ALevel CS C01 Information representation

Hexadecimal	Denary	Octonary	Binary
F	15	17	1111
E	14	16	1110
D	13	15	1101
C	12	14	1100
B	11	13	1011
A	10	12	1010
9	9	11	1001
8	8	10	1000
7	7	7	0111
6	6	6	0110
5	5	5	0101
4	4	4	0100
3	3	3	0011
2	2	2	0010
1	1	1	0001
0	0	0	0000

Binary to Denary

1	0	1	1	1
2^4	2^3	2^2	2^1	2^0

$1\times2^4+0\times2^3+1\times2^2+1\times2^1+1\times2^0 = 23$

Octonary to Denary

3	2	0	7
8^3	8^2	8^1	8^0

$3\times8^3+2\times8^2+0\times8^1+7\times8^0 = 1671$

Hexadecimal to Denary

3	A	F
16^2	16^1	16^0

$3\times16^2+10\times16^1+15\times16^0 = 943$

Denary to Binary

2 | 59 → 1
2 | 29 → 1
2 | 14 → 0
2 | 7 → 1
2 | 3 → 1
2 | 1 → 1
0

59 ~ 111011

Denary to Octonary

8 | 1671 → 7
8 | 208 → 0
8 | 26 → 2
8 | 3 → 3
0

1671 ~ 3207

Denary to Hexadecimal

16 | 943 → 15~F
16 | 58 → 10~A
16 | 3 → 3
0

943 ~ 3AF

Binary Add

```
  1 0 1 1 1 0 1 0  186
+ 1 1 1 0 1 1 0 1  237
  1 1 1 1 1 0 0 0
1 1 0 1 0 0 1 1 1  423
```

Overflow:
a condition when the result of a calculation is too large to fit into the number of bits defined for storage

Denaty to Octonary

1	0	1	1	1	1	0	1

binary: 10111101

2	7	5

octonary: 275

Denary to Hexadecimal

1	0	1	1	1	1	0	1

binary: 10111101

C	E

octonary: 275

HTML Color

#FFFFFF #333333 #FF00000 #00FF00 #0000FF #00FFFF #9324FC

color depth: the number of bits used to represent each color
black and white, **1bit** per pixel
4 color, **2 bits** per pixel
8 color, **3 bits** per pixel
Image resolution: the number of pixels that make up an image.
400*600 pixels
file size 400 * 600 image, RGB 3 * 16 * 16 color depth :
400 * 600 * 3 * ($\log_2256$) bits
= 240000 * 3 * 8 bits = 720000 byte
= 720000 / 1024 kB = 703 kB
= 703 / 1024 MB = 0.68MB

	R	G	B	range
hexadecimal	93	24	FC	00~FF
denary	147	35	252	0~255
binary	10010101	00100100	11111100	

Calculation of file size:
image file size:
image resolution(in pixels) * colour depth (in bits)
sound file size:
sample rate(in HZ) * sample resolution (in bits) * length of sample (in seconds)

Decimal prefix

Decimal prefix name	Symbol Used	Factor applied to the value
kilo	k	10^3
mega	M	10^6
giga	G	10^9
tera	T	10^{12}

Binary prefix

Binary prefix name	Symbol used	Factor value
bit	b	1 bit
nibble		4 bits
byte	B	8 bits
kibi byte	KiB	1024 B
mebi byte	MiB	1024 KiB
gibi byte	GiB	1024 MiB
tebi byte	TiB	1024 TiB

Denary: + 21
Binary: (signed)

0	0	0	1	0	1	0	1

One's complement: the binary number obtain by subtracting each digit in a binary number

0	1	1	0	1	0	1	0

Two's complement: the one's complement of a binary number, plus 1

0	1	1	0	1	0	1	1

BCD (Binary Code Decimal): use a nibble to represent a denary digit

0.26	0000 0000	0010 0110
0.85	0000 0000	+ 1000 0101
1.11	0000 0001	0001 0001

Usage:
1.on a screen of a calculator.
2. digital time display.

ASCII and Unicode

Standard ASCII code: character set consists of 7-bits codes
Extended ASCII: use 8 bit codes give another 128 codes to allow for non-English alphabets.
Unicode: represent any possible text in code form.
UTF-8: the most popular version of unicode.

Given:	Ask:	Answer:
Hex ~ 41	D	D Hex ~ 44 Denary ~ 64
A	G	G Hex ~ 47 Denary ~ 67

Image (Vector)

Vector graphic: a graphic consisting of drawing objects defined in a drawing list
Drawing list: contains one set of values for each drawing object
Drawing object: a component defined by geometric formulae and associated properties
Property: defines one aspect of the appearance of the drawing object

Vector and Bitmap Usage:

1. **vector** - part of an architectural, engineering or manufacturing design
2. **bitmap** - printer, digital camera. publication, web page

difference	
Vector	Bitmap
made of shapes	made of pixel
scalable without losing quality	loss quality when resized larger

Image (Bitmaps)

Picture element(Pixel): the **smallest identifiable component** of a bitmap image, defined by just two properties: its position in the bitmap matrix and its colour
Color depth: the number of bits used to represent one pixel
Bit depth: the number of bits used to represent each of the red, green and blue colours
Image resolution: the number of pixels in the bitmap file defined as the product of the width and the height values
Screen resolution: the product of width and height values for the number of pixel that the screen can display
File header: a set of bytes at the beginning of a bitmap file which identifies the file and contains information about the coding used
Bitmap file size is **larger than** the size of the graphic along because of the file header. The file header will define the **colour depth and the resolution**

Sound File

Analogue data: data obtained by measurement of a physical property which can have any value from a continuous range of values
Digital data: data that has been stored as a binary value which can have one of a discrete range of values
Sampling: taking measurements at regular intervals and storing the value
Sampling resolution: the number of bits used to store each sample
Sampling rate: the number of samples taken per second
An increased sampling rate and an increased sampling resolution will both cause an increase in file size and accurate representation.

aaaaaaaabbbbbbcc
↓ run-length encoding
a8b6c2

huffman coding

Code	Character
10	e
01	t
111	o
110	h
0001	l
0000	p
0011	w
0010	z

Compression

Lossless compression: coding techniques that allow subsequent decoding to recreate exactly the original file
Lossy compression: coding techniques that cause some information to be lost so that the exact original file cannot be recovered in subsequent decoding
Practice:
vector - text file - lossless
bitmap - bit file - lossy(reduce colour depth) or lossless
sound - bit file - lossy(lower sample resolutuib, time domain to frequency domain) or lossless

ALevel CS C02 Network (1)

WAN(Wide area network): a network connecting computers **on different sites**, possibly thousands of kilometers apart

WAN benefits:

1. a 'job' could be run on a remote computer that had the required application software
2. a data archive that was stored on a remote computer could be accessed
3. a message could be transmitted electronically to a user on a remote computer.

