



OCR GCSE Computer Science



Your notes

Networks & Topologies

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Types of Network

Types of Networks

What are the different types of networks?

- A network is **two of more devices connected together** with the purpose of sharing resources
- There are two different types of networks
 - **Local Area Networks (LANs)**
 - **Wide Area Networks (WANs)**
- For the exam it is important to understand the properties as well as the advantages and disadvantages of LANs and WANs
- It is also important to understand the advantages and disadvantages of having a network

What are the advantages of having a network?

- Users can share resources such as printers and connection to the internet
- Users can access their files from any computer on the network
- Communication can be made easier via email and social networks
- Users can share files and folders easily such as central databases and spreadsheets
- Servers can be used to provide centralised backups, updates and security

What are the disadvantages of having a network?

- There is an increased security risk to data
- Malicious software can infiltrate the network and render it unusable
- Servers and switches can provide a central point of failure, resulting in users not being able to complete tasks using their computer
- Factors can impact the performance of the network such as the number of users and data on the network at one time

Local Area Networks & Wide Area Networks

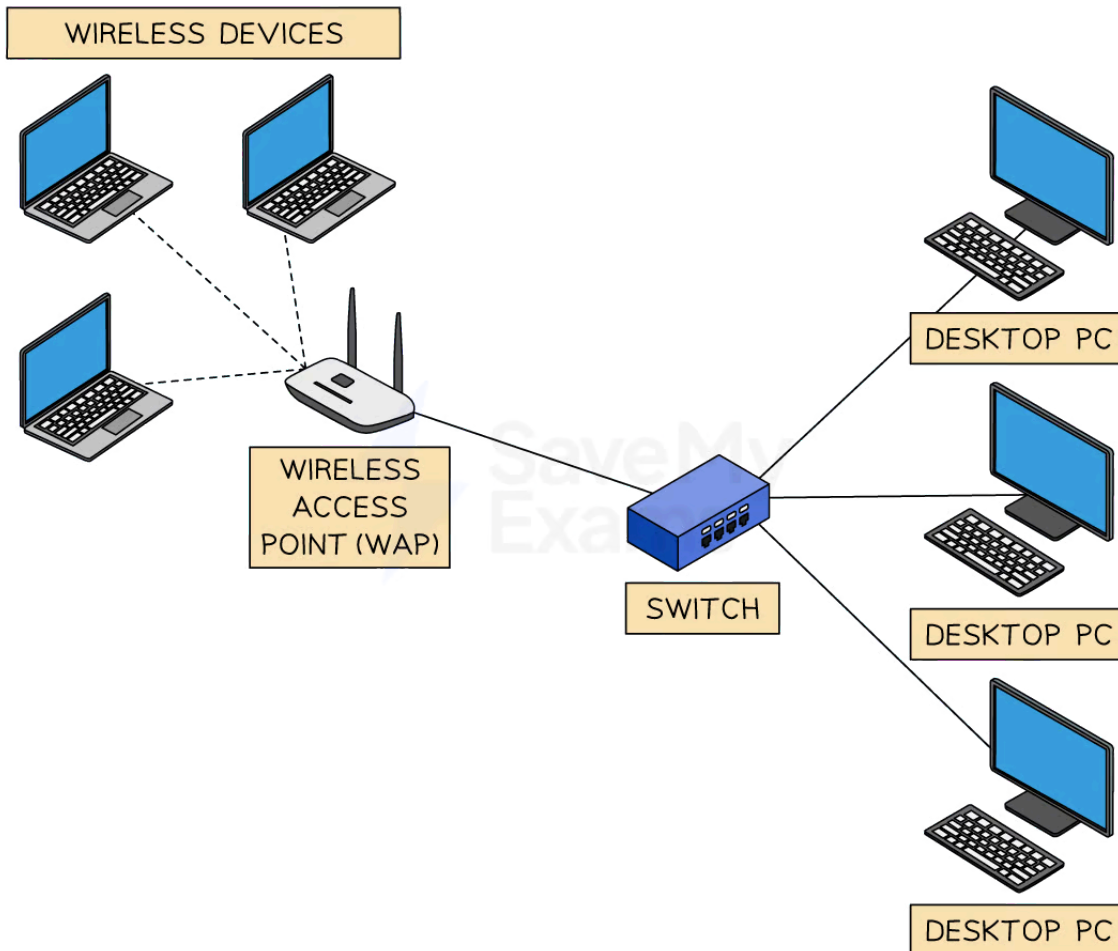
What is a local area network?

