Cambridge (CIE) IGCSE ICT

Your notes

Networks

Contents

Your notes

Router

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 correct destination/devices in your home network
- 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

What are data packets?

- Data packets are **small 'chunks' of data** that make up a larger piece of data that has been **broken down** so that is can **transmitted** over the internet
- Data can include anything from text, images, audio, video, animations, etc, or any combination of these
- A data packet consists of:

Header	Payload	Trailer
Source IP address	Actual data being transported	Additional security information (less common)
Destination IP address		End of packet notification

Packet number (1 of 5 etc.)		
Error checking (checksums)		

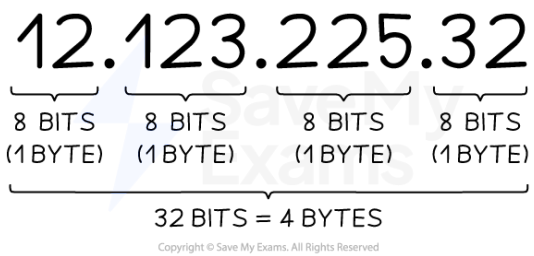
Your notes

What is an IP address?

- An IP (Internet Protocol) address is a **unique identifier** given to devices which communicate over the Internet (**WAN**)
- IP addresses are **dynamic**, they can change
- IP addresses make it possible to **deliver data to the right device**
- A device connecting to a network will be given an IP address, if it moves to a different network then the IP address will change

IPv4

- Internet Protocol version 4 is represented as **4 blocks of denary numbers** between **0** and **255**, separated by **full stops**
- Each block is **one byte** (8 bits), each address is **4 bytes** (32 bits)



- IPv4 provides over **4 billion unique addresses** (2^{32}), however, with over **7 billion** people and **countless devices per person**, a solution was needed

IPv6

- Internet Protocol version 6 is represented as **8 blocks of 4 hexadecimal digits**, separated by **colons**
- Each block is **2 bytes** (16 bits), each address is **16 bytes** (128 bits)

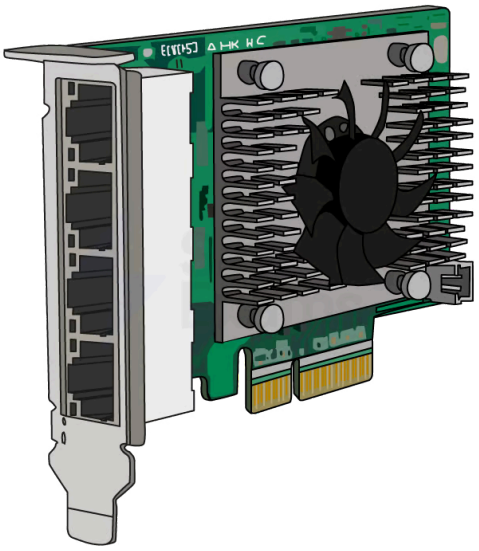
- IPv6 could provide over **one billion unique addresses** for **every person** on the planet (2^{128})

Your notes

Network Interface Card (NIC)

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



Hub

What is a hub?

- A hub is a networking device which is used to **connect multiple devices** in a network
- Hubs are "**dumb**" devices that pass on anything received on one connection to all other connections
- **All data is sent to all devices**, this can lead to network inefficiencies and security issues

Switch

What is a switch?

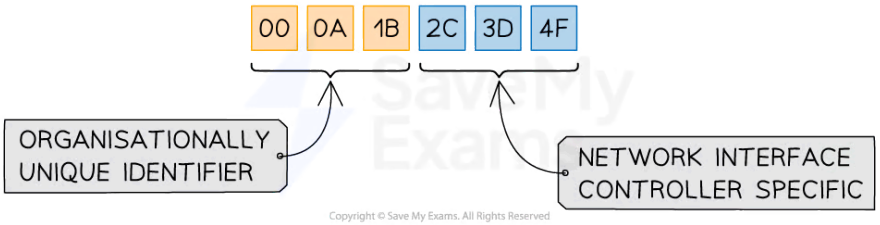
- A network switch is a device that **connects multiple devices** on a network together
- Unlike a hub, a switch **only sends data to the device it was intended for**, which improves network efficiency
- This is done by a switch having a **lookup table**

- When a switch receives a data packet, it examines the destination **MAC address** of the packet and looks up that address in the lookup table
- Once it has found the matching MAC address it will then **forward the data packet** to the corresponding device

Your notes

What is a MAC address?

