1.1.1 Architecture of the CPU

Purpose

The Von Neumann Architecture consists of the CPU and Memory which are interconnected and can both store instructions and data. The CPU itself consists of different components: Registers, Cache, Control Unit and Arithmetic Logic Unit. The purpose of the CPU is to fetch, decode and execute instructions.

Other components in the CPU:

Control Unit:
Decodes instructions and sends signals the other components on how to respond to this instruction.

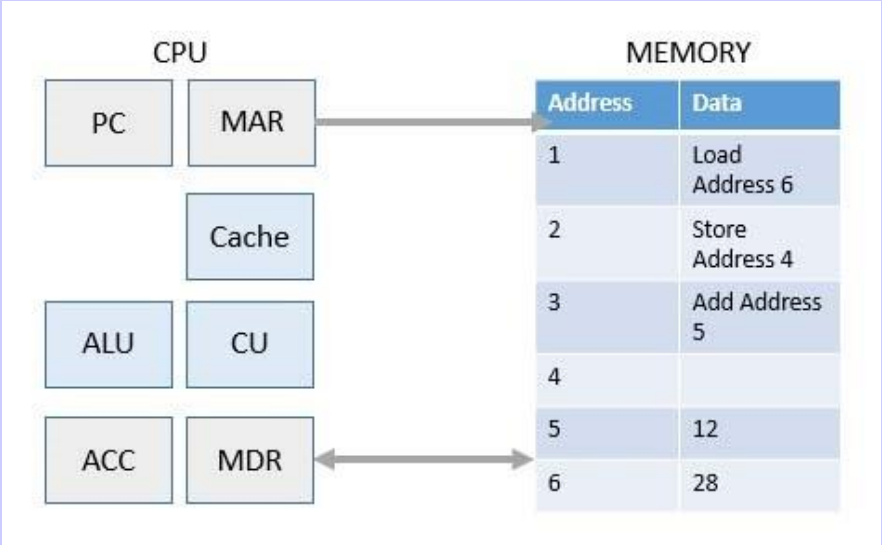
Cache:
Stores frequently used instructions.

Arithmetic Logic Unit:
Responsible for performing arithmetic calculations and logical decisions.

Registers

Program Counter:
Stores the next instruction ready to be used.

Memory Address Register:
Stores the location of the next address to be fetched.



Memory Data Register:
Data written to and from the main memory.

Accumulator:
Stores the results of the arithmetic calculations.

What is a register?

A location within the CPU that stores addresses and data which can be accessed quickly.

Did you know?

The clock is another component found in the CPU. This controls the rate in which cycles are processed every second. The rate is determined by the **Clock Speed.**

Key terms:

Fetch Decode Execute
Instructions Data Signals

1.1.2 CPU Performance

Purpose

To get the best out of a CPU, there are a number of characteristics that can determine how well it performs:

- Clock Speed
- Cores
- Cache

Did you know?

CPU's can run at a higher clock speed then it was designed to run. This is known as **overclocking** and is commonly done with PC's designed to play video games.

Revision tip:

If you struggle to remember any of the characteristics that impact the performance of the CPU, remember they all begin with the letter **C**

Cache Size

Definition/Meaning:

The cache stores instructions that are previously used or frequently used. It acts as the intermediary between the CPU and Main Memory.

How does an increase in Cache Size impact CPU performance?

- More instructions used can be stored on the CPU.
- This means that data stored in the cache doesn't need to be fetched from main memory.
- As a result, creating a more efficient process

Clock Speed

Definition/Meaning:

This controls how many cycles can be processed per second. The higher the clock speed, the more instructions executed per second.

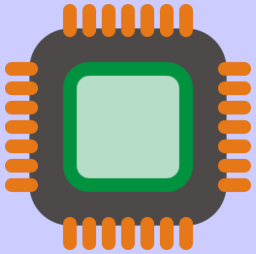
How does an increase in Clock Speed impact CPU performance?

- An increase in Hz (Hertz) can lead to more tasks being executed per second.
- As a result, programs/software will respond faster.

Cores

Definition/Meaning:

It acts as the 'brain' of the CPU and is responsible for executing instructions. Modern CPU's will use a multi-core processor. (i.e. multiple cores)



How does an increase in cores impact CPU performance?

- It allows instructions to be split up between the processors.
- As a result, they can be executed simultaneously.
- This will help to reduce the amount of time required to run a program.

1.1.3 Embedded Systems

What is an embedded system?

An embedded system is a computer system that is typically found within another device and is designed to perform a set of dedicated/specific functions. They are also referred to as **Special-Purpose Computer Systems.**

Real time systems

A real-time system is well-defined system with fixed time constraints meaning it will provide an immediate response to an input. For example, if you press a button on a digital camera, it will send a signal to capture the image immediately.

General-Purpose Computer Systems

Laptop		Browse the internet, open documents, send emails.
Smartphone		Browse the internet, use GPS, play games, calls, text messages.
Games Console		Play games, browse the internet, watch movies.

Special-Purpose Computer System

Microwave		Set the time manually, pre-set options for defrosting certain foods.
Washing Machine		Pre-set functions for washing clothes at different temperatures, different times, selecting spin speed.
MP3 Player		Listen to music, select tracks, skip tracks.

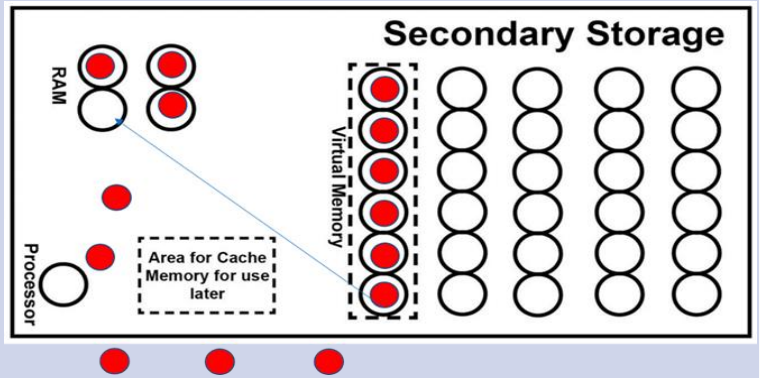
1.2.1 Primary Storage

Purpose

A primary storage device is a medium that holds memory for short periods of time while a computer is running. There are two types of primary storage used by computer systems: RAM and ROM.

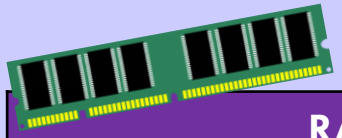
Virtual Memory

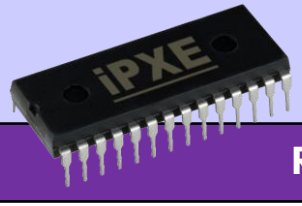
Description:
When the RAM becomes full, the overflow of data normally stored in the RAM will be stored in Virtual Memory which is located on the hard drive. Once space becomes available, data will move from VM and back to RAM. However this is a slow process.