- A local area network (LAN) is a network which has a **small geographical area** (under 1 mile)

- All of the hardware is **owned by the company/organisation/household using it**
- LANs will use unshielded twisted pair (UTP) cable, fibre optic cable or wireless connections (Wi-Fi)



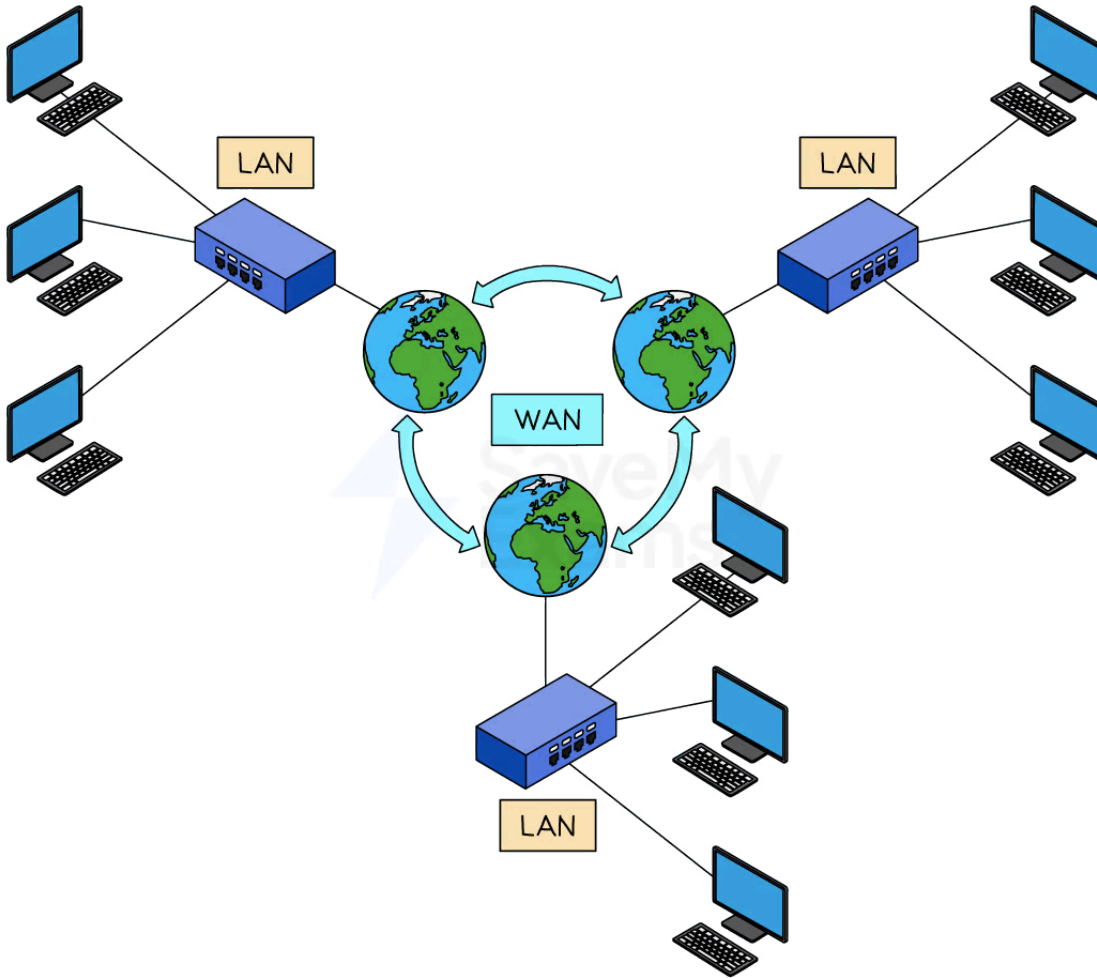
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What is a wide area network?

- A wide area network (WAN) is a network which has a **large geographical area** (over 1 mile)
- They are a **collection of LANs joined together**
- The computers on a WAN are **connected via routers**
- The hardware used to connect the networks together is **not all owned by the company/organisation/household using it**.
- Telephone lines **owned by telecommunication companies** are an example

- WANs will use fibre optic cable, telephone lines and satellite to connect the LANs together



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Worked Example

A travel agent has offices in two sites that are 10 miles apart. Describe the difference between a LAN and a WAN [2]

1 mark per bullet

- LAN is small geographical area
- WAN is over a large geographical area

or

- LAN (usually) has its own/dedicated infrastructure
- WAN uses external / shared infrastructure or hardware



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Factors of Network Performance

Factors of Network Performance

What are the factors that affect network performance?

- 5 key factors can impact how well a network performs
 - **Number of Users**
 - **Bandwidth**
 - **Latency**
 - **Error Rate**
 - **Transmission Media**

Number of users

- This is how many users are on the network **at the same time**
- Too many users can cause the network to slow down if there is not enough **bandwidth** for all of the data being sent and received

Bandwidth

- Bandwidth is the **amount of data that can be sent and received** at any given time
- Measured in **bits per second** (bit rate)
- A smaller bandwidth means that less data can be sent and the network can slow down, potentially to the point of becoming unusable

Latency

- Latency is the **delay** between data being **sent and received**
- If there is a big delay between the two, more data will be on the network causing collisions
- This can lead to even more packets of data being sent as the error rate has increased