- A MAC (Media Access Control) address is a **unique identifier** given to devices which communicate over a local area network (**LAN**)
- MAC addresses are **static**, they can never change
- MAC addresses make it possible for **switches** to efficiently **forward data** to the intended **recipient**
- Any device that contains a Network Interface Card (**NIC**) has a MAC address **assigned during manufacturing**
- A device connecting to a local network already has a MAC address, if it moves to a different network then the MAC address will stay the same

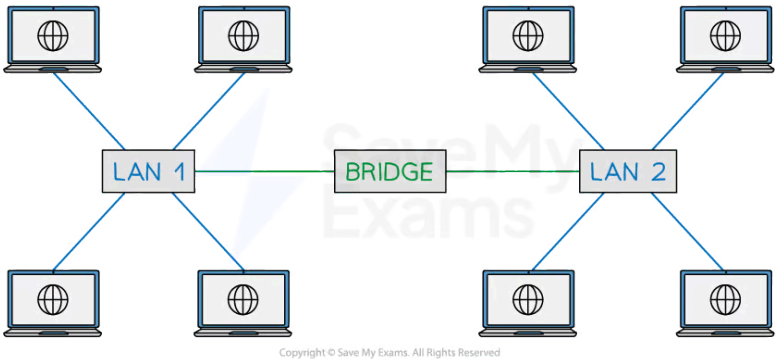


- A MAC address is represented as **12 hexadecimal digits** (48 bits), usually **grouped in pairs**
- The first three pairs are the **manufacturer ID number** (OUI) and the last three pairs are the **serial number** of the network interface card (**NIC**)
- There are enough unique MAC addresses for roughly **281 trillion devices**

Bridge

What is a bridge?

- A network bridge is a device used to **connect two local area networks** (LANs) together to create one larger network
- Unlike a switch/hub, bridges **only connect local area networks** together



Your notes

Worked Example

Explain the difference between a switch and a hub regarding data forwarding capabilities.

[2]

Answer

A switch forwards data packets based on the destination MAC address and only sends data to the intended device [1]

A hub broadcasts incoming data packets to all connected devices [1]

Your notes

What is a wireless network?

- A wireless network is a network where connections are made **using radio waves** to transmit data **through the air**
- The most common types of wireless connections are:
  - **Wi-Fi**
  - **Bluetooth**

Wi-Fi

What is Wi-Fi?

- Wireless fidelity (**Wi-Fi**) is a common **standard** for wireless networks
- Wi-Fi is common in most homes and offices to connect devices such as **laptops**, **tablets** & **smart phones**
- Using Wi-Fi, devices communicate with a **hotspot or** a wireless access point (**WAP**), which can be a standalone device or built into a **router** or **switch**
- Wi-Fi may be preferred over Bluetooth when:
  - **High speed data transfer is required**
  - **Long range communication is required**

- **Many devices are needed to be connected at the same time**

Advantages	Disadvantages
Portability - Easy to move around, location is only limited by range	**Speed** - Slower data transfer than Ethernet
Cost - Less expensive to setup and add new devices	**Security** - Less secure than Ethernet
Compatibility - Most devices are manufactured with a built in Wi-Fi adapter	**Range** - Relies on signal strength to the WAP, signals can be obstructed (up to 100m)

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Bluetooth

What is Bluetooth?

- Bluetooth is another common **standard** for wireless networks
- Bluetooth is common in most homes and offices to connect devices such as **headphones**, **controllers**, **keyboards** & **mice**
- Bluetooth is used typically for a **direct connection** between **two devices**
- When two devices **pair,** they both exchange a **cryptographic key**
- The keys are used to generate a **secret shared key** which is used to **encrypt** the data between the two devices and create a **Wireless Personal Area Network (WPAN)**
- Connected devices continuously **change their transmitting frequency** between 79 different channels to avoid **interference** and improve the reliability of the connection
- This is known as the **frequency hopping spread spectrum (FHSS)**

Advantages	Disadvantages
Compatibility - Ideal for personal devices and **ad-hoc** connections	**Speed** - Very slow transfer speeds

Power - Very low power consumption	**Security** - Data can be intercepted by anyone in range
	Range - Short range (30m)

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Differences between Bluetooth and Wi-Fi

	Bluetooth	**Wi-Fi**
Maximum number of connections	7	30
Transmission frequency	2.4Ghz	2.4Ghz, 5Ghz
Maximum range (meters)	30 meters	100 meters (depending on obstructions)
Maximum transfer speed (Depending on the standard being used)	3 Mbytes / Sec	75 Mbytes / Sec

Worked Example

A school IT team is trying to determine what technology they should use to connect students' tablets around the school for data transfer and are unsure whether to choose Wi-Fi or Bluetooth technology.