RAM and ROM

RAM (Random Access Memory) and ROM (Read-Only Memory) both store data but there are a number of key differences between the two.





RAM	ROM
Volatile memory	Non-volatile memory
Read and write data	Reads data
Stores programs/data currently in use.	Stores instructions required to boot up the computer (BIOS)
Expandable	Soldered onto the motherboard
Contents change frequently (Temporary)	Contents hardly ever change. (Permanent)

Difference between volatile and non-volatile memory.

Volatile memory means when the computer is switched off, data is lost. Whereas, non-volatile memory has the ability to retain data even when the computer is switched off.

BIOS:

BIOS stands for Basic Input/Output System. It designed to boot up the computer using a POST (Power on self-test) and determine what hardware is connected to the system.

Key terms:

Volatile Non-volatile Storage Read Write

1.2.2 Secondary Storage

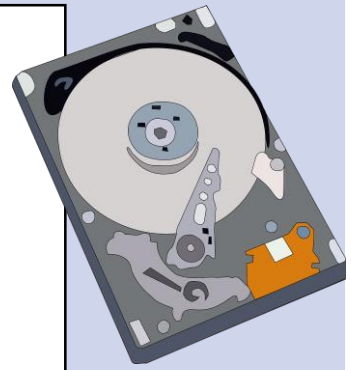
Definition/Meaning:

Secondary storage has the ability to store files even when the computer is switched off. Therefore, it's a non-volatile form of storage.

Magnetic Storage

Description

The most common example of magnetic storage is a **Hard Drive.** The hard drive contains a number of moving mechanical parts such as a spinning platter with a thin magnetic coating. A "head" moves over the platter, writing 0's and 1's on the platter.



Revision tip:

A common misconception is that secondary storage backs up data. If a duplicate copy is created then the device used to back it up would be classed as tertiary storage.

Review

Cost	Capacity	Reliability
Expensive from the outset, but cost per MB represents value for money.	Enough capacity to store different types of files. You can buy hard drives that can hold 4TB of data.	Can perform well for a long period of time but performance will eventually deteriorate.

Durability	Portability	Speed
If it's external then it can become damaged if dropped because it has moving parts.	Would have to be detached from the computer and it's heavy.	Uses a head that moves over a platter to read and write data so it's not instant.

Key terms:

Cost	How much the device costs per MB.
Capacity	How much space is available on the storage device.
Reliability	Longevity – how well it can maintain the same level of performance over time.
Durability	how resistant it is to external factors such as being dropped, scratched and how it responds to being in extreme conditions.
Portability	How easy is it to transport from one place to another.
Speed	How quickly the data can be read and transferred from the storage device.

1.2.2 Secondary Storage

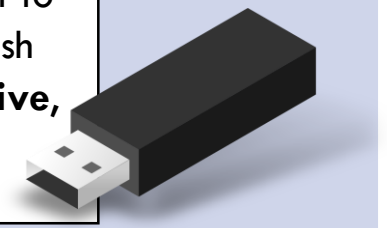
Definition/Meaning:

Secondary storage has the ability to store files even when the computer is switched off. Therefore, it's a non-volatile form of storage.

Solid-State Storage

Description

A solid-state drive (SSD) is a solid-state storage device that uses integrated circuit to store data persistently, typically using flash memory. Examples include **Solid-State Drive, USB Flash Drive** and **SD Card.**



Revision tip:

A common misconception is that secondary storage backs up data. If a duplicate copy is created then the device used to back it up would be classed as tertiary storage.

Review

Cost	Capacity	Reliability
Expensive, even the cost per MB. Although, the price is beginning to come down.	You can purchase up to 4TB of data, not as much as you can with a HDD.	It has a limited number of read and write cycles which means performance will deteriorate quickly.
Durability	**Portability**	**Speed**
Resistant to being dropped because it has no moving parts.	Most devices are small, lightweight and easy to carry around. Easy to transfer files.	It doesn't use a mechanical arm and relies on the processors embedded within.

Key terms:

Cost	How much the device costs per MB.
Capacity	How much space is available on the storage device.
Reliability	Longevity – how well it can maintain the same level of performance over time.
Durability	how resistant it is to external factors such as being dropped, scratched and how it responds to being in extreme conditions.
Portability	How easy is it to transport from one place to another.
Speed	How quickly the data can be read and transferred from the storage device.

1.2.2 Secondary Storage

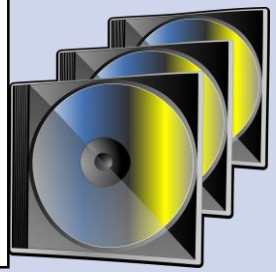
Definition/Meaning:

Secondary storage has the ability to store files even when the computer is switched off. Therefore, it's a non-volatile form of storage.

Optical Storage:

Description

Optical storage is any storage type in which data is written and read with a laser. Common examples of optical storage include: **CD**, **DVD**, and **Blu-ray.**



Revision tip:

A common misconception is that secondary storage backs up data. If a duplicate copy is created then the device used to back it up would be classed as tertiary storage.

Review

Cost	Capacity	Reliability
Cheap to buy and cheaper to buy as a bulk. You can get a blank CD for less than £1.	CD's can only store 700 MB which might not be enough to store larger files. Blu-ray can hold up to 25GB.	If CD's are stored in cases or plastic wallets then they can continue to be used for long periods.
Durability	**Portability**	**Speed**
Sensitive to scratches and dust which can make it difficult to read the data.	Most devices are small, lightweight and easy to carry around. Easy to transfer files.	It is slow reading the data because it has to access the optical drive (the drive used to read the CD).

Key terms:

Cost	How much the device costs per MB.
Capacity	How much space is available on the storage device.
Reliability	Longevity – how well it can maintain the same level of performance over time.
Durability	how resistant it is to external factors such as being dropped, scratched and how it responds to being in extreme conditions.
Portability	How easy is it to transport from one place to another.
Speed	How quickly the data can be read and transferred from the storage device.

1.2.3 Units

Why do computers use bits?

Binary is a number system that only uses two digits: 1 and 0. All information that is processed by a computer is in the form of a sequence of 1s and 0s. Therefore, all data that we want a computer to process needs to be converted into binary. These digits 1 and 0 are often referred to as bits.

Units of data storage:

Order (Smallest to largest)	Unit	Equivalent
1	Bit	0 or 1
2	Nibble	4 bits
3	Byte	8 bits
4	KB	1,000 Bytes
5	MB	1,000 KB
6	GB	1,000 MB
7	TB	1,000 GB
8	PB	1,000 TB

Sound file size:

Formula:
sound file size = sample rate x duration (s) x bit depth

Worked example:

Sample rate = 3
Duration = 1 minute 30 seconds
Bit depth = 2

3 x 90 x 2 = 540 bits

Image file size:

Formula:
image file size = colour depth x image height (px) x image width (px)

Worked example:

An image that is 400 x 400 with a colour depth of 4 bits.