Error rate

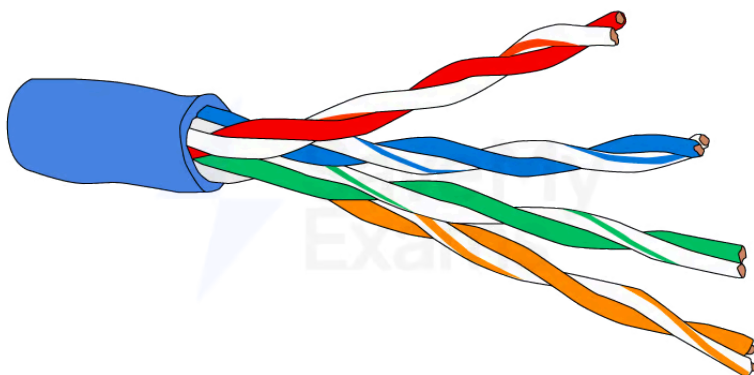
- Error rate is the measure of how many packets of data do not reach their **destination**
- An increased error rate occurs in less reliable connections – a poor wireless signal would be a contributing factor to an increased error rate



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Transmission media

- Transmission media is the **type of cable** used in wired connections
- Wired connections offer a **higher bandwidth** than wireless connections
- The main options for transmission media are unshielded twisted pair and fibre-optic
- Fibre optic has a higher bandwidth than copper cabling as well as faster transfer speeds



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Worked Example

A university has a LAN (Local Area Network). The LAN allows access by both wired and wireless devices. Users have reported that the network sometimes runs very slowly.

- (i) Explain why the number of devices using the network at the same time can affect the performance of the network [3]
- (ii) Identify one other factor that can affect the performance of the network [1]

How to answer this question

- To answer this question there must be an answer with an explanation of its impact
- An example answer that would score full marks
 - More devices accessing the network at one time would result in the network performing slower because the bandwidth would be split between them [1]
 - The impact of this would mean that there is less bandwidth for each device, slowing down how fast data could be sent and received [1]



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- Having more users/devices means that there is more data being sent and received [1]

Answers

(i) 1 mark each to a maximum of 3

- Slower transmission of data // less data can be transmitted at the same time // the transmission rate decreases // time to send/receive increases
- More devices mean more data is being transmitted at a time
- Bandwidth will be split between all the devices sending data // each device uses some of the bandwidth
 - this means that there is less bandwidth for each device
- Devices have to wait longer before they can transmit // increased latency
- If the maximum bandwidth is used then devices cannot transmit
- Central device/switch/router has to handle more requests and may run slower
- More collisions are likely // higher error rate
 - This means more data has to be retransmitted
- Loss of more packets
 - This means more data has to be retransmitted

(ii) 1 mark

- Bandwidth
- Interference // with example
- Wired // wireless // transmission medium
- Type/amount of data being transmitted
- Central hardware performance // with example
 - e.g. router/switch
- Error rate
- Distance between nodes
- Topology // physical layout
- Wireless repeaters



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Client Server & Peer to Peer Networks

Client Server Model

What is a network model?

- A network model is the **logical structure of the network**
- It defines how the network will operate on top of the physical network structure ([Star](#) or [Mesh](#))

What is a Client-Server model?

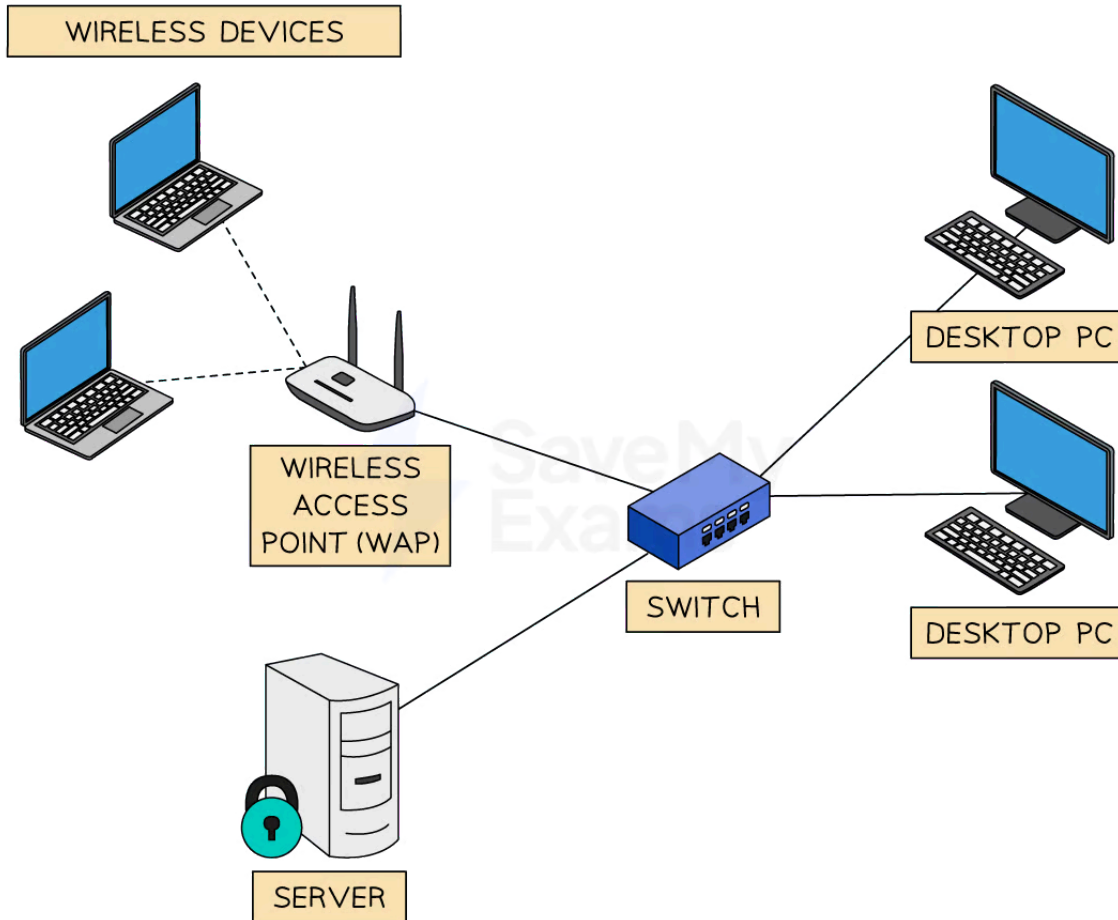
- A client is a computer on the network, these connect to the server via a **switch**
- A server is a computer on a network which often has a single purpose, for example
 - **Managing access to the Internet**
 - **Managing printing**
 - **Providing email services**
 - **Providing backups**
 - **Controlling security**
- Servers are often more powerful than the client machines
- Servers are seen as more significant than the client machines and can require specialist hardware and software
- A network which uses a server is called a client-server model
- Most companies, organisations and schools will use a client-server network model

