

## Brain dump



Write down any network devices you know




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## Network Fundamentals

A level Student Booster

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## Learning Outcomes

**By the end of this 90-minute session, you will:**

- Know the different network types and their uses
- Recognise the advantages and disadvantages of the client server and peer to peer network models
- Comprehend network addressing, including the basics of IP and MAC addresses
- Comprehend the communication principles used in wireless networks




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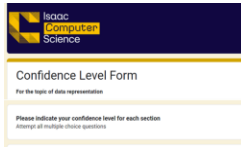
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## Confidence Check-In

Please take time to anonymously share your confidence in today's topics



leapac  
Computer  
Science

Confidence Level Form

For the topic of data representation

Please indicate your confidence level for each section  
(average of multiple choice questions)




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## Communication Systems

### Starter task

Networks have revolutionised our ability to communicate.  
There are many different **communication systems** in use.

**Write down on paper examples you know**




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## Communication Systems

### Which systems did you get?

- Telephony Systems: PSTN, VoIP
- Cellular Networks: 3G, 4G, 5G
- Computer Networks: PAN, LAN, WAN & VPN's
- Email Systems:
- Instant Messaging and Chat Systems
- Social Media Networks: e.g. Facebook, Twitter (X)
- Collaboration Platforms: e.g., Google workspace
- Broadcast Networks: TV and Radio
- Satellite Communication Systems: GPS, TV
- Fiber-optic networks.




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## Using computer networks?

It's hard to envisage modern life without computer networks, yet this convenience of information sharing also introduces significant security risks.



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Comment in the chat

- Advantages of using networks

## Why do we use networks?

### Advantages

- Share hardware devices between multiple users, e.g., printer
- Share files/folders and collaborate
- The ability to have multi-user systems e.g., Databases
- User activity tracking.
- Backup files centrally with a client server model
- Deploy and upgrade software centrally with client server model
- **Communication:** Networks enable instant communication through email, messaging apps, and video conferencing etc
- **Remote Access:** Users can access network resources and data remotely

Comment in the chat

- Disadvantages of using networks

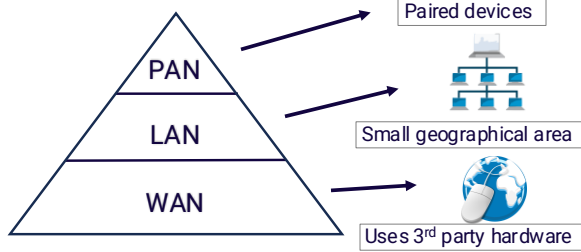
## Why do we use networks?

### Disadvantages

- Extra hardware costs for routers, servers, cabling etc.
- Initial setup costs and employing a network managers for larger organisations
- Greater security risks, malware, hacking
- **Maintenance Costs:** Regular maintenance and upgrades
- **Downtime:** Network failures can disrupt operations
- Ensuring **data privacy** on a network can be challenging
- Bandwidth limitations: can lead to performance issues.
- **Network Bottlenecks:** As the number of users and devices increases, network bottlenecks can occur.

## Networks – Network Types

Network type refers to the size of the computer network



With a partner identify examples of each




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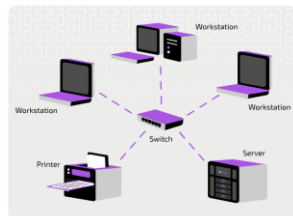
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## Computer Networks – LANs

The term **local area network** (LAN) is used to refer to a network that is formed when devices in the **same building** or on a **single site** are connected.

- Organisations 'own' and 'maintain' their own hardware.
- They can add their own internal hardware.

Write down examples of LANs




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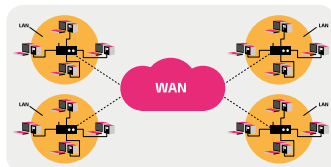
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## Computer Networks – WANs

When two or more networks are connected across a large geographical area, they form a **wide area network** (WAN).