WAN feature:

1. It will be used by an organisation or a company to connect sites or branches.
2. It will not be owned by the organisation or company.
3. It will be leased from a public switched telephone network company (PSTN).
4. A dedicated communication link will be provided by the PSTN.
5. The transmission medium will be fibre-optic cable.
6. Transmission within the WAN will be from switch to switch.
7. A switch will connect the WAN to each site.
8. There will not be any end-systems connected directly to the WAN.

LAN(Local area network): a network connecting computers **in a single room**, in a single building or on a single site

LAN benefits:

1. The expense of installing application software on each individual PC could be saved by installing the software on an application server attached to the LAN instead.
2. A file server could be attached to the LAN that allowed users to store larger files and also allowed files to be shared between users.
3. Instead of supplying individual printers to be connected to a user's PC, one or more printers could be attached to a print server that was connected to the LAN; these could be higher quality printers.
4. Managers in organisations could use electronic mail to communicate with staff rather than sending round memos on paper.
5. The 'paper-less office' became a possibility, where files were to be stored in digital form on a file server rather than as paper copies in a filing cabinet.

LAN features:

1. It will be used by an organisation or a company within a site or branch.
2. It will be owned by the organisation or company.
3. It will be one of many individual LANS at one site.
4. The transmission medium will be twisted pair cable or WiFi.
5. The LAN will contain a device that allows connection to other networks.
6. There will be end-systems connected which will be user systems or servers.

Data sent through the medium models:

1. **simplex mode** where data flow is one-way only
2. **half duplex** where data can flow either way but not simultaneously
3. **full duplex** where simultaneous both-ways data flow is possible.

Message sent type:

1. a **broadcast**, which is a one-to-all communication (as used traditionally for radio and television)
2. a **multicast**, which is from one source to many destinations
3. a **unicast**, which is a one-to-one communication.

Network topology:

the configuration of a network that defines how the various devices on the network are connected

point-to-point topology: a **dedicated** link (simplex or duplex, unicast)

bus topology: only one link but it is shared by a number of end-systems and is therefore described as a **multi-point connection**. A message must therefore be **broadcast** even though it might only be intended for one end-system.

The topology is **resilient** because a fault in an end-system or in the link to it does not affect the use of the network by the other end-systems.

mesh topology: has a point-to-point connection to each of the other end-systems. (duplex, unicast or multicast or broadcast)

star-topology: each end-system is linked to a center device. (duplex, message from center is unicast, multicast or broadcast)

The most important is that the central device can be used to connect the network to other networks and, in particular, to the Internet.

hybrid network: a collection of connected LANs where some of them have different topologies or supporting technologies

Client Server: an architecture where a client runs an application provided by a server on a network

Thin-client: a client that only provides input and receives output from the application

role of thin-client:

1. chooses an application provided by the server
2. possibly carries out some processing before running the application on the server and also after receiving output from the application
3. alternatively, possibly downloads the application from the server and runs the application itself.

Thick-client: a client that carries out at least some of the processing itself

role of thick-client:

1. The server stores a database which is accessed from the client system.
2. The server stores a web application which allows the client system to find or, sometimes, supply information.
3. The server stores a web application which allows the client system to carry out an e-commerce or financial transaction.

factors	thin clients	thick clients
Installation	browser base installation	installed locally
type of devices	used by handeld devices	Customization system use thick clients
processing type	complete processing on server side	use computer resources more than server
Deployability	easily deployable	more expensive
data validation	data verification is required from server	data verification is done by client

File sharing:

File sharing method:

1. client-server model: a user uploads files to the server, another user downloaded these from the server
2. peer-to-peer network: Each peer can therefore act as a client and request a file from another peer or it can act as a server when another peer requests the download of a file.

Peer-to-peer feature:

1. All computers are of equal status
2. Each computer provides access to resources and data
3. Computers can communicate and share resources
4. Each computer is responsible for its own security

Peer-to-peer advantages:

1. it avoids the possibility of congestion on the network when many clients are simultaneously attempting to download files
2. parts of a file can be downloaded separately
3. the parts are available from more than one host.

Peer-to-peer drawback:

1. Reduced security, no center management of security
2. No central management of backup
3. No central management of files
4. Individual computer may respond slower
5. In order to share files. all the computers involved need to be switched on

Client-server model advantages:

1. It allows an organisation to control the downloading and use of files.
2. The files can be better protected from malware attacks because the files are stored on one server which will be regularly scanned using appropriate anti-virus soft ware.

ALevel CS C02 Network (2)

Cable: a transmission using copper wire or fibre-optic
Bandwidth: a measure of the amount of data that can be transmitted per second

	Twisted pair	Coaxial	Fibre-optic
Cost	Lowest	Higher	Hightest
Bandwidth or data rate	Lowest	Higher	Much higher
Attenuation at high frequency	Affected	Most affected	Least affected
Interference	Worst affected	Less affected	Least affected
Need for repeaters	More often	More often	Less often

Wireless: a transmission using radio, microwave or infrared
Benefits of using wireless:
1. less hard-wiring, reduce cost
2. User and computers can be mobile, can be accessed from anywhere within range of access point
3. more straightforward to connect other devices, no need physically connect

Drawback of using wireless:
1. Transmission may be less secure
2. Bandwidth may be limited
3. It is subject to interference from other signals or obstacles
4. Limited range
5. Higher latency

Satellite network:
A satellite can act as a component in a network and can directly connect with ground-based components. These ground-based components can be much further apart than in a network with no satellites.
The disadvantage of satellites is that the greater transmission distance causes transmission delays, which can cause technical problems for the network.
The use of satellites in networks tends to be for specialised applications such as the Global Positioning System (GPS) or for Internet use in remote locations.

ISP(Internet service provider): give Internet access to an individual or company.
Router: a device that acts as a node on the internet
function: Each router is connected to several other routers and its function is to choose the best route for a transmission.
PSTN(public switched telephone network):
digital data could be transmitted provided that a modem was used to convert the digital data to analogue signals.Another modem was used to reverse the process at the receiving end. Such so-called 'dial-up' connections provided modest-speed, shared access when required.
PSTN Service:
the PSTNs have upgraded their main communication lines to fibre-optic cable employing digital technology. two service:
1. a broadband network connection for traditional network access.
2. WiFi hotspot technology, where an access point has a connection to a wired network providing Internet access.