Advantages	Disadvantages
Managing backups of the network is easier as it is done from one central point	Servers can be expensive to purchase, setup and maintain
Updating and installing new software can be done centrally instead of having to log on to each machine	A specialist network manager would be required as servers require specialist IT knowledge
Security of files can be managed easily	Servers can be a single point of failure, meaning all users would lose access to the network if the server

fails



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Examiner Tips and Tricks

It makes it easier in exams to relate to things you know. If you are asked about a client-server network, just think about how your school computers work and the advantages and disadvantages that come with that.

Peer to Peer Model



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What is a Peer-to-Peer model?

- A peer is a computer on a network which is **equal to all other computers**
- Each peer on the network
 - **Often have their own printer attached**
 - **Will provide access to their own files**
 - **Is responsible for their own backups**
 - **Is responsible for their own security**
 - **Is responsible for carrying out their own backups**
- A network with no server providing services is a peer-to-peer network
- Most homes will have a peer-to-peer network model

Advantages	Disadvantages
Very easy to set up and maintain	Users will need to manage their own backups
Very cheap to set up because there is no expensive hardware to purchase	Users will need to manage their own software updates
No specialist knowledge or staff are required to run the network	The network can be less secure



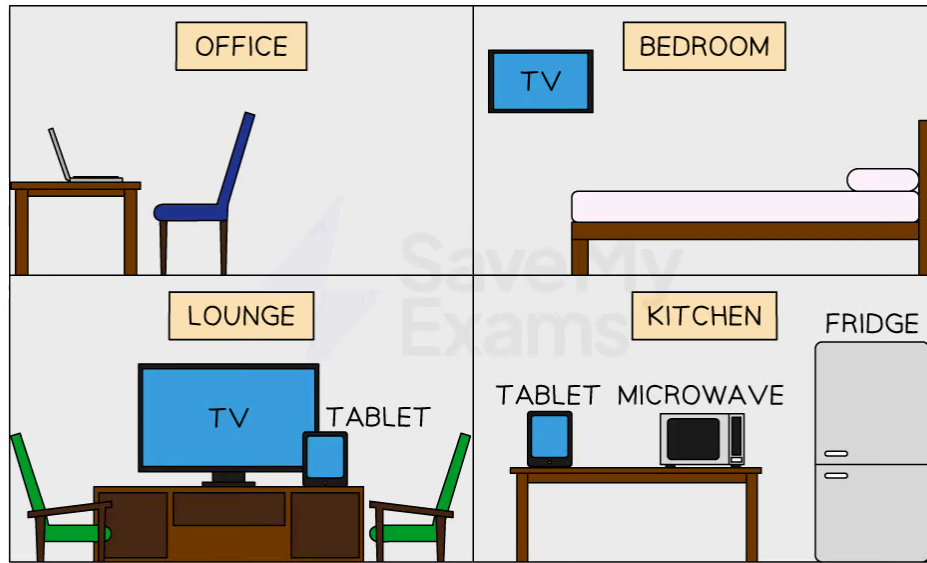
Examiner Tips and Tricks

If you are asked about a peer-to-peer network, just think about how your home network is set up and how each computer is responsible for itself, there is no one computer in charge of all of the others.




Worked Example

Lucy has a network in her house. The main devices are shown in the diagram.



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1) State whether Lucy's network is a LAN or a WAN. Justify your choice. [3]

How to answer this:

To answer this, you must give a choice which will be worth 1 mark, then give your justification which will be worth an additional 2 marks.