Consider the advantages and limitations of both and justify your answer

[7]

Answer

WiFi offers significantly faster transfer rates compared to Bluetooth [1]

so students will be able to upload and download files faster [1]

WiFi coverage can be over a much larger area compared to Bluetooth [1]

so that students will be able to access resources wherever they are in the school [1]

Bluetooth however, is easy to set up [1]

students can transfer data without the school having to invest in expensive infrastructure [1]

Given the current situation, the school is in, the preferred choice for connecting student's tablets would be Wi-Fi [1]

Your notes

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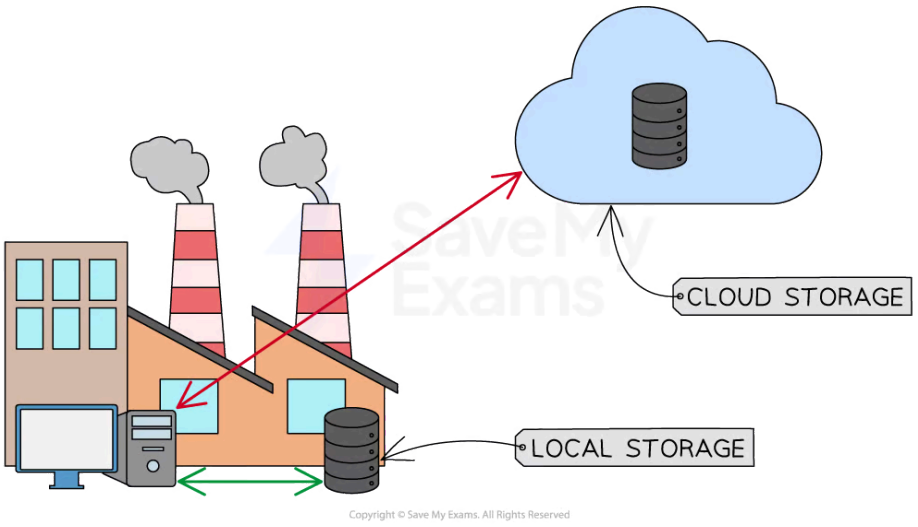
Cloud Computing

What is cloud storage?

- Cloud storage is a term to describe **long-term (secondary) storage of data** that resides in a **remote location**, accessible only **via a wide area network** (Internet)
- Data is stored on **remote servers**, typically using magnetic storage (**HDD**), but increasingly using solid state (**SSD**)
- The three types of cloud storage are:
  - **Public cloud** - The customer and the cloud storage provider are different companies
  - **Private cloud** - The customer and the cloud storage provider are a single organisation
  - **Hybrid cloud** - Combines both public and private cloud options and allows for sensitive data to remain private whilst providing public cloud services for less sensitive information



Advantages and disadvantages of cloud storage

Advantages	Disadvantages
Data can be **accessed from anywhere**	A **stable internet** connection is required to use cloud storage

Data can be accessed by anyone with the **relevant permissions,** making it **quick to share files** and collaborate with others	Storing data in the cloud may be **vulnerable** to **security breaches**
Data can be **accessed on any device** with an internet connection	The user is **dependent** on the storage provider for the **availability** and reliability of its services
Allows customers to **increase** or decrease their **storage capacity** as needed	Should the company dissolve or cease to exist, all cloud **data may be lost**
Providers often use **multiple servers** to store and **backup data**, reducing the risk of data loss due to hardware failure	As the amount of storage or **bandwidth** required increases, the service may become expensive over time
Providers offer **advanced security features**, such as data **encryption** and **multi-factor authentication multi-factor authentication**, to protect user data from unauthorised access	
There is **no need to hire specialist staff** as IT services being provided by the cloud storage provider	

Your notes

Worked Example

Explain the difference between cloud storage and local storage

[2]

Answer

Cloud storage involves storing data on remote servers accessed via the internet [1]