Cell phone network: For users of devices with mobile (cell) phone capability

Bit streaming: before data is transmitted it is stored in bytes which can be transmitted one after the other as a 'byte stream'. Because of the file sizes involved, streamed media is always compressed to a sequence of bits - a 'bit stream'.
on demand: In this case the delivery of the media and the playing of the media are two separate processes. The incoming media data are received into a buffer created on the user's computer. The user's machine has media player software that takes the media data from the buffer and plays it.
real-time(live transmission):the content is being generated as it is being delivered such as when viewing a sporting event.
bit rate: The process of delivering the content is determined by the bit rate. example 300kbps or 128kbps

Wired Lans:
Server: a system **providing a service** to end-systems
Repeater: a device that connects two cables and provides a full-strength signal to the second cable
Bridge: a device that **connects two segments of a LAN**
Network Interface Card (NIC): a component used to identify the end-system
Switch: a connecting device that can send a unicast message
Wireless Lans:
Wireless Access Point (WAP): the connecting device in a WiFi LAN
Wireless Network Interface Card (WNIC): provides the NIC function in a WiFi LAN

Ethernet:
collision: If two end-systems were to transmit messages at the same time there would be what is described as a 'collision'.
CSMA/CD(Carrier sense multiple access with collision detection): if a message was being transmitted there was a voltage level on the Ethernet cable which could be detected by an end-system
CSMA/CD step:
1. Check the voltage on the transmission medium.
2. If this indicates activity, wait a random time before checking again.
3. If no activity is detected, start transmission.
4. Continuously check for a collision.
5. If no collision is detected, continue transmission.
6. If a collision is detected, stop transmission of the message and transmit a jamming signal to warn all end-stations; after a random time, try again.

Although there might be some legacy Ethernet LANs still operating, modern Ethernet is switched.Since collisions are now impossible, CSMA/CD is no longer needed.

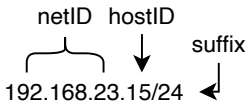
WWW(World wide web): a distributed application which is available on the internet.
the web the web consists of an **enormous collection of websites** each having one or more web pages.
The special feature of a web page is that it can contain **hyperlinks** which, when clicked, give direct and essentially immediate access to other web pages.
Cloud computing: provision of computing services usually via the internet.
Private cloud: owned by and only accessed by an organisation
1. The organisation takes full responsibility for creating and managing the cloud installed on-site and connected to a private network
2. The organisation outsources to a third-party the creation and management of an on-site installation connected to a private network
3. The organisation outsources the creation and management of an Internet accessible system by a third-party.

Public cloud: owned by a cloud service provider for general access
Cloud advantages:
1. For the infrastructure provision, the advantages include the better performance when running software and the increased storage capacity.
2. For the platform provision, the cloud can offer facilities for software development and testing.
3. For the software provision, the cloud will be able to run applications that require high performance systems. Alternatively, it could be that the costs to a company of buying and installing a software package themselves would be far too high.
4. Regard to outsourcing. The cloud user no longer needs technical expertise.
5. Can access data from any computer with internet access
6. Data can be easily shared
7. Can easily increase capacity

Cloud disadvantages:
1. The cloud service provider has complete access to all of the data stored on the cloud. The cloud user cannot be sure that their data is not being shared with third-parties.
2. The cloud service provider is being relied on to ensure data cannot be lost.
3. Can only access with internet access
4. It can take long time to upload/download the data
5. It can be more expensive in the long term

ALevel CS C02 Network (3)

IPv4 addressing: a **32-bit** long, hierarchical address of a device on the Internet
The original addressing scheme was designed on the basis of a hierarchical address with a group of bits defining a network (a **netID**) and another group of bits defining a host on that network (a **hostID**).
CIDR(Classless inter-domain routing)： CIDR retains the concept of a netID and a hostID but removes the rigid structure and allows the split between the netID and the hostID to be varied to suit individual need.



Sub-netting:
On the Internet, all of the allocated IP addresses have a netID pointing to the router. The router then has to interpret the hostID to direct the transmission to the appropriate workstations on one of the LANS via a gateway.
NAT(Network address translation):
Sub-routing deviates from the principle that every IP address should be unique.
The solution for dealing with the addressing is to use network address translation (NAT)
The NAT box has one IP address which is visible over the Internet and so can be used as a sending address or as a receiving address.
Difference between public IP address and private Ip address:
1. Private Ip is only known within the LAN, public IP is known outside of the LAN
2. public is allocated by ISP, private is allocated by the router
3. public address are unique throughout the internet, private addresses are unique only within the LAN
4. private IP addresses are more secure than public IP address
Dynamic IP address: The ISP will have available a large number of hostIDs. However, the number of users that the ISP is supporting could very likely be larger than the total number of addresses available. Fortunately for the ISP and for an individual user many of these potential users will not be engaged in Internet interaction. The normal practice is for the ISP to create a 'dynamic address' for a user.
Static IP address:The alternative is a 'static address' which never changes and can be provided if a user is prepared to pay an extra charge.
IPv6 addressing: IP version 6 (IPv6) uses a 128bit addressing scheme allowing 2 128different addresses
Difference between static IP address and Dynamic IP address:
1. static Ip address is provided by ISP, dynamic IP address is provided by DHCP
2. static IP does not change any time. dynamic IP change any time
3. static IP is less secure
4. the cost to maintain the static ip is high than dynamic ip
5. static ip is more stable than dynamic ip

IPv6 addressing:
1. use a 128-bit addressing scheme.
2. Documenting these addresses is going to be difficult.
2. The address is **written in a colon hexadecimal notation**.
4. The code is broken into 16-bit parts, with each part represented by four hexadecimal characters.
Difference between IPv4 and IPv6:
1. IPv4 has 4 group of digits, IPv6 has 8 groups of digits
2. In IPv4 each group is from 0-255, in IPv6 each group is from 0-65536
3. IPv4 use a full-stop between each group, IPv6 use a colon between each group
4. IPv4 is **32-bits**, IPv6 is **128-bits**

IPv6 address	comment
63E3:43D3:FFFE:FFFF:3221:1A2D:3434:FF01	A full address
72E6::CFEE:3D21:1190:231A:FF01	:0000:0000 has been replaced by ::
6C48:23:FFFE:FFFF:3D23:1190:95A:FF01	leading zeros ommitted
::192.31.23.12	An IPv4 address used in IPv6