- Organisations make use of external hardware.  
( This is usually the internet)
- In client server, need a team of people, e.g., network manager

Write down examples of WANs




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## Networks – client-server model

**Client-server** networks allow you to access your files and emails from any authorised device.

### Centrally you can manage

- Security ( e.g., permissions)
- Software installation
- Emails
- Backups

### With a partner

Discuss and write down

- Advantages of Client-server
- Disadvantages of Client-server




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## Networks – peer-to-peer model

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

### On Individual Computers you

- Manage security
- Install software
- Backup
- Backups

### With a partner

Discuss and write down

- Advantages of peer-to-peer
- Disadvantages of peer-to-peer




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## Activity – Isaac Questions

Open the Isaac Computer Science topic here and complete the questions at the bottom:

[https://isaaccomputerscience.org/concepts/net\\_network\\_network?examBoard=all&stage=a\\_level&topic=networking](https://isaaccomputerscience.org/concepts/net_network_network?examBoard=all&stage=a_level&topic=networking)

Related questions

Client-server networking (A Level - P1)

Peer-to-peer networking (A Level - P1)




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## Computer Network Topologies

Network **topology** describes the arrangement of network devices (layout) and their interconnections.

Topologies can be both **physical** (how devices are connected) and **logical** (how data flows)..



## Point-to-Point Topology

**Point-to-point** is a simple network topology where two devices are directly paired. This pairing can occur wirelessly, typically using Wi-Fi Direct or Bluetooth, or through a physical cable connection.

### Examples.

- 2 laptops
- 2 mobile devices
- Mobile and printer
- Wireless mouse and PC

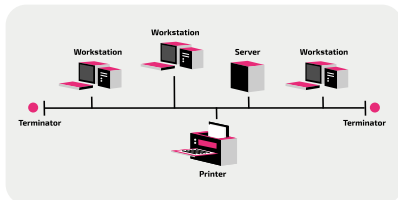


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## Network Topologies – Bus

**Bus topology** is a network configuration where all devices (nodes) are connected to a single communication line, known as the **bus**.




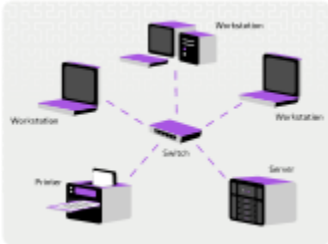
### Bus limitations

- Collisions can occur if more than one device transmits.
- Security concerns arise as all devices receive the data.



## Network Topologies – Star

In this topology, devices connect to a central Hub or Switch.  
A switch uses a table to direct messages to the specific port of the intended recipient

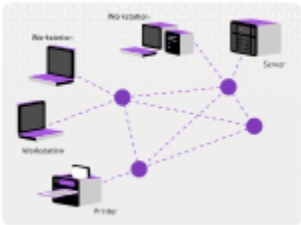


**Discuss with a partner**  
Why is a switch better than a hub in a star topology

## Network Topologies – Mesh

In this topology, there is no central communications point. Instead, there are multiple paths between the communication devices (e.g. switches 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.



## Networks activity – Handout 1

Use handout 1 consider the scenarios provided. For each, identify and specify the network size, topology, model and level of security.

**Handout 1 – Network scenario sheet**  
Consider the scenarios provided below. For each, identify and specify the network size, topology, model and level of security.

Scenario	Network Size	Topology	Model	How Secure
A school				
Home				
Small business with 20 staff				
University campuses across a city				
Public Wi-Fi in a shopping centre				
Military base				
Mobile phone connection using Bluetooth in a car				

## Handout 1 solutions

Scenario	Network Size	Topology	Model	How Secure
A school	LAN	Star	Client-server	High (Secure with internal security policies)
Home	LAN	Star	Peer-to-Peer	Moderate (Dependent on user security measures)
Small business with 20 staff	LAN	Star	Client-server	High (Secure with professional IT solutions)
University campuses across a city	WAN	Mesh	Client-server	Very High (Highly secure with advanced protocols)
Public Wi-Fi in a shopping centre	LAN	Star	Client-server	Low (Vulnerable to public access risks)
Military base	LAN/WAN	Mesh	Client-server	Very High (Extremely secure with advanced encryption and monitoring)
Mobile phone connection using Bluetooth in a car	PAN	Point-to-Point	Peer-to-Peer	Moderate (Dependent on Bluetooth protocol security)

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## Activity – Isaac Questions

Open the Isaac Computer Science topic here and complete the questions at the bottom:


[https://isaaccomputerscience.org/concepts/net\\_network\\_topologies?examBoard=aga&stage=a\\_level&topic=networking](https://isaaccomputerscience.org/concepts/net_network_topologies?examBoard=aga&stage=a_level&topic=networking)

Related questions

Bus topology (A Level - P1)

Star topology (A Level - P1)

Office space (A Level - P1)

 You have 3 minutes!