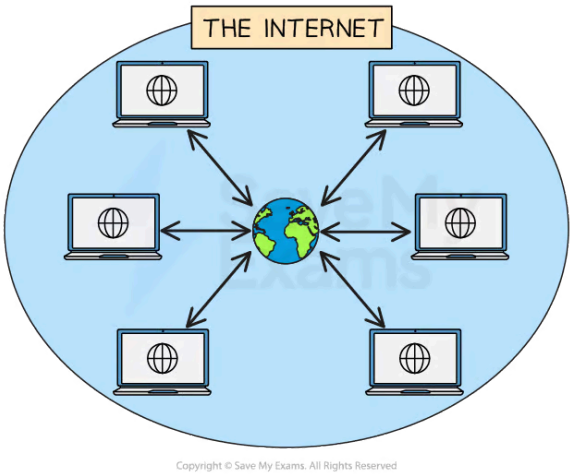
While local storage refers to storing data on physical devices like hard drives or flash drives [1]

Your notes

Internet

What is the Internet?

- The Internet is a **global network** of **networks**
- Internet, short for **INTER**connected **NET**works is multiple local area networks (LANs) connected to form a large wide area network (WAN)
- The Internet is the most well-known wide area network (**WAN**)
- The Internet is used to **provide connectivity** to the World Wide Web



What is the World Wide Web?

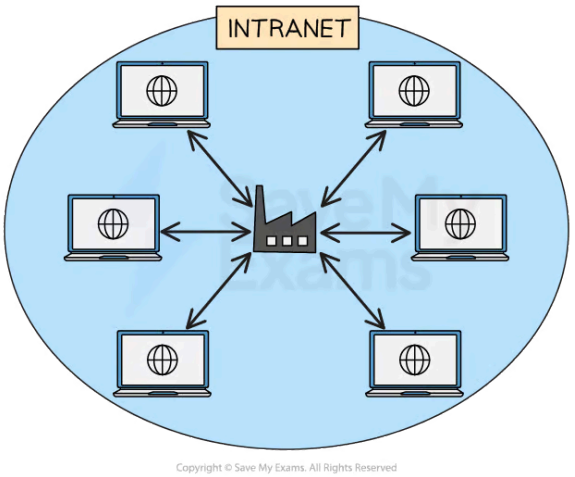
- The world wide web, or simply **the web**, is a **collection of websites** and **web pages** that are **accessed using the internet**
- It was created in 1989 by **Tim Berners-Lee**, who envisioned it as a way to **share** and **access** information **on a global scale**
- The web consists of **interconnected documents** and **multimedia files** that are stored on **web servers** around the world
- **Web pages** are accessed using a web browser, which communicates with web servers to retrieve and display the content

Intranet

What is an intranet?

- An intranet is a network designed to work much like the internet, but **operate only within a local area network** (LAN)

- Intranets provide companies with **a secure platform** to share information and resources **exclusively with their employees**
- An intranet is a **private** network
- Intranets sit behind a **firewall** to ensure security and that **only authorised users** can access it



Advantages of intranet over internet

- Better **bandwidth** than the internet
- Data is kept **within the organisation**
- Less chance of **hacking** and attacks
- Administrators can **manage access** to external sites and links

Extranet

What is an extranet?

- An extranet is **an extension to an intranet** that allows **authorised access** from **outside** of the local area network
- Once authenticated, users will have **managed access** to network resources and/or information
- An extranet is useful for companies who want to provide access to:
  - **Customers**
  - **Clients**
  - **Key stakeholders**

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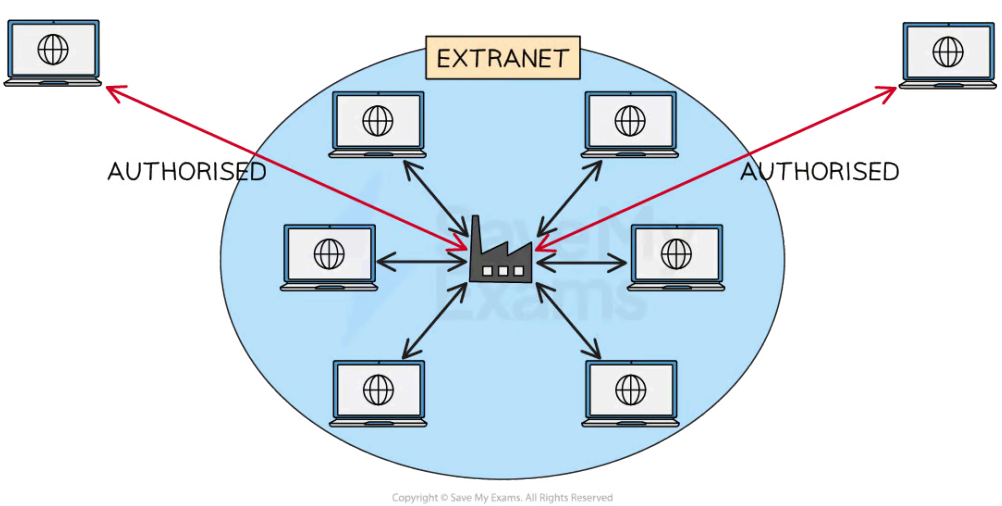