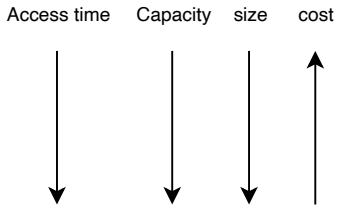
Domain name service (DNS): a hierarchical distributed database installed on domain name servers that is responsible for mapping a domain name to an IP address. Also known as domain name system.
The domain name service (DNS) service allocates readable domain names for Internet hosts and provides a system for finding the IP address for an individual domain name.
There are more than 250 top-level domains which are either generic (e.g. .com, .edu, and .gov) or represent countries (e.g. .uk and .nl).
The domain name is included in a universal resource locator (URL), which identifies a web page, or an email address.
name resolution:
1. If the domain is under the control of the server to which the query is sent then an authoritative and correct IP address is returned.
2. If the domain is not under the control of the server, an IP address can still be returned if it is stored in a cache of recently requested addresses but it might be out of date.
3. If the domain in the query is remote then the query is sent to a root server which can provide an address for the name server of the appropriate top-level domain. This in turn can provide the address for the name server in the next lower domain. This continues until the query reaches a name server that can provide an authoritative IP address.
DNS translate IP address step:
1. URL is parsed to obtain the Domain name
2. Domain name is sent to the nearest Domain Name Server (DNS)
3. DNS holds a list of Domain names and matching IP addresses
4. DNS name resolver searches its database for the Domain name
5. If DNS does not find the Domain name, the request is forwarded to a higher level DNS
6. If the Domain name is found, the IP address is returned
7. If the Domain name is not found, the request is passed to a higher level server
8. If the Domain name is finally not found, an error message is generated

ALevel CS C03 Hardware(1)

Computer three major area of operation capability:
1. the processing of data
2. the storage of data
3. the input and output of data

Data Storage:

Component	Category
Register	Processor component
Cache memory	Primary storage
Main memory	Primary storage
Hard disk	Secondary storage
Auxiliary storage	Secondary storage



Choosing a storage medium:

integral part of the system, which the user cannot normally get access	hard disk solid-state drive
individual item, can be inserted into a drive	floppy disk optical disc magnetic tape cartridge
peripheral device, can be connected to the system when needed	hard drive memory stick memory card
portable item, can carry around with them for attaching to different systems	flash memory stick floppy disk optical disc
remote from the system, possibly accessible via a network connection;	cloud storage magnetic tape RAID SAN

Primary memory

RAM:
1. SRAM
2. DRAM

ROM
1. PROM
2. EPROM
3. EEPROM

Secondary storage

hard disk driver(HDD)

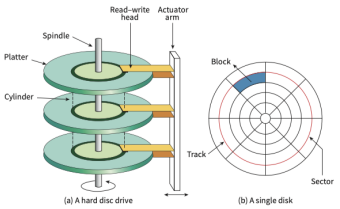
solid state driver(SSD)

removable devices
1. DVD/CD/Blu-ray
2. flash memory stick
3. hard disk driver

Data output:
1. screen display
2. hardcopy using a printer or plotter
3. virtual headset display
4. a speaker
5. writing to any of the data storage devices described earlier
6. transmission on a network link.

Data input:
1. keyboard or keypad entry by a user
2. user interaction with a screen using screen icons or menus; possibly using a pointing device and possibly involving the use of a touch screen
3. a user using a game controller
4. a user using a scanner
5. a user using a microphone in tandem with voice recognition software
6. reading from any of the storage devices described earlier
7. transmission on a network link.

Magnetic media:
For either type of magnetic medium the interaction with it is controlled by a read head and a write head.



1. there is more than one **platter** (**disk**)
2. each platter has a **read–write head** for each side
3. the platters **spin in unison (all together and at the same speed)**
4. the **read–write heads** are attached to **actuator arms** which allow the heads to move over the surfaces of the platters
5. the motion of each read–write head is synchronised with the motion of the other heads
6. a **cushion of air** ensures that a head does not touch a platter surface.

Embedded System:
An embedded system must still contain a processor, memory and an I/O capability.
If these are constructed on one chip this is called a **microcontroller**.

advantage:
1. they are special-purpose, possibly performing only a single function.
2. Mass production of an embedded system brings economies of scale

disadvantage:
1. programming was difficult because the memory space available to store a program was limited.
2. if errors were found following installation then new chips had to be manufactured and used to replace the faulty ones.

Random-access memory(RAM): volatile memory that can be read from or written to any number of times

RAM feature:
1. **direct-access memory**: any byte of data stored can be accessed without affecting the other bytes stored.
2. **read–write memory**: RAM can be repeatedly read from or written to.
3. **volatile**: when the computer system is switched off the contents of the memory are lost.

Dynamic RAM(DRAM): constructed from capacitors that leak electricity and therefore need regularly recharging (every few milliseconds) to maintain the identity of the data stored.

Static RAM(SRAM): constructed from flip-flops that continue to store data indefinitely while the computer system is switched on.

Basis for comparison	SRAM	DRAM
Speed	Faster	Slower
Size	Small	Large
Cost	Expensive	Cheap
Used in	Cache memory	Main memory
Density	less dense	highly dense
Construction	Complex	Simple, few transistors
power consumption	Low	High

Read-only memory (ROM): non-volatile memory that cannot be written to but can be read from any number of times

ROM feature:
1. **read-only**: cannot be written to when in use within the computer system.
2. **non-volatile**: not lost when the computer system is switched off

ROM usage:
1. storing the bootstrap program

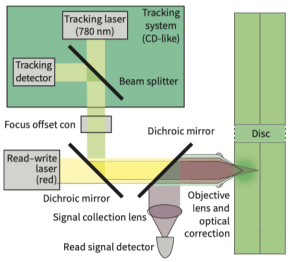
Four different types of ROM:
1. **simplest type of ROM**: programs or data are installed as part of the manufacturing process. If different contents are needed the chip must be replaced.
2. **Programmable ROM(PROM)**: The system builder installs the program or data into the chips. the program or data once installed cannot be changed.
3. **Erasable PROM (EPROM)**: The installed data or program can be erased (using ultraviolet light) and new data or a new program can be installed. However, this reprogramming usually requires the chip to be removed from the circuit.
4. **Electrically Erasable PROM (EEPROM)**: an electrical signal can be used to remove existing data. This has the major advantage that the chip can remain in the circuit while the contents are changed. However, the chip is still used as read-only.

Buffer: a temporary storage created for data transmitted from one part of the system to another which functions as a queue

DRAM	SRAM
1. consists of a number of transistors and capacitors 2. needs to be **constantly refreshed** 3. **less expensive** to manufacture than SRAM 4. has a **higher memory** capacity than SRAM 5. **main memory** is constructed from DRAM 6. consumes **more power** than SRAM under reasonable levels of access, as it needs to be constantly refreshed	1. uses flip-flops to hold each bit of memory 2. does not need to be constantly refreshed 3. has a **faster data access** time than DRAM 4. **processor memory cache** makes use of SRAM 5. if accessed at a high frequency, power usage can exceed that of DRAM

ALevel CS C03 Hardware(2)

Optical media:
feature for the process of reading data from the disc:



1. The optical disc has one spiral track running from the inner extreme of the surface to the outer edge.
2. During operation, the disc spins.
3. Simultaneously the laser moves across ensuring that it is continuously focused on the spiral track.
4. The track on the surface of the disc has what are referred to as 'pits' and 'lands'.
5. The laser beam is reflected from the surface of the disc.
6. The difference between the reflection from a pit compared to that from a land can be detected.
7. This difference in the intensity of the light the detector receives can be interpreted as either a 1 or a 0 to allow a binary code to be read from the disc.