2) Explain why Lucy's network uses a peer-to-peer model and not a client-server model.

Answer

1) LAN [1]

1 mark per bullet for justification [2]

- Small geographic area
- They will own the hardware // dedicated hardware // do not need to use outside hardware

2) 1 mark per bullet to a maximum of 3

- No server (required for client-server)
- Computers are directly connected
- Computers are independent/equal
- Computers will have software installed/updated individually
- no central installation/updates
- Computers will need own security // no central security
- Computers will have their own files // no central file storage

- Less initial cost/maintenance
- Easier to add new devices
- Lesser need for file sharing
- If any device fails/is removed the remainder can continue



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Local Area Network Hardware

Local Area Network Hardware

What hardware is needed to make up a local area network?

- Network hardware is a selection of essential components that enable the **connectivity** and **communication** of devices within computer networks
- You need to understand the purpose of the following network hardware:
 - Router
 - Wireless access point (WAP)
 - Switch
 - Network interface card (NIC)
 - Transmission media

What is a router?

- The router is responsible for routing **data packets** between different networks
- An example of data the router can direct is, sending internet traffic to the right devices in your home
- The router connects networks together, local area networks (LAN) to the wider internet which is a type of wide area network (WAN)
- The router can manage and prioritise data traffic, which can help to keep connections stable
- The router will assign IP addresses to the devices on the network



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What is a wireless access point (WAP)?

- The Wireless Access Point (**WAP**) allows wireless devices to connect to a local area network (**LAN**)
- The WAP connects to a **Switch** or **Hub** via an **Ethernet** cable
- The WAP **range** is limited so the use of multiple Wireless Access Points can be used for complete coverage or a home/business



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What is a switch?

- A Switch allows multiple wired devices to connect to a local area network (**LAN**)
- The Switch is an **active device**, which means it can inspect network data and route it to the correct device, thus reducing traffic on the network
- A Switch can contain **extra Software** to allow administration/configuration



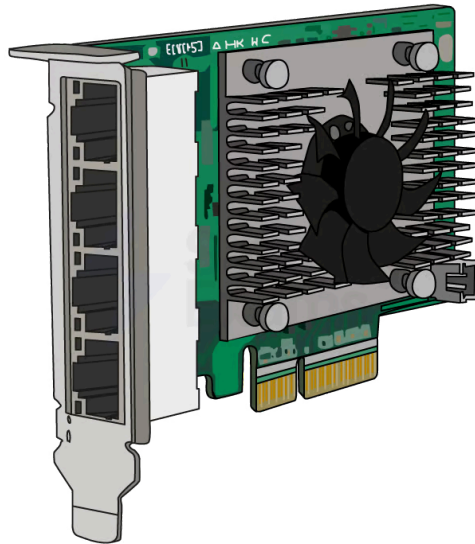
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What is a network interface card (NIC)?

- The Network Interface Card (**NIC**) is required for a computer to connect to a network
- A NIC can be both wired and wireless and allows your computer to send and receive data over a network



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What is transmission media?

- Transmission media is the phrase used to describe the method of connecting a wired network
- There are 3 main types of transmission media used
 - Unshielded Twisted Pair (UTP)
 - Coaxial (Copper)
 - Fibre Optic

Unshielded twisted pair (UTP)

- A Twisted Pair cable is made up of insulated pairs of copper wires twisted around each other
- Twister Pair is **Low Bandwidth** and more affordable than the other two cables, so is commonly found in Local Area Networks (**LAN**)

Coaxial

- A coaxial cable is a medium bandwidth and more expensive than UTP
- Coaxial cables are used to connect **large-scale networks** such as telephone networks and digital cable/satellite television

Fibre optic

- A Fibre Optic cable, unlike the other two, is **unaffected by electrical noise**, making it the fastest in terms of **data transfer**
- Fibre Optic is **High Bandwidth** and the most expensive
- Fibre Optic is commonly used for **high data volume networks** and long-distance connections such as between cities/countries



Your notes



Worked Example

One piece of network hardware is a router. State 3 tasks carried out by a router. **[3]**

To answer the question you must simply identify 3 tasks a router does.

Answer

1 mark each to max 3 e.g.

- Receive packets
- Forward/send packets
- Maintain a routing table
- Identify the most efficient path to the destination / correct IP / correct location
- Assign IP addresses to nodes / devices
- Converts packets from one protocol to another



Your notes

The Internet

The Internet

What is the Internet?

- The Internet is a **collection of networks** spanning the whole world
- The Internet is the most well-known Wide Area Network (WAN)
- The Internet is used to provide connectivity and is different from the World Wide Web, which is the collection of webpages you access via a web browser

How does the Internet work?