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- Similarities between the internet, intranet and extranet are as:
  - They are all **web based technologies**
  - They allow users to access information **remotely**
  - They all use **client server architecture**
  - They all use security measures such as **authentication** and **encryption**
  - They all promote and facilitate **information and resource sharing**

Worked Example

A company uses an Intranet. Explain what is meant by an Intranet

[2]

Answer

An Intranet is a private network that is accessible to employees of the organisation and not to members of the public [1]

It provides employees access to company information and to share resources internally [1]

Your notes

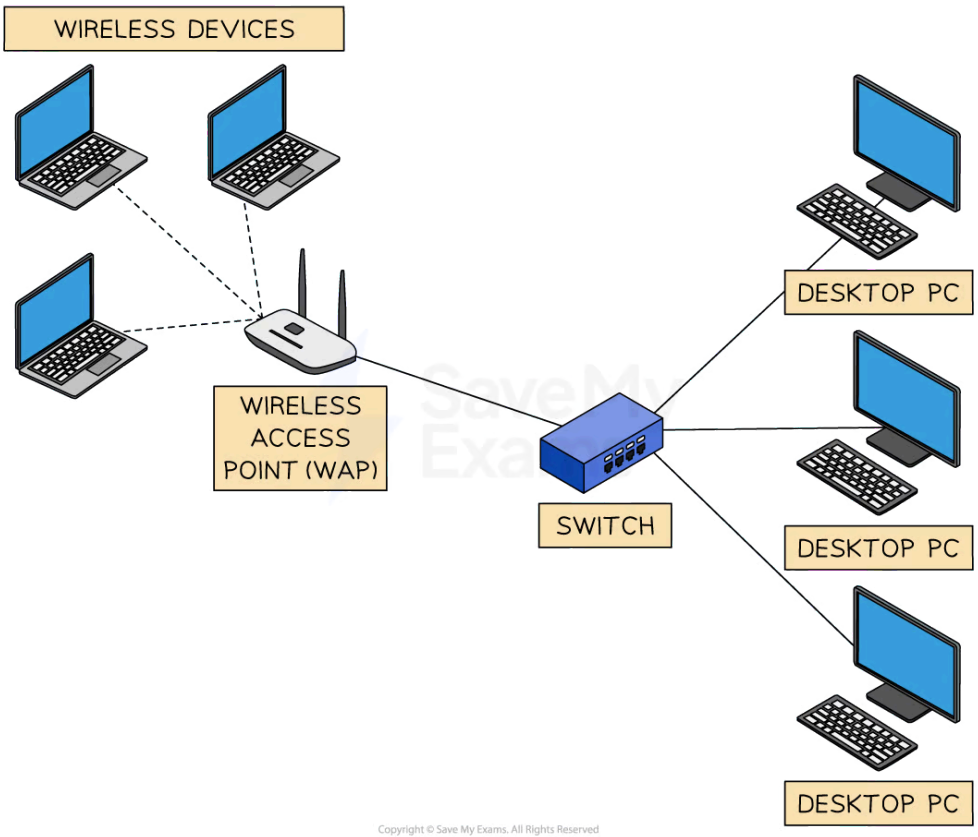
What are the different types of networks?

- A network is **two of more devices connected together** with the purpose of sharing resources
- There are three types of networks
  - **Local Area Networks (LANs)**
  - **Wireless Local Area Networks (WLAN)**
  - **Wide Area Networks (WANs)**

Local Area Network (LAN)

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)



Advantages and disadvantages of LANs

Advantages	Disadvantages
Allows **centralised** management of updates, backups and software installations	If **hardware fails**, the network may not function properly or even at all
Can **secure** its devices with the use of firewalls, antivirus software and other security features to prevent unauthorised access	Networks are more **prone to attacks** than standalone computers
Allows users on the network to **share resources** such as printers and other peripherals	Access to data and peripherals can be slow depending on **network traffic**
Allows the users of the network to **collaborate** and **share files and folders**	Require maintenance to ensure that software is up to date, upgrades and backups which can be costly

Your notes

Wireless Local Area Network (WLAN)

What is a wireless local area network?