(400 x 400) x 4 = 640000 bits
640000/8 = 80,000 bytes

Text file size:

Formula:
text file size = bits per character x number of characters

Worked example

Document that consists of 56 characters.

50 x 8 = 400 and 6 x 8 = 48
(400 + 48 = 448 bits)

Exam tip:

Use of 1,024 for conversions and calculations would be acceptable.
Allowance for metadata in calculations may be used

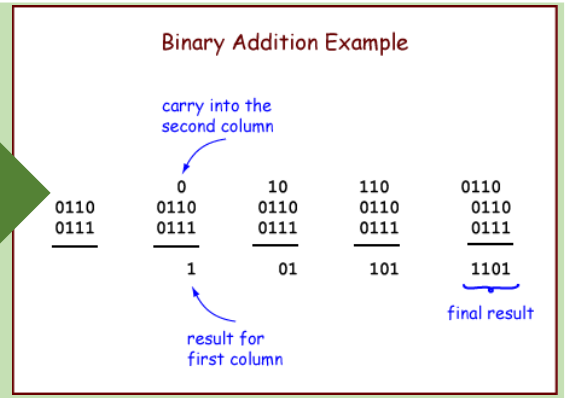
1.2.4 Data Storage

Binary

Binary is the language of the computer. Computers are made up of complex circuitry. These consist of billions of transistors that act as switches and they can only be in one of two states. ON (1) or OFF (0)

Binary addition:

Addition		Result	Carry
0 + 0	=	0	0
0 + 1	=	1	0
1 + 0	=	1	0
1 + 1	=	0	1



Denary to Binary:

1 Denary (decimal) to Binary

Example: Convert 81 to an 8-bit binary number.

128	64	32	16	8	4	2	1
0	1	0	1	0	0	0	1

=81

TIP:

1. Best way to remember this is what numbers do we use to make the number 81?
2. In this example, **64+16+1 = 81**
3. Because we used these numbers, they are represented by **1**.
4. The others are represented by **0** as they were **not** used.

2 Binary to Denary (decimal)

Example: Convert the 8-bit binary number 00110111 into a denary (decimal) number.

128	64	32	16	8	4	2	1
0	0	1	1	0	1	1	1

\- + - + 32 + 16 + - + 4 + 2 + - = 55

TIP:

1. The blanks represent the 0's because they were not used in this calculation.
2. Once the numbers were identified, it was easy to input the 1's in the correct place.

Binary shift:

9 Binary Shift

When working directly with binary numbers, a binary shift to the left and right can be used for multiplication and division respectively.

A left shift will multiply a binary number by 2

For example, a left shift of 1 (binary number x2)

128	64	32	16	8	4	2	1
0	0	1	0	1	1	0	0

=44

128	64	32	16	8	4	2	1
0	1	0	1	1	0	0	

=88

A right shift does the opposite

It will divide a binary number by 2. For example, a right shift of 1 (binary number / 2)

Binary overflow

When numbers are added together, there is a risk that a binary overflow may occur. This is when there is not enough space to store a piece of data. For example, 255 bits can be stored in one byte. So the number 256.

1.2.4 Data Storage

Hexadecimal

In 1859, Nystrom proposed a hexadecimal (base 16) system of notation, arithmetic, and metrology called the Tonal system. Hexadecimal numerals are widely used by computer system designers and programmers because they provide a human-friendly representation of binary-coded values.

Hexadecimal to Binary:

5 Binary to Hexadecimal

Example: Convert 10110011 to hexadecimal.

Method

First you need to split them into two nibbles.

128	64	32	16	8	4	2	1
1	0	1	1	0	0	1	1

8	4	2	1
1	0	1	1

Add the first nibble 8 + 2 + 1 **= 11**

8	4	2	1
0	0	1	1

Add the first nibble 2 + 1 **= 3**

Remember is 11 is B in hex so the answer would be **B3.**

6 Hexadecimal to Binary

Example: Convert 5E to binary

Method - For this you must split them into two nibbles.

5E

8	4	2	1
0	1	0	1

This represents 5.

8	4	2	1
1	1	1	0

This represents E, which is hex for 14.

128	64	32	16	8	4	2	1
0	1	0	1	1	1	1	0

You bring them together to form an 8-bit binary number. So the answer is **01011110**

Hexadecimal to Denary:

3 Denary (decimal) to Hexadecimal

Example: How to convert 74 to hexadecimal. (Look at Hex table)

Method

1. How many digits represent hexadecimals? **16**
2. The formula would then be *number to be converted/number of digits* **(74/16)**
3. If the number is not equally divisible then we must check how many times it goes into 16.
4. In this example, 74 goes into 16 **4** times.
5. It means the first part of the hexadecimal number is 4.
6. What remains? 16 x 4 = 64 (74-64 = 10)
7. The remainder is 10 and in the hex table 10 is represented by **A**, and that completes the hexadecimal number.
8. Therefore the hexadecimal number of **74** is **4A**

4 Hexadecimal to Denary (decimal)

Example: Convert 5E to decimal

Method

1. How many digits represent hexadecimals? **16**
2. The formula would then be *first number*number of digits* **(5*16= 80)**
3. Find out the value of E which is 14.
4. Add the 14 to the 80
5. 80 + 14 = 94
6. Therefore the denary number of **5E is 94.**

Hex Table:

Denary	Hex
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	A
11	B
12	C
13	D
14	E
15	F

1.2.4 Data Storage

Characters

Every word is made up of symbols or characters. When you press a key on a keyboard, a number is generated that represents the symbol for that key. This is called a character code. A complete collection of characters is a character set. A character set is a defined list of characters used so they can be encoded by a computer.

Binary representation of ASCII:

Example:

On the right is a section of the ASCII table which identifies each character and it's ASCII (Decimal) and Binary representation.

For example, the acronym ASCII in binary would be….