- In your home, you have a router
- Inside your router is a modem which allows you to connect to your Internet Service Provider (ISP) via a telephone line or fibre optic
- An ISP is connected to a database called a Domain Name System (DNS)
- This results in other routers also connecting together, forming a large interconnection of multiple networks
 - Servers
 - Other routers
 - Other LANs
- All of these inter-connected networks are known as The Internet

Domain Name System (DNS)

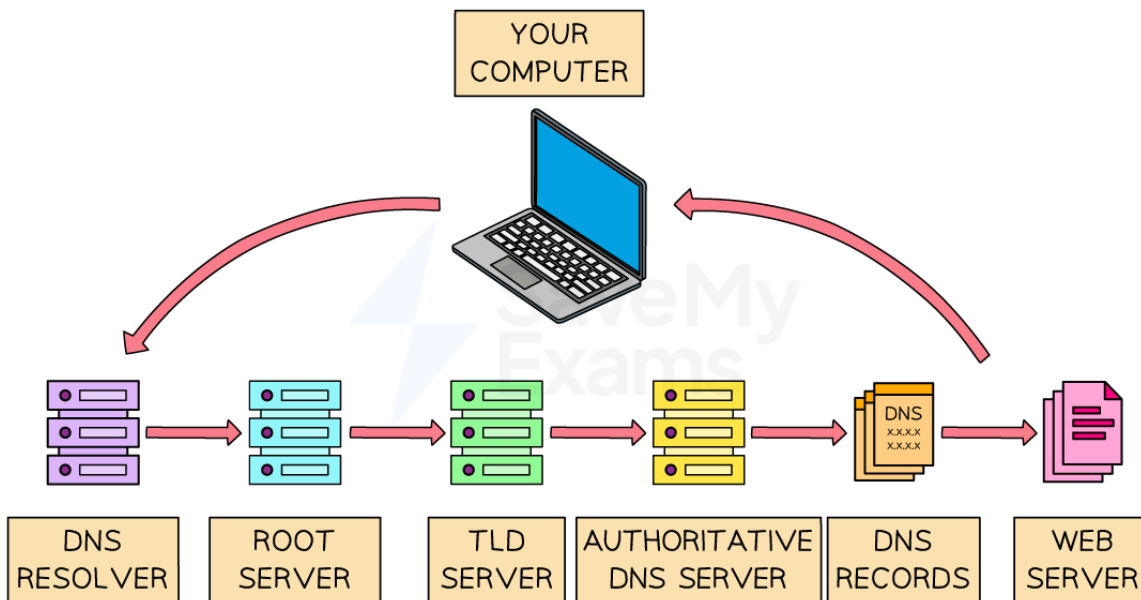
What is a domain name system?

- The Domain Name System (DNS) can be thought of as the Internet's equivalent to a **phone book**
- It is essentially a directory of domain names and is used to translate human-readable domain names to the numeric IP addresses that computers use
- When you type a URL into your browser, the DNS translates the domain name into its associated IP address so your computer can connect to the server hosting the website
- Without DNS, we would have to remember the IP address of every site we want to visit

- When a domain is newly registered, or a server changes its IP address, the DNS record for that domain needs to be updated in what's known as DNS propagation

How does DNS work?

1. URL Entry: The user enters the URL (web address) of a website into the web browser
2. DNS Query: The web browser sends a query to a DNS server (usually hosted by your **ISP**) to translate the URL into an IP address
3. DNS Resolver: The DNS resolver checks its cache to see if it has the IP address for the requested domain. If not, it sends the request to the DNS root servers
4. Root Server Query: The root server directs the resolver to a Top-Level Domain (TLD) server (like .com, .org) based on the extension of the URL
5. TLD Server Query: The TLD server then provides the resolver with the IP address of the domain's authoritative DNS server
6. Retrieve IP Address: DNS server responds with the IP address for the requested domain
7. Request the Web Page: The web browser sends an HTTP or HTTPS request to the IP address it received
8. Server Response: The server at the given IP address processes the request and sends back the data for the web page (HTML, CSS, JavaScript, etc.)
9. Render the Web Page: The web browser renders the received data into the web page that you see



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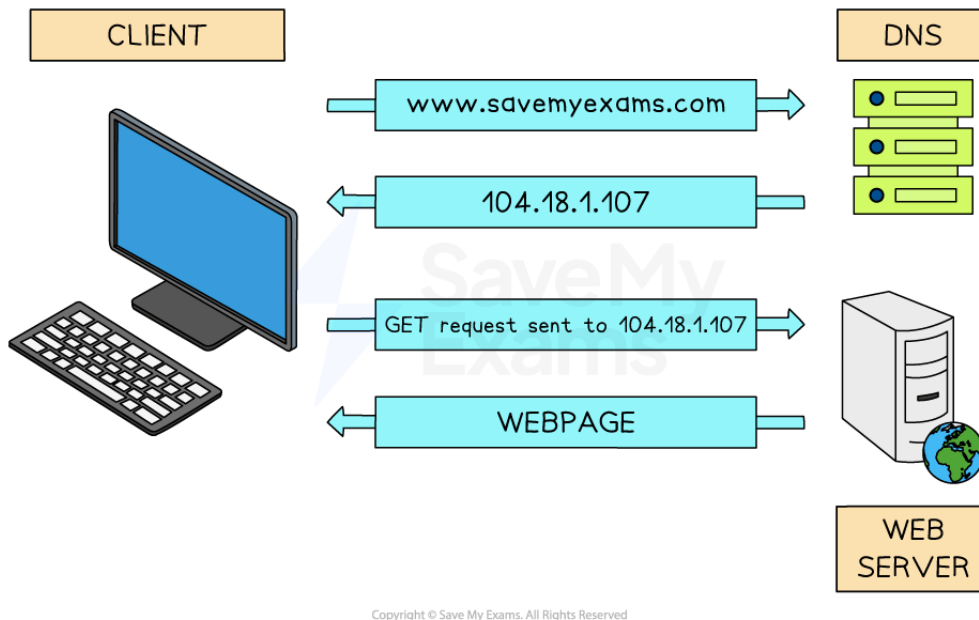
Web Servers & Clients

What are web servers?

