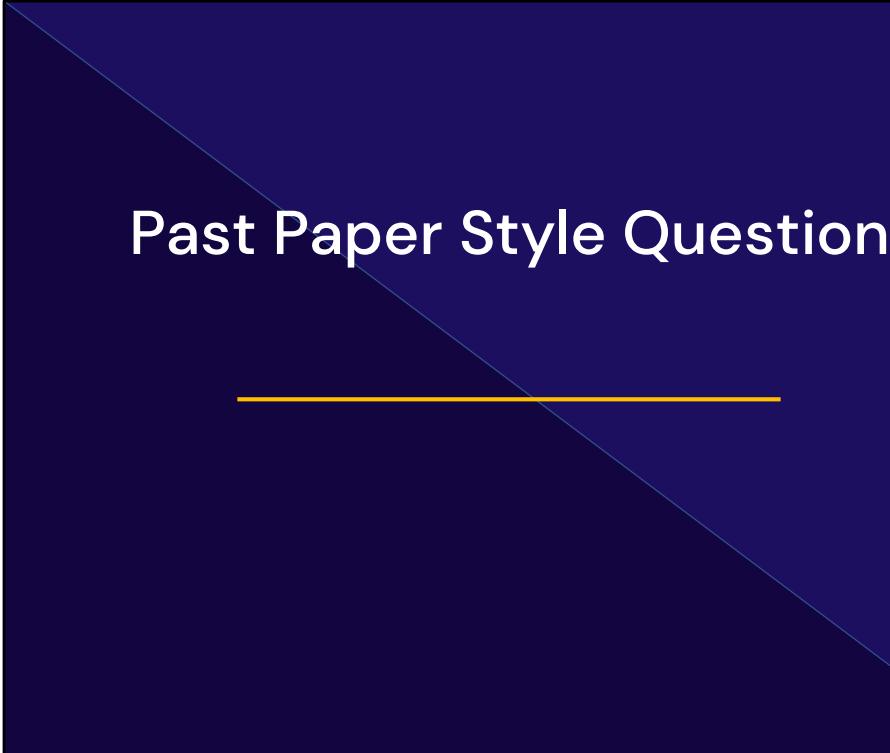
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- **Relies on Devices Being On:** If a device is off, its files can't be accessed.

Past Paper Style Question



Timing: 30 secs

Key outcome: Introduce new section CS/P2P

Activity:

Background:

Questions:

Misconceptions/issues to note:

Activity 6: Past Paper Style Question



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



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.

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



Timing: 6 minutes

Key outcome: Check understanding of today's content with a past paper question

Activity: They complete the question

Background: allow 6 mins then 4 mins to review

This is loosely based on OCR J277 Paper 1, June 2022 Question .

Questions:

Misconceptions/issues to note:

There are 9 marks so usually they would get 10 minutes in the exam, but we will run as a walking-talking mock, with 60% of the time to do the Q and 40% to review

Activity 6 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**

Timing: 4 minutes

Key outcome: Check understanding of today's content with a past paper question

Activity: Go through the answers

Background: Questions:

Misconceptions/issues to note:

Activity 6 Answers to 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**.



Timing: 4 minutes

Key outcome: Check understanding of today's content with a past paper question

Activity: Go through the answers

Background: Questions:

Misconceptions/issues to note:

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.

Network Fundamentals for Isaac GCSE Booster [Edit]

- Shape of the network 1
- Client-server and peer-to-peer networking
- Network topologies
- Star network topologies
- Data packets
- IP addresses
- Wireless connection
- Layers and protocols
- Network cables
- Network problem

ncce.io/isc-net1



Timing: 1 minute

Key outcome: Remind them of the gameboard

Activity: Discuss Isaac again, it's free!

Background: This does NOT have to form part of the booster. It's to give students more practice if they want it.

Questions:

Misconceptions/issues to note:

Check for more ISAAC boosters

The screenshot shows the Isaac Computer Science website homepage. At the top, there's a yellow header bar with the Isaac logo, 'MY ACCOUNT LOG OUT', and a search bar. Below the header, there are navigation links: 'My Isaac', 'Teachers', 'Learn', 'Events' (which has an arrow pointing to a callout box), and 'Help and support'. A message in the top right says: 'Your email address is not verified - please find our email in your inbox and follow the verification link. You can request a new verification email if necessary. To change your account email, go to My account.' There's a 'Snooze' button next to this message. The main content area has a 'Welcome' section with links for 'GCSE resources', 'A Level resources', and 'Events'. Below this is a 'For you' section with links for 'Key stage 3 courses', 'Key stage 4 courses', and 'A level courses'. To the right, there's a section titled 'I Belong in Computer Science posters' featuring several colorful posters with diverse people. A callout box with a blue border and white text says: 'Keep an eye out for more student booster events'. At the bottom of the page, there's a decorative footer with a yellow and dark blue pattern.

Timing: 1 min

Key outcome: Be aware of Isaac booster events

Activity: Show where to find the boosters on the Isaac page

Background information:

Questions:

Misconceptions / issues to note:

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
- understand **IP addresses**, **protocols**, **packet switching**, **DNS** and **URLs** and how the **internet** works
- know some effects on network **performance** and define **bandwidth**, **latency** and **congestion**



Timing: 1 minute

Key outcome: Review LOs again

Activity: Discuss the slide

Background:

Questions:

Misconceptions/issues to note:

Questions?



Timing: 1 minute

Key outcome: Any questions?

Activity:

Background:

Questions:

Misconceptions/issues to note:

Thank You