01000001 01010011 01000011 01001001 01001001

Symbol	Decimal	Binary
A	65	01000001
B	66	01000010
C	67	01000011
D	68	01000100
E	69	01000101
F	70	01000110
G	71	01000111
H	72	01001000
I	73	01001001
J	74	01001010
K	75	01001011
L	76	01001100
M	77	01001101
N	78	01001110
O	79	01001111
P	80	01010000
Q	81	01010001
R	82	01010010
S	83	01010011
T	84	01010100
U	85	01010101
V	86	01010110
W	87	01010111
X	88	01011000
Y	89	01011001
Z	90	01011010

Symbol	Decimal	Binary
a	97	01100001
b	98	01100010
c	99	01100011
d	100	01100100
e	101	01100101
f	102	01100110
g	103	01100111
h	104	01101000
i	105	01101001
j	106	01101010
k	107	01101011
l	108	01101100
m	109	01101101
n	110	01101110
o	111	01101111
p	112	01110000
q	113	01110001
r	114	01110010
s	115	01110011
t	116	01110100
u	117	01110101
v	118	01110110
w	119	01110111
x	120	01111000
y	121	01111001
z	122	01111010

Character sets:

ASCII	Extended ASCII	Unicode
Consists of up to 128 characters (0-127)	Consists of up to 256 characters (0-255)	Consists of 143,859 characters.
Uses 7 bits	Uses 8 bits	UTF-8/UTF-16
Contains letters, numbers, control characters, and other symbols.	Contains extra characters such as characters from foreign languages and special symbols for drawing pictures.	A universal encoded character set that supports storage of information from most languages in a single character set

Exam tip

Don't define a character set as a 'set of characters'. As this just repeats the question. You run the risk of losing marks in the examination.

Exam tip

Remember uppercase and lowercase are represented by different binary numbers. Also numbers represented as characters are also different to their denary equivalent.

1.2.4 Data Storage

Images

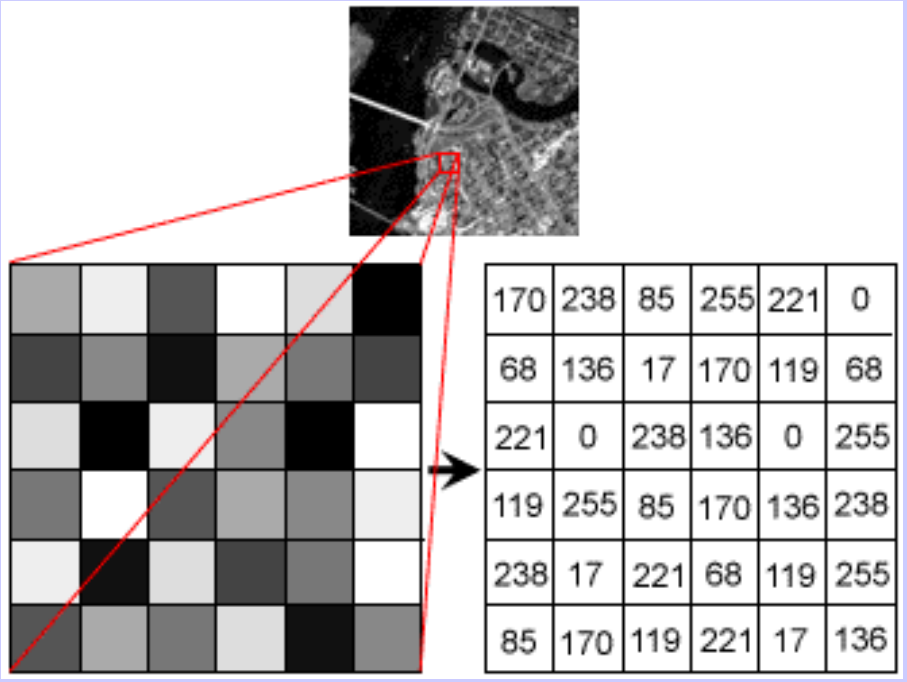
A bitmap image is a digital image that is made up of a series of picture elements (known as pixels) which are used to display images on our screen.

Colour Depth and Resolution:

Colour Depth:
Colour depth refers to how many possible colours can be represented in each pixel (bits per pixel)

Resolution:
Image resolution is typically described in PPI, which refers to how many pixels are displayed per inch of an image.

How an image is represented on a computer



170	238	85	255	221	0
68	136	17	170	119	68
221	0	238	136	0	255
119	255	85	170	136	238
238	17	221	68	119	255
85	170	119	221	17	136

- Each square is known as a Pixel
- Each pixel has the ability to store binary value.
- The binary value depends on how many bits can be stored in each pixel.
- Each binary value represents a unique colour.

Impact:

The impact of an increase in colour depth and resolution results in more pixel information and creating a high-quality, crisp image.
On the other hand, it does increase the size of the file.

Metadata

Metadata is 'data about data'. In other, it's data about the image itself.

Examples include:
Dimensions (Height and Width), File type, File size, Time/Date, Resolution, Colour depth.

1.2.4 Data Storage

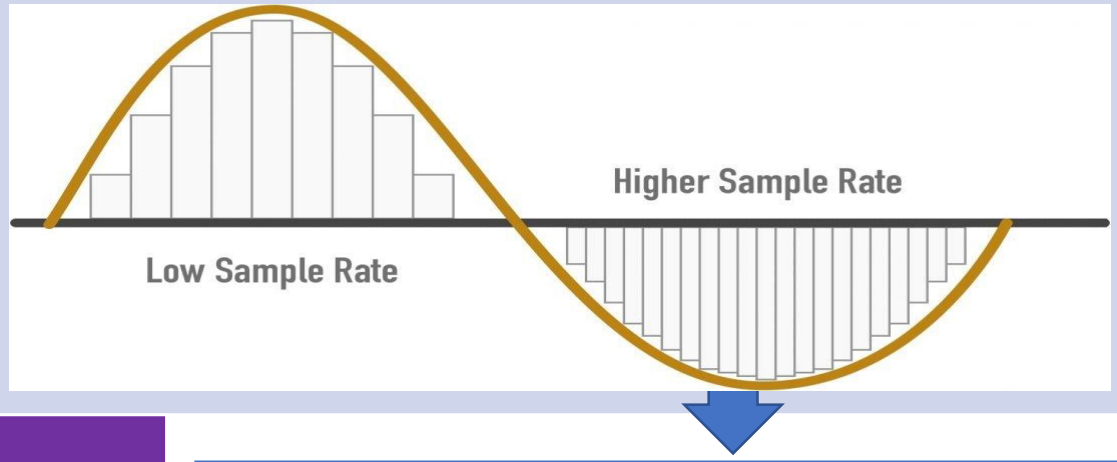
Sound

When we make sounds, it causes vibrations in the air thus creating sound waves. Technology has the ability to convert these sound waves into digital form.