Laser printers: used to produce working, solid objects. The solid object is built up layer by layer using materials such as powdered resin, powdered metal, paper or ceramic.

Colour laser printers use four toner cartridges – blue, cyan, magenta and black.
1. data from the document is sent to a **printer driver**
2. printer driver ensures that the data is in a format that the chosen printer can understand
3. check is made by the printer driver to ensure that the chosen printer is available to print
4. data is sent to the printer and stored in a temporary memory known as a **printer buffer**
5. **printing drum given a positive charge.** As this drum rotates, a laser beam scans across it removing the positive charge in certain areas, leaving negatively charged areas which exactly match the text/images of the page to be printed
6. **drum is coated with positively charged toner** (powdered ink). Since the toner is positively charged, it **only sticks to the negatively charged parts of the drum**
7. negatively charged sheet of paper is rolled over the drum
8. **toner on the drum sticks to the paper** to produce an exact copy of the page sent to the printer
9. to prevent the paper sticking to the drum, the electric charge on the paper is removed after one rotation of the drum
10. the paper goes through a **fuser (a set of heated rollers)**, where the heat melts the ink so that it fixes permanently to the paper
11. a discharge lamp removes all the electric charge from the drum so it is ready to print the next page

Screens: LCD, LED, OLED(organic light emitting diode)
OLED does not need back light. LCD needs back light.
OLED allows for very thin screens
Screen displays are based on the **pixel** (the smallest picture element) concept where each screen pixel is **made up of three sub-pixels, which are red, green and blue.**
The greater the number of pixels on a screen, the greater is the **screen resolution**
Touch screen: Capacitive and Resistive
Capacitive: a rigid surface above a conductive layer that undergoes a change in electrical state when a finger touches the screen
Capacitive benefits:
1. Medium **cost technology**.
2. Screen visibility is good even in strong sunlight.
3. Permits **multi-touch capability**.
4. Screen is very **durable**; it takes a major impact to break the glass.

Capacitive drawbacks:
1. Only allows use of bare fingers as the form of input; although the latest screens permit the use of a special stylus to be used.

Resistive:a flexible surface that causes contact between electrically resistive layers beneath when touched
Resistive benefits:
1. Relatively **inexpensive** technology.
2. Possible to use bare fingers, gloved fingers or stylus to carry out an input operation.

Resistive drawbacks:
1. Screen **visibility is poor in strong sunlight.**
2. Does **not permit multi-touch capability.**
3. Screen durability is only fair; it is vulnerable to scratches and the screen wears out through time.

Solid-state media: no moving parts and all data is retrieved at the same rate. **flash memory(use NAND)** and **EEPROM(use NOR)**.
1. are **more reliable** (no moving parts to go wrong)
2. are considerably lighter (which makes them suitable for laptops)
3. do not have to 'get up to speed' before they work properly
4. have a lower power consumption
5. run **much cooler** than HDDs (both these points again make them very suitable for laptop computers)
6. are very **thin** (because they have no moving parts)
7.access data considerably faster.

Inkjet printers:
Inkjet printers are made up of:
1. a **print head** consisting of nozzles that spray droplets of ink onto the paper to form characters
2. an **ink cartridge or cartridges**; either one cartridge for each colour (blue, yellow and magenta) and a black cartridge, or one single cartridge containing all three colours and black (note: some systems use six colours)
3. a **stepper motor and belt** which moves the print head assembly across the page from side to side
4. a **paper feed** which automatically feeds the printer with pages as they are required.

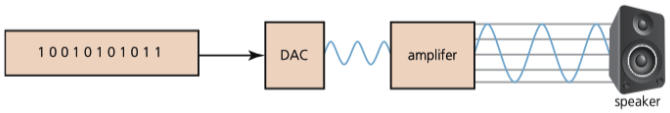
Inkjet printer step:
1. data from the document is sent to a printer driver
2. printer driver ensures that the data is in a format that the chosen printer can understand
3. check is made by the printer driver to ensure that the chosen printer is available to print
4. data is sent to the printer and stored in a temporary memory known as a printer buffer
5. a sheet of paper is fed into the main body of the printer. A **sensor detects** whether paper is available in the paper feed tray – if it is out of paper (or the paper is jammed), an error message is sent back to the computer
6. as the sheet of paper is fed through the printer, the **print head moves from side to side across the paper** printing the text or image. The four ink colours are sprayed in their exact amounts to produce the desired final colour
7. at the end of each full pass of the print head, the paper is advanced very slightly to allow the next line to be printed. This continues until the whole page has been printed
8. if there is more data in the printer buffer, then the whole process from stage 5 is **repeated until the buffer is empty**
9. once the printer buffer is empty, the printer sends an interrupt to the processor in the computer, which is a request for more data to be sent to the printer. The process continues until the whole of the document has been printed

3D printers: Laser printers use dry powder ink rather than liquid ink and make use of the properties of static electricity to produce the text and images.
3D printers use **additive manufacturing** (the object is built up layer by layer); this is in contrast to the more traditional method of **subtractive manufacturing** (removal of material to make the object).
3D printer step:
1. A 3D design is created in a suitable computer-aided design (CAD) package.
2. The design is split into layers.
3. The data for the first layer is transmitted to the 3D printer.
4. the 3D printer uses a nozzle to squirt material on to the printer bed to create a physical layer to match the design.
5. This process is repeated for successive layers.
6. it has to be cured in some way to ensure that the layers are stuck together and the material has been converted to the form required for the finished product.

3D printer type:
1. **Direct 3D printing**: uses inkjet technology;
2. **Binder 3D printing**; uses two passes for each of the layers; the first pass sprays dry powder and then on the second pass a binder (a type of glue) is sprayed to form a solid layer.
3. Newer technologies use **lasers and UV light** to harden liquid polymers; this further increases the diversity of products which can be made.

ALevel CS C03 Hardware(3)

Speakers:
speakers step:
1. The digital data is first passed through a **digital to analogue converter (DAC)** where it is converted into an electric current.
2. This is then passed through an **amplifier** (since the current generated by the DAC will be small) to create a current large enough to drive a loudspeaker.
3. This electric current is then fed to a loudspeaker where it is **converted into sound**.