- Web servers are dedicated servers that store web pages/websites and other resources
- They have a dedicated IP address to ensure that users can access them 24/7
- The most common web servers in use are
 - Hosting websites
 - Dealing with client requests

What are clients?

- Clients are end-users who make requests of web servers
- For example, a client requests a webpage such as www.savemyexams.com
 - The user will request the website by typing in the URL into their web browser
 - The request will be sent to their local ISP DNS
 - The DNS will return the IP address of that URL: 104.18.1.107
 - The client machine will then send a GET request to the web server
 - Save My Exams webserver will then return the webpage/resource to the client's web browser
 - More details about this process are above under the heading of 'DNS'



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What is hosting?

- Hosting is the storing of websites, files and other content on servers
- The servers need to be accessible by potentially thousands of users and they need to be available 24/7
- The servers must be reliable and secure from any form of attack
- The IP address for the server must remain the same so that users can access the website whenever they want
- Servers are set up with the single purpose of serving these files in this manner and in a safe and secure way

The Cloud

What is the cloud?

- The cloud is a collection of servers which are used to store data, applications and files over the internet
- There are a number of advantages and disadvantages to use 'The Cloud' or cloud storage

Advantages & disadvantages of the cloud



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Advantages	Disadvantages
Content in the cloud can be accessed anytime and from anywhere	Accessing content and software is only possible when the user has an internet connection
Users can use any device to access their content	Expanding capacity can become expensive if using it across a business
Users have a large storage capacity available to them	Vulnerable to security threats such as data leaks and photo leaks
Low cost / free to set up and use	It is not thoroughly clear to users who is the owner of the data once it is uploaded to a cloud service
Responsibility for backups and security is with the cloud service provider	
Users can easily collaborate	

Summary of learning

Keyword	Definition
Internet	A collection of LANs connected together spanning the whole world (WAN)
LAN	A collection of computers connected in a small geographical area using its own hardware
WAN	A collection of LANs connected together
DNS	Domain Name System: A directory of domain names (URLs) and their corresponding IP addresses
URL	Uniform Resource Locator: The web address typed into a web browser

ISP	Internet Service Provider: the company that provides internet services to you
-----	---



Your notes



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Star & Mesh Networks

Star Network Topology

What is a network topology?

- A network topology is the **physical structure of the network**
- It defines how the network hardware will be arranged to create the network
- Different network models ([PS2P/Client-Sever](#)) can be used on a topology
- Many different topologies have been used in the world of networking however, there are two popular topologies to understand for the exam
 - **Star Topology**
 - **Mesh Topology**

What is a star topology?

- A star topology has a central switch which all other devices connect to
- A switch is an intelligent device which ensures that traffic only goes to the intended device
- A star topology is commonly seen in most homes, businesses, organisations and schools

What are the advantages of a star topology?

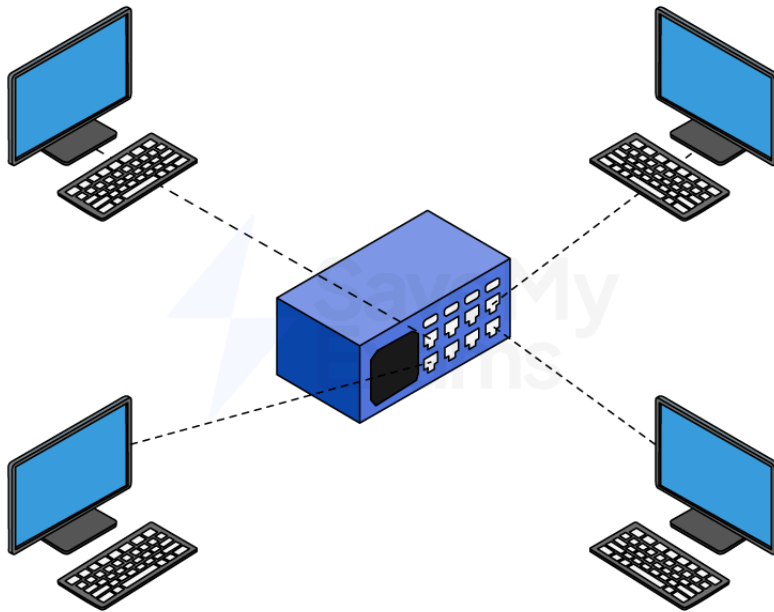
- If any single cable stops working, the rest of the network will continue to work
 - An example you may have experienced would be in school when one computer won't log on to the network, but all other classmates can get logged on
- This is important because in other topologies if a cable was broken, all computers on the network would stop working which would have a negative impact on learning in schools and businesses completing their daily tasks

What are the disadvantages of a star topology?