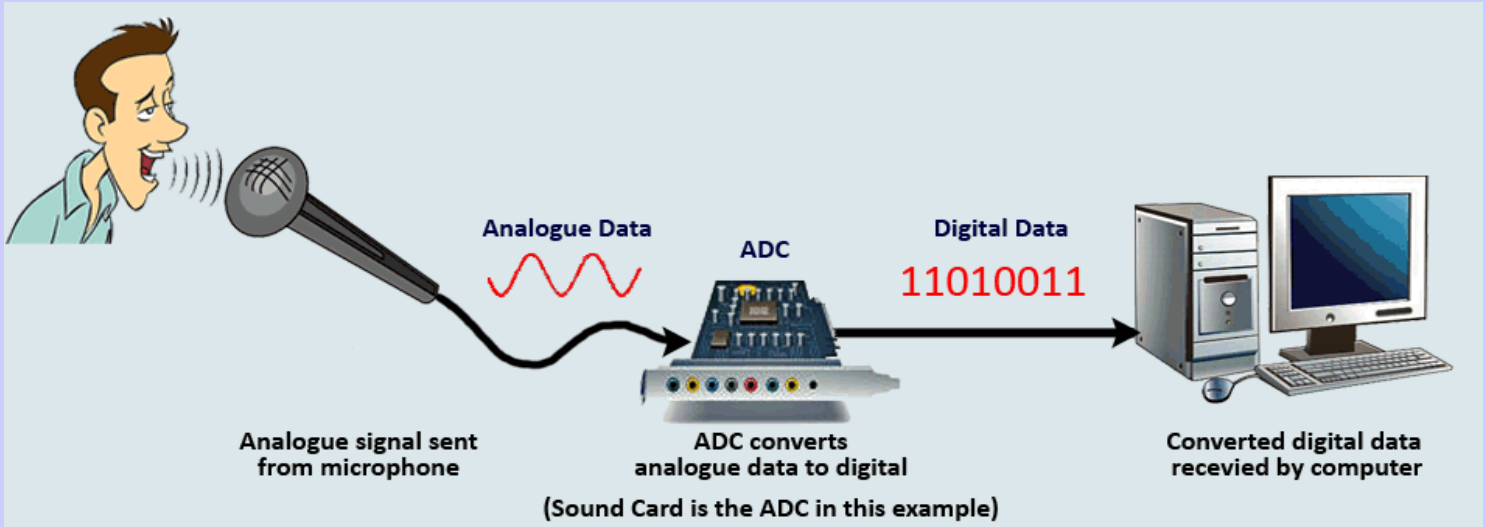
Sampling:

Definition

When sound is recorded, samples are taken at regular intervals as you can see in the diagram on the right. The sample rate is measured in Hz (Hertz)



How sound becomes digitised:



Analogue to Digital:

During the conversion process, samples are taken that are then converted from analogue into a digital recording.

Impact:

The impact of more samples being taken at regular intervals will lead to an increase in the quality of a file and it will create a more accurate representation of the original sound. However, it will lead to an increase in file size.

Bit depth

Bit depth is the number of bits available for each sample . If the bit depth increases it can increase the dynamic range of volume (this affects how loud the sound will be). This will also contribute to the quality of the sound file improving.

1.2.4 Data Storage

Compression

Compression is an algorithm designed to reduce the size of a file. There are two types of compression: Lossy and Lossless.

Impact on size:

cafe wonderland teaparty	08/09/2020 12:38	JPG File	84 KB
cafe wonderland teaparty	10/05/2019 10:51	Adobe Photoshop...	2,449 KB

Example:

The top file has been compressed using lossy and this will:

- Save space on the device it's being stored.
- Use less bandwidth if file is transferred over a network (i.e. e-mail)

Lossy and Lossless Compression:

Lossy Compression	Lossless Compression
It reconstructs all the original data but this means data is lost during the compression process.	Data is reconstructed and doesn't remove any data.
Once data is removed, it's permanent and cannot be restored. It's irreversible.	Because data is retained, it's reversible so changes can continue to be made.
This can impact the overall quality of the graphic.	The overall quality of the graphic is retained.
It does significantly reduce the overall size of the file.	The size of these files tend to be large.
JPG is a common file format that uses lossy compression.	PNG/PSD are common file formats that use lossless compression.

Impact on quality:

Example:

As you can see above, the image at the top has been saved in a lossless format whereas the image below, has been saved in a lossy format. You can see that the quality of the image below has reduced because data has been permanently removed.

1.3.1 Networks and topologies

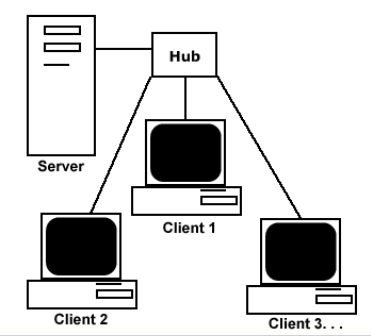
What is a network?

A group of interconnected devices with the intention of sharing resources over a network.

Exam tip:

Defining LAN as covering a local area and WAN as a wide area will not get you any marks. This is merely repeating what has been stated in the question.

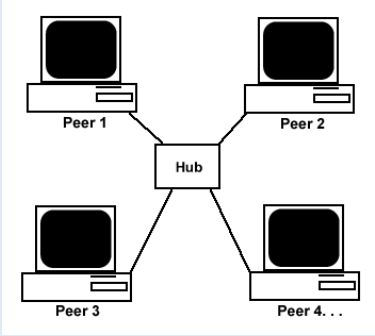
Client-Server Network:



Description:
This allows all files can be stored centrally so workers can access files from any computer and all computers can update the central database. Backups and software updates can also be implemented centrally. The server has sole responsibility.

Examples:
Your school

Peer-to-Peer Network:



Description:
In this network, files might be stored on their own computers or spread across many computers. This means each would need to perform their own backups and software updates. All devices on the network have equal responsibility.

Examples:
Your home

LAN

Description:
A LAN is a Local Area Network which is designed to cover a small geographical area and take ownership of hardware required to set it up.

Examples:
Your home
Your school

WAN

Description:
A WAN is a Wide Area Network which is designed to cover a large geographical area. It's usually made up of a series of LAN's

Examples:
Banks Internet
Mobile Phone Networks

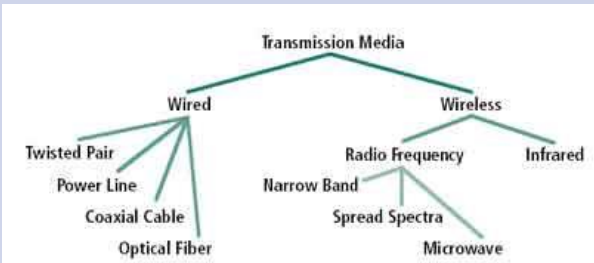
1.3.1 Networks and topologies

Network hardware

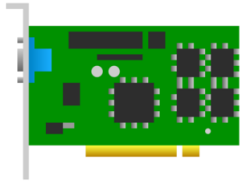
These are devices which are required for communication and interaction over a computer network.

Transmission Media:

Description:
This is the technology used to transmit data from sender to receiver, usually in the form of a cable. On the right are some common examples.



Examples:

Network Interface Controller (NIC)		All computers need one to connect to a network. It formats data sent to and received by the computer.
Router		To connect different networks together. It works by receiving data and inspecting it's IP address. Once it determines who the data is intended for, it is then forwarded to the correct network.
Hub		To connect all the devices together on a network. It's designed not to filter any data so when data arrives, it's sent to all the other devices on that network.