- A wireless local area network is a local area network where devices connect to the network **wirelessly** instead of using cables
- Extra hardware, **wireless access points** (WAPs) or **hotspots** are connected to the network so that users can connect using Wi-Fi

Advantages and disadvantages of WLANs

Advantages	Disadvantages
Allows users to connect anywhere that is in the range of a **Wireless Access Point (WAP)** without the need for additional hardware or wiring.	**Limited** in their coverage and can be further affected by walls and other structures
Can be used in a **variety of environments** both indoors and out making them highly flexible	**Bandwidth** speeds can become an issue in high traffic areas
Additional wireless access points can be added relatively easily resulting in additional users being able to use the network or **increased network coverage**	**Interference** from other devices which can affect performance and connectivity

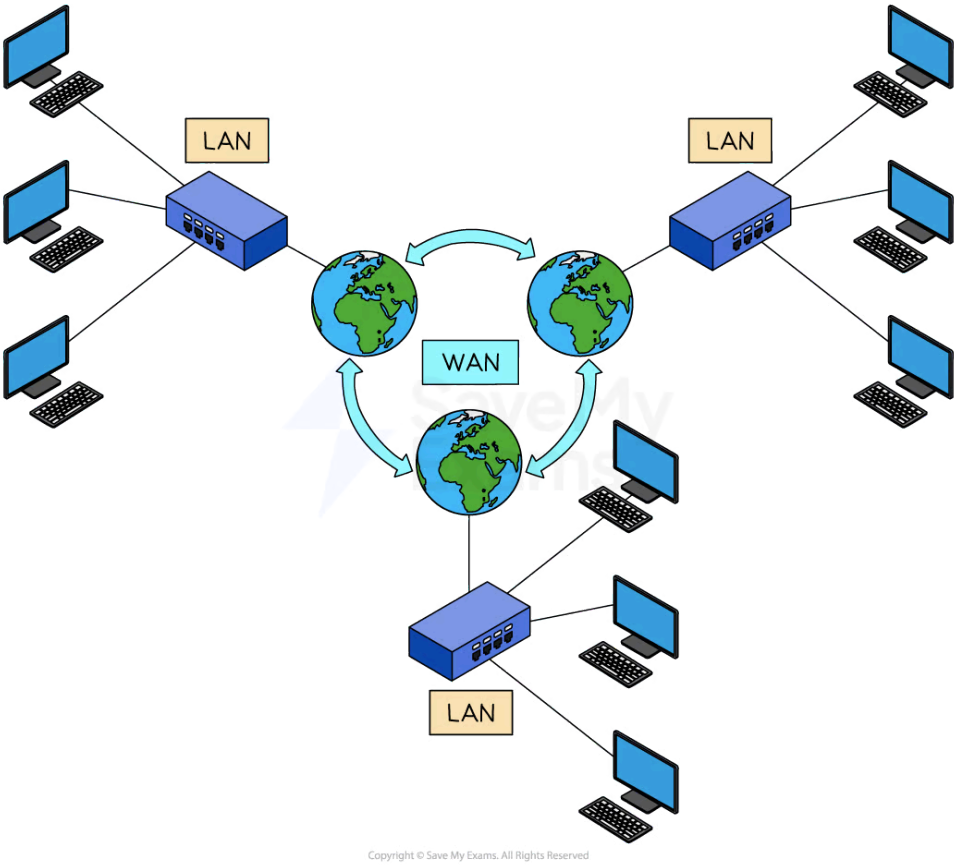
Access to **peripherals** such as printers	Vulnerable to **security threats** due to wireless signals being intercepted

Your notes

Wide Area Network (WAN)

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**.
- For example, telephone lines **owned by telecommunication companies**
- WANs will use fibre optic cable, telephone lines and satellite to connect the LANs together



Worked Example

Give 2 reasons why a fitness centre may want to install a WLAN

[4]

Answer

The fitness centre may wish to install a WLAN for several reasons such as :

Customers can connect to their Wi-Fi and search for information such as class times etc [1]

will improve customer services [1]

Staff at the fitness centre will be able to access resources wirelessly such as printers [1]

allowing them to move freely around the centre [1]

Your notes