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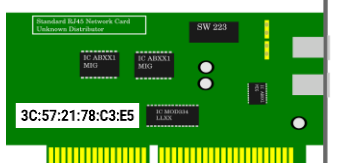
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## Network addressing–MAC address

A **MAC** (Media Access Control) **address** is a unique identifier assigned to a network interface card (NIC). They **can't be changed**.

MAC addresses are represented as hexadecimal numbers for **human readability**. There are 6 pairs of characters separated by a : Each pair represents a byte.



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## Network addressing–IP address

An IP address uniquely identifies devices on a network. There are 2 parts to it called the Network ID and Host ID. Ip addresses **can change**.

**There are two standards for IP addressing:**

**ipv4:** 32-bit addresses usually displayed as four sets of denary numbers separated by dots, e.g., **192.168.1.105**

**Network ID**

**Host ID**

**ipv6:** 128-bit addresses usually displayed as eight sets of hexadecimal numbers separated by colons,

e.g., **2a00:23c1:f002:ec01:690e:4024:ed81:3fee**




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## Switches Routers & Gateways



**Switch**

sends data only to the specific device it is meant to reach.

Commonly used in LANs only. So found in schools, businesses etc.



**Router**

connects different networks together and manages the data traffic between them.

**Home router:** has the ability to connect to other networks, but also has a switch and WAP built in.




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## Switches Routers & Gateways



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**Gateway**

Serves as bridge that enables communication between **different networks** using **different protocols**.

A gateway is not typically used within a LAN because devices communicate using the same protocols and addressing scheme, such as IPv4

**Email Security Gateway**

used between an office LAN and the internet to examine emails

**Payment Gateway**

used to process credit card transactions securely for customers




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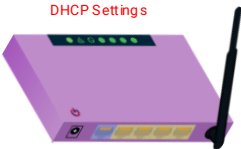

## Switches Routers & Gateways

Comparison table for features of Switches Routers & Gateways

Feature	Router	Switch	Gateway
Function	Connects multiple networks	Connects multiple devices within a network	Connects different networks with different protocols
Primary Use	Directs data between networks	Forwards data within a network	Translates and routes data between different networks
Addressing	IP Addresses	MAC Addresses	IP Addresses, and possibly other protocols
Device Communication	Uses IP to route packets	Uses MAC addresses to switch frames	Converts data formats, addresses, protocols
Typical Location	Between LANs or between LAN and WAN	Within a LAN	Between different networks (e.g., LAN to Internet)
Traffic Management	Routes traffic based on IP addresses	Switches traffic based on MAC addresses	Routes and translates data between networks

## DHCP server

IP addresses are managed by a DHCP server. This is configured in a home router by logging in as admin.



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## Wireless networks



Wireless networks are pivotal in global communication. How many types are you familiar with?"

With a partner

Discuss and write down examples

Which did you get?

- Wi-Fi Networks (WLAN)
- Bluetooth networks
- Cellular Networks: 3G, 4G, 5G
- Broadcast Networks: TV and Radio
- Satellite Communication Systems
- Wireless PAN



## Wireless networks – WLAN

A typical wireless local area network (**WLAN**) is based around a central communications device called a **wireless access point** (WAP).

### SSID

People join by selecting the SSID. This is the **network name** publicly available.

**WAPs** forward data to devices based on MAC addresses, while routers handle IP-based traffic routing.

2.4 GHz

Wireless: ☒ ON

Channels: Smart (Channel 11)

Network name: BT-60CG6N

WPS: ☒ ON

Security type: WPA2

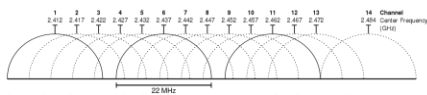
Security password: jufj0cnfjyjh9K

Password strength:

## Frequency bands

Wireless networks use a specific range of radio wave frequencies (the frequency band) to transmit data. Most WLAN devices will be dual-band and will operate on:

**2.4GHz** - travels further and is better at penetrating walls  
**5.0GHz** - less congested and higher data transfer rates



## Wireless networks – CSMA/CA



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### Crossing the road safely



In pairs

- Identify the decisions and actions required to cross the road safely [5 mins]



## Wireless networks – CSMA/CA

CSMA/CA is a protocol used in wireless networking. It makes sure that network collisions (when two devices attempt to communicate at the same time) are avoided.