Examples:

Switch		They store the MAC addresses, which is a way of uniquely identifying a device on a network. So when data is sent to a switch, it's only redirected to the intended destination.
Wireless Access Point		These are used to connect cabled networks. They convert data received through cables into wireless signals.
Server		A piece of hardware that can store and share your files; share a single internet connection between all your devices.

1.3.1 Networks and topologies

What is the internet?

The Internet is a global network of networks while the Web, also referred formally as World Wide Web (www) is collection of information which is accessed via the Internet. The internet is an example of a WAN (Wide Area Network)

Domain Name System (DNS):

What is DNS?
It contains a database of domain names that allows users to look the IP address and its associated domain name.

Step 1:
User enters the domain name into the web browser.

Step 2:
Client contacts DNS to find domain name.

Step 3:
If the domain name doesn't exist, it will try a second server.

Step 4:
The second server finds the domain name and returns to first server.

Step 5:
The server returns the IP address to client.

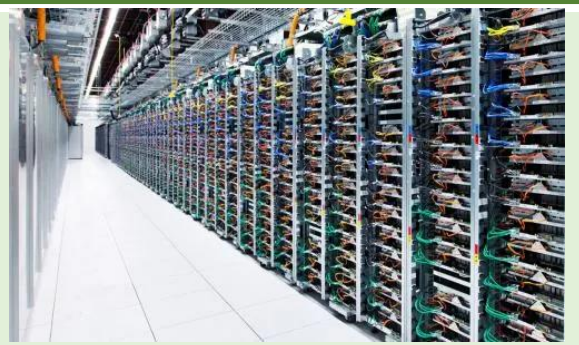
Step 6:
Client contacts the host using the IP address.

Cloud Computing:

What is Cloud Computing?
It's the delivery of computing services including: servers, storage, databases, networking, over the Internet

Pros	Cons
Data is backed up frequently and easy to recover.	Data is held offsite by a company you do not control.
You can extend the amount of available storage by varying how much you pay.	If your Internet connection fails, so does your access to remotely stored data.
Since your data is stored remotely you can access it whether you are in Manchester or Madrid.	Difficult to migrate data to another cloud provider later on.

Hosting



Description
Web hosting is a service that allows organisations and individuals to post a website or web page onto the Internet. They store the websites data on servers and provide the data when it is requested by the client (User trying to access the website)

1.3.1 Networks and topologies

What is a network topology?

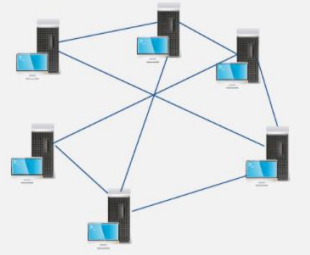
A network topology describes the structure of a network.

Did you know?

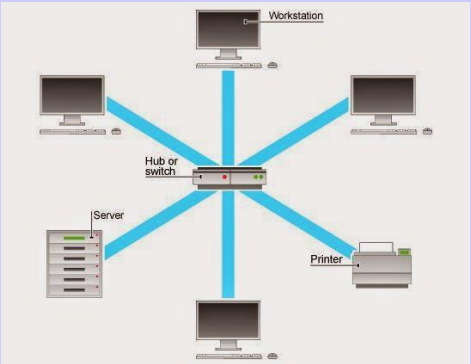
Bandwidth and Number of users to are two common causes for a drop in network performance. Bandwidth refers to the amount of data that can be transferred over a network in a given amount of time.

Partial Mesh:

Description:
In a partial mesh not all nodes are connected directly to each other. As you can see in the diagram.



Star Network

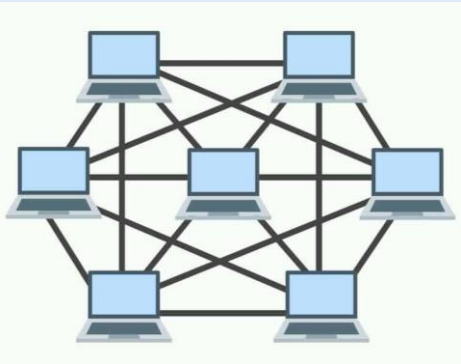


Description:
In a star network each device on the network has its own cable that connects to a switch or hub.

Examples:
Your school

Pros	Cons
If one cable or device fails to work then every device would still work because the server is still up and running.	If the server fails to work then no device can connect to the network until the server works.
Computers can be added or removed without disturbing the whole network.	

Mesh Network



Description:
In a mesh topology there is no central connection point. Instead, each node is connected to at least one other node and usually to more than one.

Examples: Traffic light control

Pros	Cons
Data should transmit quickly and reliably because there are so many routes the data can travel through.	It would require a lot of investment in the maintenance side.
New nodes can be added without interruption because everything is already interconnected.	Difficult to manage – cannot be maintained by one network manager.

1.3.2 Wired and wireless networks, protocols and layers

Purpose

All methods of communication need rules in place in order to pass on the message successfully. These sets of rules are called protocols. Network protocols are a set of rules that determine how data is transmitted over a network.

Packet switching

Step 1: Request processed by web server.

Step 2: Request put into packets.

Step 3: Packets given address & number.

Step 4: Packets sent across the network

Step 5: Packets received by host server.

Step 6: Have all packets arrived?

Step 7: If not – back to Step 4.

Step 8: If yes, packets put in order.

Layers

Application Layer HTTP, HTTPS, FTP, SMTP, POP, IMAP
Transport Layer TCP
Internet Layer IP
Data Link Layer Ethernet/Wi-Fi

Layers allows different protocols to be divided into different sections.
This is because each protocol performs a specific task.
It also means that when one layer needs to be changed, then the others remain interrupted.

Example:
If you request to use a website and the Wi-Fi is disconnected then it will fail to transmit the data. However, if the Wi-Fi reconnected then the request can be completed.

Protocols

HTTP	Data sent between web browser and server.
HTTPS	Data sent between web browser and server securely using encryption.
FTP	Transfer files between computers.
SMTP	To send emails.
POP	To retrieve/store emails on a device.
IMAP	To retrieve/store emails on a server.
TCP/IP	Data packets sent to the intended location.

1.3.2 Wired and wireless networks, protocols and layers

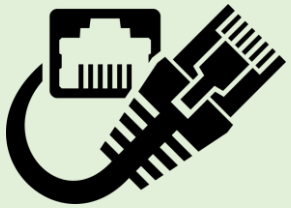
Modes of connection

Modes of connection refers to the way in which we choose to communicate over a network. This could be through a wired or wireless connection.

Wired technologies:

Ethernet cable:

The most common type of network cable used on a wired network whether at home or a small business.