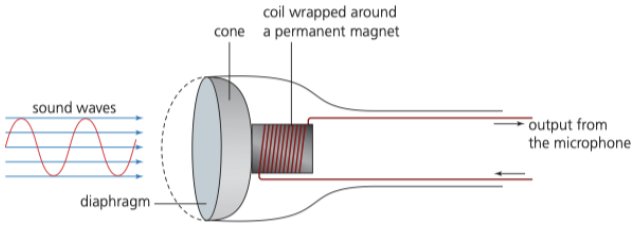


Keyboard: allow user to input a text. The key press has to be converted to a character code, which is transmitted to the processor.
keyboard work details:
1. the keyboard has electrical circuitry together with its own microprocessor and a ROM chip
2. The keys are positioned above a key matrix, which consists of a set of rows of wires and another set of columns of wires.
3. Pressing a key causes contact at one of the points where wires cross.
4. The microprocessor continuously tests to see if any electrical circuit involving a row wire and a column wire has become closed.
5. When the microprocessor recognises that a circuit has become closed, it can identify the particular intersection (wire crossing point) that is causing this.
6. The processor then uses data stored in the ROM to identify the character code relating to the key associated with that intersection and sends this character to the screen .

Monitoring: collection, recording, and reporting of project information that is of importance to the project manager and other relevant stakeholders.
Control: uses the monitored data and information to bring actual performance into agreement with the plan.
Sensors: Sensors are input devices which read or measure physical properties, such as temperature, pressure, acidity, and so on.
1. Real data is analogue in nature
2. ADC(analogue to digital)
3. used in both monitoring and control applications.
Actuator: a hardware device that receives a signal from a computer and adjusts the setting of a controlling device
feedback devices are used as part of a closed-loop system. A control system monitors an output, and then sends this output information back to the system as a feedback signal, which it uses to compare the actual output with the forecasted one.

sensor	Example applications
temperature	1. control a central heating system 2. control/monitor temperature in a greenhouse
pressure	1. detect intruders in a burglar alarm system 2. check weight (such as the weight of a vehicle) 3. monitor/control a process where gas pressure is important
infrared	1. turn on windscreen wipers on a car when it rains 2. detect an intruder in a burglar alarm system 3. count people entering or leaving a building
sound	1. pick up noise levels (such as footsteps or breaking glass) in a burglar alarm system 2. detect noise of liquids dripping from a pipe

Microphones: **analogue to digital converter (ADC)**
microphone steps:
1. When sound is created, it causes **the air to vibrate**.
2. When a **diaphragm** in the microphone picks up the air vibrations, the diaphragm also begins to vibrate.
3. A **copper coil** is wrapped around a permanent magnet and the coil is connected to the diaphragm using a cone. As the diaphragm vibrates, the cone moves in and out causing **the copper coil to move backwards and forwards**.
4. This forwards and backwards motion causes the magnetic field around the permanent magnet to be disturbed, inducing **an electric current.**
5. The electric current is then either amplified or sent to a recording device. The electric current is **analogue** in nature.

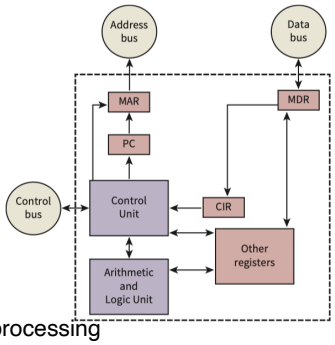


Virtual headset: give the user the feeling of being there.
1. Video is sent from a computer to the headset
2. Two feeds are sent to an LCD/OLED display. lenses placed between the eyes and the screen allow for focusing and reshaping of the image/video for each eye, thus giving a 3D effect and adding to the realism.
3. Most headsets use 110° field of view which is enough to give a pseudo 360° surround image/video.
4. As the user moves their head (up and down or left to right), a series of sensors and/or LEDs measure this movement, which allows the image/video on the screen to react to the user's head movements
5. Headsets also use binaural sound (surround sound) so that the speaker output appears to come from behind, from the side or from a distance, giving very realistic 3D sound.
6. Some headsets also use infrared sensors to monitor eye movement

ALevel CS C05 Processor fundamenta

Von Neumann features:

1. There is a processor - CPU(Center processing unit)
2. The processor has direct access to memory
3. The memory contains a 'stored program' and the data required by the program
4. The stored program consists of individual instructions
5. The processor executes instructions sequentially



ALU(Arithmetic Logic Unit): arithmetic or logic processing requirements of the instructions in a running program

Control Unit:

1. controlling the flow of data throughout the processor and the rest of the while computer system
2. ensuring that program instructions are handle correctly

Internal clock: controls the cycles of activity within the processor
System clock: controls the cycles of activity outside the processor

Registers

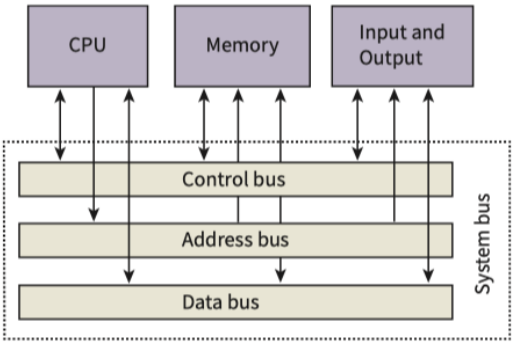
feature:

1. placed very close to ALU, allow very short access time
2. limited storage capacity

Accumulator(ACC): a general-purpose register that **stores a value** before and after the execution of an instruction by the ALU
Current instruction register(CIR): Stores the current instruction while it is being decoded and executed
Index register(IX): Stores a value; only used for **indexed addressing**
Memory address register(MAR): Stores the address of a memory location or an I/O component which is about to have a value read from or written to
Memory data register(MDR): Stores data that has just been read from memory or is just about to be written to memory
Program counter(PC): Stores the address of where the next instruction is to be read from
Status register(SR): Contains bits that are either set or cleared which can be referenced individually

BUS

Address Bus: a component that carries an address. This can be to the memory controller to identify a location in memory which is to be read from or written to or it can be to the I/O system to identify the source or destination of the data
The address bus is a '**one-way street**'. It can only be used to send an address to a memory controller or an I/O controller.
Data Bus: a component that can carry data from the processor to the memory or to an output device or can carry data from the memory or from an input device
The data bus is **two-way(bidirectional)**.
Control Bus: transmit a signal from the control unit to any other system component or transmits a signal to the control unit.
The control bus is a **bidirectional bus**.
A major use of control bus is to **carry timing signals**.