### How it works

- Carrier-sense:** A device listens to the network to check if any other device is transmitting.
- Collision avoidance:** If the channel is busy, it waits for a random period of time. This repeats until the channel is free.
- Transmission:** Once the channel is free, the device transmits its data
- It waits for an acknowledgment to confirm successful receipt



## Wireless networks – CSMA/CA

### Traffic Analogy

#### Carrier Sense (check for traffic)

Pedestrians waiting at a traffic light.  
Before crossing,



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#### Collision Avoidance (don't risk a gap when on red)

If the traffic light is red and cars are approaching, the pedestrian waits for a green light to avoid collisions

#### Transmission (cross if green)

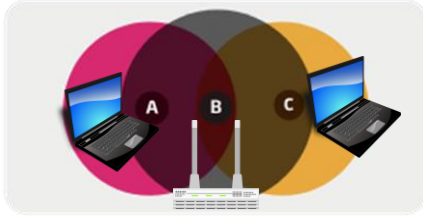
When the traffic light turns green, pedestrians cross.



## Wireless networks – CSMA/CA

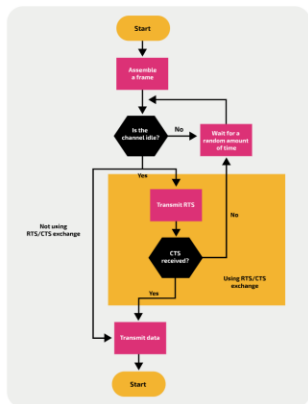
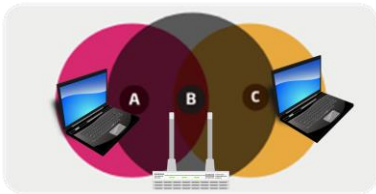
### Hidden Node Problem

In this arrangement both A and C can see B



## Wireless networks – CSMA/CA

**RTS/CTS**, standing for "**R**eserve to Send/**C**lear to Send," is a network protocol where a device sends an **RTS** to reserve the channel, and upon receiving a **CTS** reply, it proceeds with data transmission.

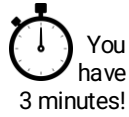


## Activity – Isaac Questions

Open the Isaac Computer Science topic here and complete the **related questions** at the bottom:

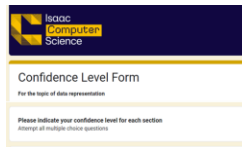
[https://isaacomputerscience.org/concepts/net\\_network\\_wifi?examBoard=all&stage=a\\_level&topic=networking](https://isaacomputerscience.org/concepts/net_network_wifi?examBoard=all&stage=a_level&topic=networking)

Related questions	
It's not wired (A Level - P1)	Limit wireless collisions (A Level - C1)
Getting connected (A Level - P1)	Needed for WiFi (A Level - P1)
Benefits of WiFi (A Level - P1)	The order of CSMA/CA (A Level - P1)



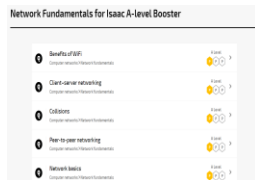
## Confidence Check-In

Please take time to anonymously share your confidence in today's topics



## Isaac Gameboard practice

- If you want more networking 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.



[nccce.io/isc-Anet](https://nccce.io/isc-Anet)



## Learning Outcomes

**By the end of this 90-minute session, you will:**

- Know the different network types and their uses
- Recognise the advantages and disadvantages of the client server and peer to peer network models
- Comprehend network addressing, including the basics of IP and MAC addresses
- Comprehend the communication principles used in wireless networks



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## Check for more ISAAC boosters

The screenshot shows the ISAAC website interface. At the top, there's a navigation bar with 'MY ACCOUNT' and 'LOG OUT' links. Below this, a 'Welcome' section is visible, featuring links to 'GCSE resources', 'A Level resources', and 'Events'. A callout box with an arrow points to the 'Events' link, containing the text: 'Keep an eye out for more student booster events'. The page also includes a section for 'I belong in Computer Science posters' and a list of 'Key stage 3 courses', 'Key stage 4 courses', and 'A level courses'.



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**"By developing a common digital language for computers across networks, these two men prepared the way for a technological revolution"**

President George W. Bush

in recognition of the of the contributions of Vint Cerf and Robert Kahn in the development of TCP/IP protocols.



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