Wireless technologies:

Wi-Fi:

Technology that allows a PC, laptop, mobile phone, or tablet device to connect at high speed to the internet without the need for a physical wired connection.

Bluetooth:

Bluetooth is a wireless technology that uses a radio frequency to share data over a short distance, eliminating the need for wires

Wired v Wireless

Wired	Wireless
Difficult to set up as cables would have to be run from the router to all rooms.	Easy to set up because all you need is a wireless router.
Installation is expensive	It's cheaper because you only need to buy the router.
Very fast bandwidth: 1 Gbps	Not as fast as wired but new technology is catching up.
Should not experience any interference.	Can be affected by walls, electronic equipment, distance from the router.
You have to unplug and re-connect if you wanted to use it elsewhere.	You can access the network from any room within a certain radius.

Did you know?

Wi-Fi operates over two frequency bands:

- 2.4 GHz – The standard which can transmit over long distances.
- 5 GHz – Can transmit data quicker than 2.4 but only over a shorter distance.

1.3.2 Wired and wireless networks, protocols and layers

Definition/Meaning:

Both MAC Address and IP Address are used to uniquely identify a machine on the internet.

Did you know?

NIC's (Network Interface Controllers) use MAC addresses to uniquely identify that device. This means if the network uses a switch, it can store the MAC address to ensure data goes the intended recipient.

IP Addressing

172.16.254.1

Properties:
IP addresses can be changed / are allocated as needed
IP(v4) addresses are 4 bytes long
IP(v4) addresses are normally written in denary
IP addresses are configured by software
IP addresses are used for routing across a WAN / internet

MAC Addressing

E4-BC-E9-8D-45-7A

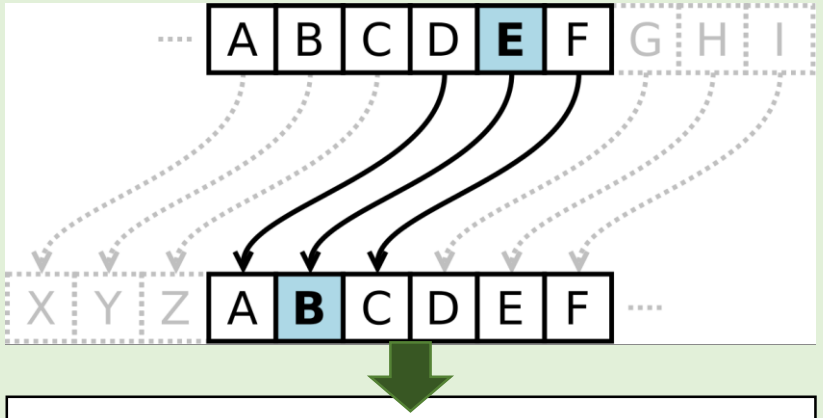
Properties:
MAC addresses can't be changed / every device has a fixed MC address
MAC addresses are 6 bytes long.
MAC addresses are normally written in Hex.
MAC addresses are configured in hardware.
MAC addresses are only used within the LAN

Encryption:

https://

Definition:

Encryption is an algorithm designed to scramble data into an unreadable form. This is to stop potential hackers intercepting the data over a network. This is because in order to decrypt the data into it's unreadable form, you would need a private key.



Example

Here there has been a shift to the left three times. So E is now B, D is now A and so on.

Encrypted websites include:

Banking, Shopping, Social media accounts. Anything that will store sensitive data.

1.4.1 Threats to computer systems and networks

Network threats:

Many attacks on networks use methods that bypass the users and target the network operating system and security..

What is SQL?

It stands for Structured Query Language and its code uses to create, access and maintain databases. A database allows you to store records that can be accessed, modified and deleted.

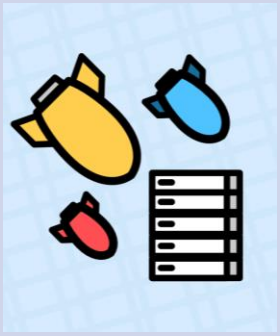
SQL Injection:

Definition:
This attack is used to interfere with queries that an application makes to its database in order to gain unauthorised access to users data.

Brute Force Attack:

Definition:
This method of attack requires very little 'specialist knowledge'. Hackers will use automated software to try millions of different password combinations. Therefore this can be referred to as a 'trial and error method'.

Distributed Denial of Service Attack:



Definition:
This method overloads the network by using bots to send useless requests to servers to a point in which is becomes flooded and unresponsive. These bots can be designed to perform malicious tasks such as stealing data.

Packet Sniffers:

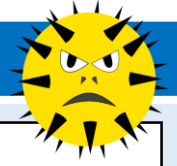
Definition:
This involves the use of packet analysers (packet sniffers)
These are used to intercept data packets on a network which are then analysed. Sensitive data such as login names, passwords and credit card numbers can be stolen.

1.4.1 Threats to computer systems and networks

What is Malware?

Short for malicious software, is a blanket term for viruses, worms, trojans and other harmful computer programs

Virus



Description:
A type of malware that can copy itself and spread to other users by attaching itself to other files.

Trojan

Description:
Enter users computer as a normal file or program and once downloaded, will perform malicious tasks.

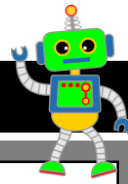
Adware

Description:
This is designed to provide users with advertisements in the form of pop-ups that redirect them elsewhere.

Worm

Description:
This needs user actions to spread it and as a result, can continue to spread, exploiting the network and consuming bandwidth.

Bot:



Description:
An automated type of malware used to perform DDOS attacks to get access to servers

Ransomware

Description:
Encrypts the user personal data using strong encryption methods and will demand a ransom to decrypt. This ransom will usually be in the form of a fee.

Spyware

Description:
Used to track users activity without their knowledge and might use key loggers to monitor actions taken by the user and gain personal information.

Rootkit

Description:
Created to provide remote access to a computer without detection. This can allow it to modify system settings and even install other types of malware.

1.4.2 Identifying and preventing vulnerabilities

Network threats:

All networks need to be protected to prevent unauthorised access to sensitive data. There are a range of strategies used to tackle this.

Physical security

Definition:
This could involve fitting alarms, using locks, keypads, biometric or CCTV.

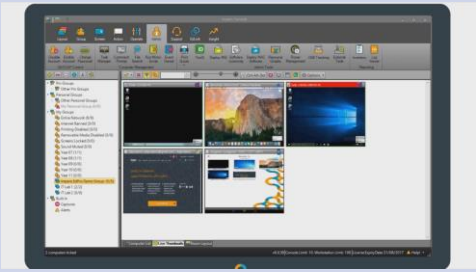
Strong passwords:

Definition:
A strong password would consist of upper and lower case letters, numbers and symbols.

Penetration testing:

Definition:
This used to test a computer system or a network to find vulnerabilities. Ethical hackers are employed to assess security and test users own awareness of security.