Factors contributing to system performance

Processor clock speed: One clock cycle defines the shortest possible time that any action can take.
Cores: Performance improves with increasing number of cores.
Cache memory: Cache memory is the fastest component of the IAS. Performance improves with increased storage size for the cache and with increased rate of access.
Address bus width: Special techniques are used when the storage capacity of the memory is too large for direct addressing. Their use affects system performance.

I/O port

Each I/O device is connected to an interface called a port.
Each port is connected to the I/O or device controller.
Universal Serial Bus(USB):
The **plug-and-play** concept was only fully realised by the creation of the USB standard.
Specialised multimedia ports:
VGA port: provides high-resolution screen display. **not support audio component**
HDMI port: allow the transmission of high-quality video **including the audio component.**

The fetch-execute(F-E) cycle (fetch, decode and execute cycle)

1. The **PC holds the address** of the next instruction to be loaded.
2. address in the PC transferred within the **CPU to MAR**
3. the instruction held in the address pointer to by the MAR is **fetched into MDR**
4. The instruction stored in the MDR is transferred within the CPU to the **CIR**
5. In the final step the **PC is incremented by 1**.

The clock cycle is the one controlled by the system clock which will have settings that allow one data transfer from memory to take place in the time defined for one cycle.

Register transfer notation:
MAR ← [pc]
PC ← [pc] + 1; MDR ← [[MAR]]
CIR ← [MDR]

The content of the MAR is an address; it is the content of that address which is being transferred to the MDR.

Interrupt handling
reasons for an interrupt to be generated:

1. a fatal error in a program
2. a hardware fault
3. a need for I/O processing to begin
4. user interaction
5. a timer signal

interrupt handle step:

1. The content of PC and other register are stored safe in the memory
2. The appropriate interrupt handler or ISR program is initiated by loading its start address into the program counter
3. check if further interrupt need handling.
4. Further interrupts are dealt with by repeated execution of the ISR program.
5. If there are no further interrupts, the safely stored contents of the registers are restored to the CPU and the originally running program is resumed.

ALevel CS C08 System Software(1)

Operating system: a software platform that provides facilities for programs to be run which are of benefit to a user
why need OS:
1. The hardware is unusable without an OS // hides complexity of hardware from user
2. Acts as an interface/ controls communications between user and hardware / hardware and software // or by example 1
3. Provides software platform / environment on which other programs can be run
User-system interface: Allow the user to get the software and hardware to do something useful
1. a commend-line interface(**CLI**)
2. a graphical user interface(**GUI**)
Program-hardware interface: Program development tools associated with a programming language allow a programmer to write a program **without needing to know the details of how the hardware**, particularly the processor, actually works.
Resource Management:
1. **Scheduling of processes**
2. resolution of conflicts when **two processes require the same resource**
Memory Management: Handles the allocation of memory to processes
1. Memory protection ensures that one program does not try to use the same memory locations as another program
2. The memory organisation scheme is chosen to achieve the best usage of limited memory size, for example, virtual memory involving paging or segmentation
3. Memory usage optimisation involves decisions about which processes should be in main memory at any one time and where they are stored in this memory
tasks:
1. Allocates / deallocates RAM to programs/tasks/processes
2. Keeps track of allocated and free memory locations
3. Swaps data to and from the hard drive
4. Handles virtual memory
5. Paging // segmentation
6. Memory protection, preventing a process accessing memory not allocated to it
Device(peripheral) management: Include Monitor screen, keyboard, printer, webcam etc.
tasks:
1. Install/manage device drivers
2. Control of hardware usage by processes // allocation of devices to processes // inter process communication
3. Device detection
4. Power Management
5. Keep track of device status (free or busy)
6. Buffer management
File management:
1. File naming conventions
2. directory (folder) structures
3. access control mechanisms
Security Management: Provides user accounts and passwords
1. Provision Tor recovery when data Is loss
2. prevention of intrusion
3. ensuring data privacy
tasks:
1. Sets up user accounts
2. Checks usernames, passwords // Authentication
3. Implements access rights
4. Automatic backup
5. System restore / roll back (to previous stable state)
Error detection and recovery: Errors can arise in the execution of a program either because it was badly written or because it has been supplied with inappropriate data.
tasks:
1. Deals with interrupts
2. Deal with run time errors generated by software
3. Deal with hardware faults
4. Error diagnostic messages
5. Deadlock detection and recovery
6. Safe-mode boot-up routines
7. System shutdown
8. Saves system restore points
Interrupt processing: Handles the signals sent when the attention of the processor is required elsewhere
Provision of a software platform: Provides an environment within which programs can be run

Disk formatter tasks: setting up a disk so it is ready to store files
1. **removing existing data** from a disk that has been used previously
2. **setting up the file system** on the disk, based on a table of contents that allows a file recognised by the operating system to be associated with a specific physical part of the disk
3. **partitioning the disk** into logical drives if this is required.
Disk repair: scans for errors in a disk and corrects them
purpose:
1. **Checks for any errors** / inconsistencies / bad sectors on the disk
2. **Resolves any errors on the disk**
3. **Retrieves files** / data from a damaged disk // re-constructs directory // recovers disc when data corrupt
4. Marks bad sectors on the disk // marks bad sectors as unusable
Hard disk defragmenter: move parts of files so that each file is contiguous in memory
fragmented state: the constant creation, editing and deletion of files
A defragmenter utility program reorganises the file storage to return it to a state where all files are stored in one block across a sequence of sectors.
step:
1. **Re-organises** the disk contents
2. **Moves split files** so they are **contiguous**
3. **Creates a large area of (contiguous) free space**
Backup software: creates a copy of data in case the original is lost
1. establish a schedule for backups
2. only create a new backup file when there has been a change.
File compression:
used regularly by an operating system to minimise hard disk storage requirements.
Virus checker:
1. installed as a permanent facility to protect a computer system.
2. regularly updated and for it to scan all files on a computer system as a matter of routine.

Program libraries
The 'programs' in a program library are usually **subroutines** created to carry out particular tasks. A programmer can use these within their own programs.
how to use program libraries:
1. Program libraries store pre-written functions and routines
2. The program library can be referenced/imported
3. the functions/routines can be called in her own program
DLL(dynamic linked library):
1. When a DLL routine is available the executable code just requires a small piece of code to be included.
2. This allows it to link to the routine, which is stored separately in memory, when execution of the program needs it.
3. Many processes can be linked to the same routine.
DLL advantages:
1. the executable files for all programs need **less storage space**.
2. **Memory requirement** is also minimised.
3. if a new version of the routine becomes available it can be loaded into memory so that any program using it is **automatically upgraded**.
DLL disadvantages:
1. **relying on the routine** being available and performing the expected function.
.2. If for some reason the DLL becomes **corrupted** or **a new version has bugs** not yet discovered the program will fail or produce an erroneous result.
3. The user running the program will find it **difficult to establish** what needs to be done to get the program to run without error.