- The central switch is a single point of failure
- This means that if the switch stops working, all of the devices connected to it will not be able to connect to the network or any of its facilities and resources



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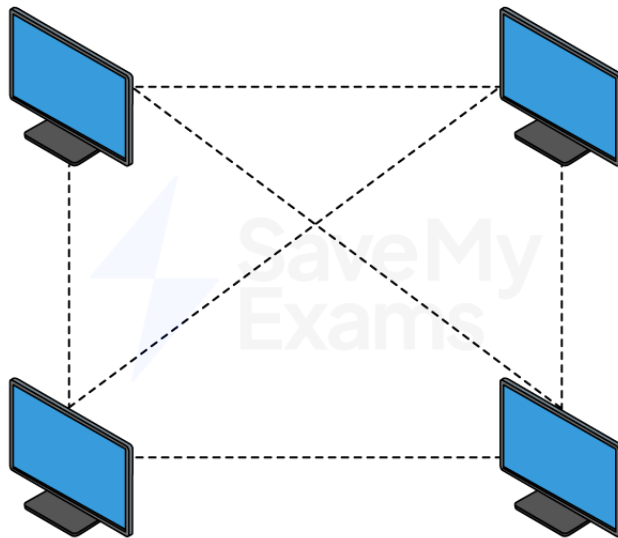
Mesh Network Topology

What is a mesh topology?

- A mesh topology allows **all computers to be connected to all other computers**
- This is known as a full mesh network topology
- LANs can make use of mesh networks however, they are more commonly seen in **IoT** devices such as wearable technology and smart home devices



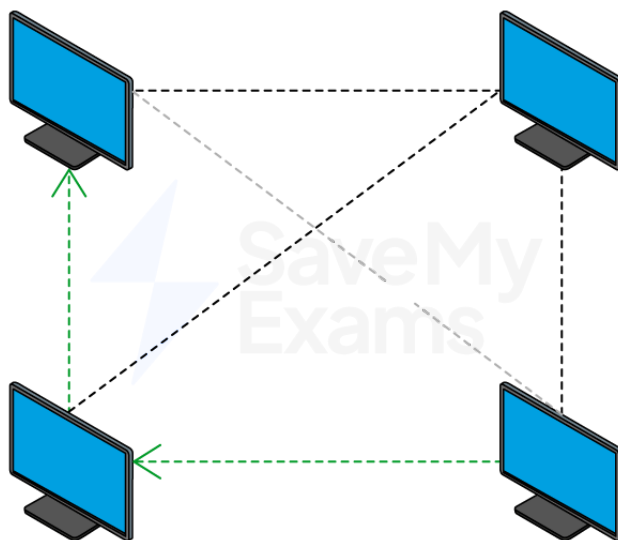
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What are the advantages of a full mesh topology?

- If any single cable stops working, the rest of the network will continue to work as the data can find a different route to get to its destination
- In the example below you can see that one cable has been marked as not working and that that data can simply use an alternate route



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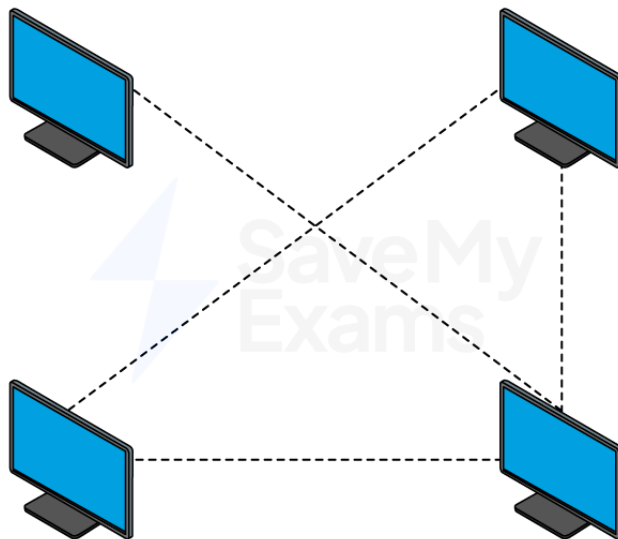
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What are the disadvantages of a full mesh topology?

- The topology requires a lot of hardware, cables and switches to set up
- This means there is a higher cost for setting up the network
- Adding new devices is not as easy as in a star topology, making it more challenging to scale the network
- The solution to these disadvantages is called a 'Partial Mesh Topology'

What is a partial mesh topology?

- A partial mesh topology is very similar to a full mesh, with the difference being that each device is not connected to every other device directly
- This means
 - Less cables and hardware are required
 - Multiple routes still exist between devices
 - It is a compromise solution to reduce the amount of hardware needed
- The diagram below is an example of how the backbone structure of the Internet appears



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