Network forensics:



Definition:
This monitors, records and analyses network events such as: who has logged on, when, how many unsuccessful login attempts, user activity and what has been deleted/modified.

User measures:

Definition:
User access levels to determine the rights users have with regards to the data they have access to. (e.g. some files might only be read-only for certain users)

Anti-malware software:

Definition:
A computer program used to prevent, detect, and remove malware.

Did you know?

Encryption and Firewall are two common methods used to identify and prevent attacks. You can read more about these in **1.5.2 Utility Software.**
In addition to this, organisations can put network policies in place to educate employees on how to use the network.

1.5.1 Operating Systems

Definition/Meaning

Systems Software comprises of two parts: Operating System and Utility Software.
The purpose of the operating system is to provide an interface that will allow the user to interact with the computer. Below are some popular examples of operating systems we use today.



User interface:

Description:

The user interface is design to provide a platform that will allow the user to interact with the computer.

Examples:

GUI – Graphical User Interface
Command Line Interface
Natural Language Interface
WIMP – Windows, Menus, Icons and Pointers.

User management:

Description:

To allow administrator to manage users access to a variety of resources such as devices, settings, applications etc.

Examples:

At school you will see three typical levels of access: Administration, Staff and Students. For example, students won't be able to download software because they don't have the rights.

Memory management:

Description:

It will manage data by allocating memory to applications currently in use. As a result, this allows multitasking to take place.

Examples:

It assigns portions called blocks to various running programs to optimise overall system performance. These could either be physical divisions (paging) or logical divisions (segmentation)

Peripheral device management

Description:

It allows the operating system to control how the peripheral devices function and they do this by using device drivers.

Examples:

If you wanted to connect a new mouse then you plug it in via the USB port, the device will install a driver onto the computer so it they can communicate.

File Management

Description:

The purpose is to create a logical structure in which files can be stored to make it easier for the user to locate.

Examples:

It allows you to create new files/folders, re-name, delete, password-protect, move and compress them. It also allows you to create shortcuts to go onto your desktop.

1.5.2 Utility Systems Software

Definition/Meaning

Systems Software comprises of two parts: Operating System and Utility Software.
The purpose of the utility software is to maintain and optimise the performance of the computer.

Exam tip

Learn the mnemonic ABCDEF.
A = Anti-virus
B = Backup
C = Compression
D = Defragmentation
E = Encryption
F = Firewall

Backup methods:

There are two common types of backup methods:
Incremental – Only backs up files changed since the last backup.
Full – Creates a backup for all files regardless.

Anti-virus

Purpose:
It is designed to protect your computer from viruses that can infect your computer or steal confidential data.

Backup

Purpose:
Designed to create duplicate copies of files so they can be distributed or retrieved in the case of data loss.

Compression

Purpose:
It is designed to reduce the size of one or more files in order to take up less disk space.

Defragmentation

Purpose:
Data is divided into multiple chunks of data that are stored on the hard drive. This means they're not grouped together.

Encryption

Purpose:
Designed to make data unreadable to users that should have no access to this information

Firewall

Purpose:
Firewall software monitors what data is attempting to enter your computer or network.

Alternative examples of utility software include:

System Monitor Registry Cleaner Disk Clean-up Debugger Disk Partition Editors

1.6.1 Ethical, legal, cultural and environmental impact

Legislation

Many countries have created legislation or have passed laws about the use of computers and data to protect data about people; Hacking computer systems; Protecting copyright and patents.

Copyright

Copyright is the legal right to protect the original work of the people whom it may belong to.

Copyright can protect….

- Books
- Music
- Art
- Images
- Sound
- Software

Data Protection Act

Purpose:
It controls how your personal information is used by organisations, businesses or the government.

Freedom of Information

Purpose:
An act that gives individuals and organisations the right to request official information held by public authorities.

Computer Misuse Act

Purpose:
An act to make provision for securing computer material against unauthorised access or modification; and for connected purposes.

Creative Commons License

This license was developed to allow copyrighted material to be more freely distributed.

Attribution: Material can be copied, modified and used. However, the original creator must be given credit.

Non-commercial: Material can be copied, modified and used as long as there is no intention to make money from it.

No derivative works: Material can be copied and use but it cannot be modified.

Share-a-like: Material can be modified and used but must be covered by a similar license.

1.6.1 Ethical, legal, cultural and environmental impact

Software licenses:

Proprietary software is software that is owned by one person/organisation and they have exclusive control over it. Open-source software allows users to access the source code and modify the software to meet their needs.

Source code

Definition:
The part of software that most computer users don't ever see; it's the code computer programmers can manipulate to change how a piece of software works.

Open-source v Proprietary Software

Open-source	Proprietary
Very little professional and technical support and no user manuals to troubleshoot.	Professional and technical support available. User manuals provided for troubleshooting.
Reliable as there are community of users constantly creating updated versions.	Stable product that will contain regular updates to automatically fix any bugs.
There are very little or no upfront costs.	Can be costly to buy a license.
Source code can be viewed, shared and modified.	Source code cannot be modified.

Did you know?

Licensed software that can be used at no extra cost is known as Freeware. Users also have the option to pay an optional fee if they wish.

Examples:

Examples of Proprietary Software:
Windows, Adobe Web Premium, Microsoft Office, Internet Explorer.

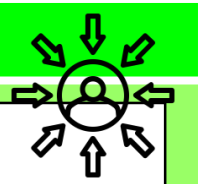
Examples of Open-source Software:
Linux, WordPress, Mozilla Firefox, Open Office

1.6.1 Ethical, legal, cultural and environmental impact

Impacts of digital technology on wider society:

Technology affects the way individuals communicate, learn, and think. It helps society and determines how people interact with each other on a daily basis.

Stakeholders:



Description:

A stakeholder is a person with an interest or concern in something, especially a business. Examples include:

- Customers
- Businesses
- Local communities
- Government
- Managers
- Shareholders

Cultural issues:

Online services:

Online sales as a proportion of all retailing reached a record high of 22.3% in March 2020 as consumers switched to online purchasing following the pandemic. It's changed the way we shop, bank, game and access news.

Remote working

It's change the way we work and how we receive our education.

Environmental issues:

E-Waste:

Old computer equipment ends up as electronic waste that goes to landfill sites.

Energy consumption:

Devices need charging, servers need to run 24/7 and this means more electricity is being used.

Recycling:

It creates more opportunities to upcycle old devices and sell them as refurbs.

Ethical issues:

Digital divide:

This is the gap between people who have access to technology to those that don't. The common cause for this is diverse levels of disposable income.

Privacy issues:

GPS Tracking:

Our movements can be detected through the location settings on our phones and nearby phone masts can track phone calls.

Surveillance

The increasing need to use CCTV to monitor everyday activity. Some people will welcome this as it aims to keep communities safe. However, some people would argue it's an invasion of privacy.