ALevel CS C08 System Software(2)

language translator purpose:
To convert a (higher level) programming language to a different form
Assembler: Assembler language
Interpreter steps:
1. The interpreter program, the source code file and the data to be used by the source code program are **all made available**.
2. The interpreter program begins execution.
3. The first line of the source code is read.
4. The line is analysed.
5. If an error is found, this is reported and the interpreter program halts execution.
6. If no error is found, the line of source code is converted to an intermediate code.
7. **The interpreter program uses this intermediate code to execute the required action.**
8. The next line of source code is read and Steps 4–8 are repeated.

Compiler steps:
1. The compiler program and the source code file are made available but no data is needed.
2. The compiler program begins execution.
3. The first line of the source code is read.
4. The line is analysed.
5. If an error is found this is recorded.
6. If no error is found the line of source code is converted to an intermediate code.
7. The next line of source code is read and Steps 4–7 are repeated.
8. When the whole of the source code has been dealt with one of the following happens.
    1. If no error is found in the whole source code the complete intermediate code is **converted into object code**.
    2. If any errors are found a list of these is output and no object code is produced.

programmer of creating interpreted or compiled programs:
1. An interpreter has advantages when a program is being developed because errors can be identified as they occur and corrected **immediately** without having to wait for the whole of the source code to be read and analysed.
2. An interpreter has a disadvantage in that during a particular execution of the program, parts of the code which contain syntax errors may not be accessed so if **errors are still present**, they are not discovered until later.
3. An interpreter has a disadvantage when a program is error free and is distributed to users because the **source code has to be sent to each user**.
4. A compiler has the advantage that an executable file can be distributed to users, so the **users have no access to the source code**.

user of interpreted or compiled programs:
1. For an interpreted program, the interpreter and the source code have to be available each time that an error-free program is run.
2. For a compiled program, only the object code has to be available each time that an error free program is run.
3. Compiled object code will provide faster execution than is possible for an interpreted program.
4. Compiled object code is **less secure** because it could contain a virus.

why choose interpreter:
1. one error in a program can **lead to several other errors** occurring
2. an interpreter can **detect and correct an early error** so limiting subsequent ones
3. the debugging facilities provided in association with the interpreter speed this process.

why choose compiler:
1. an executable file can be created
2. this can be **distributed** for general use
3. execution of the program will be **faster** than if an interpreter were used.

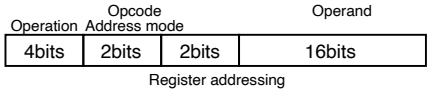
IDE features:
Prettyprinting: Prettyprint refers to the presentation of the program code typed into an editor.
Context-sensitive prompts: This feature displays hints (or a choice of keywords) and available identifiers that might be appropriate at the current insertion point of the program code.
Dynamic syntax checks: When a line has been typed, some editors perform syntax checks and alert the programmer to errors.
Expanding and collapsing code blocks:When working on program code consisting of many lines of code, it saves excessive scrolling if you can collapse blocks of statements.
Debugging: finding and correcting errors, often called ‘bugs’, in a program
debug tools:
1. Breakpoints
2. Single stepping
3. Report windows

ALevel CS C06 Assembly Language

Machine code instructions

Facts:
1. The only language that the CPU recongnises is machine code
2. Machine code consists of a **sequence of instructions**
3. Different processors have different instruction sets associate with them

Opcode: defines the action associated with the instruction
Operand: defines any data needed by the instruction
Machine code instruction: a binary code with a defined number of bits that comprises an opcode and, most often, one operand



Symbolic addressing: The use of symbolic addressing allows a programmer to write some assembly language code without having to bother about where the code will be stored in memory when the program is run.
Relative addressing: Illustration identifying the offset from the base address which is the address of the first instruction in the program.
Absolute addressing: Identifying actual memory addresses

Addressing mode: when the instruction uses a value this defines how the operand must be used to find the value
Immediate addressing: The operand is **the value** to be used in the instruction. SUM #48, MOV AX,3064H
Direct addressing: The operand is **the address which holds the value** to be used in the instruction. ADD TOTAL, MOV AX, [2000H]
Indirect addressing: The operand is **an address that holds the address which has the value to be used** in the instruction. MOV AX, [BX]
Index addressing: The operand is **an address to which must be added the value currently in the index register (IX)** to get the address which holds the value to be used in the instruction. Mov AX, COUNT[SI]

Assembly language instruction groups: data movement, input and output, comparisons and jumps, arithmetic operations, shift operations.

Data movement: involve loading data into a register or storing data in memory.

opcode	openand	exmpanation
LDM	#n	Immediate addressing. Load the number n to **ACC**.
LDR	#n	Immediate addressing. Load the number n to **IX**.
LDD	<address>	**Direct addressing**. Load the **contents** at the given address to ACC.
LDI	<address>	**Indirect addressing**. The address to be used is at the given address. Load **the contents of this second address** to ACC.
LDX	<address>	**Indexed addressing**. Form the address from <address> + the contents of the index register. Copy **the contents of this calculated address** to ACC.
MOV	<register>	Move the contents of the accumulator to the given register (**IX**).
STO	<address>	Store the contents of **ACC** at the given address.

Arithmetic operations:
There are no instructions for general-purpose multiplication or devision.General-purpose addition and subtraction are created for

opcode	openand	exmpanation
ADD	<address>	Add the contents of the given address to the ACC
ADD	#n	Add the denary number n to the ACC
SUB	<address>	Subtract the contents of the given address from the ACC
SUB	#n	Subtract the denary number n from the ACC
INC	<register>	Add 1 to the contents of the register (ACC or IX)
DEC	<register>	Subtract 1 from the contents of the register (ACC or IX)

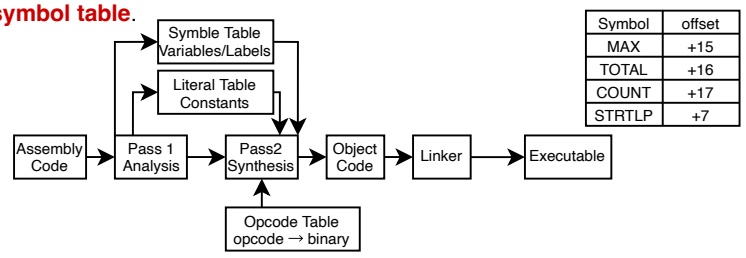
Shift operations:
Logical shift: where bits in the accumulator are shifted to the right or to the left and a zero moves into the bit position vacated
Cyclic shift: similar to a logical shift but bits shifted **from one end reappear at the other end**
Arithmetic shift: uses the shift to carry out multiplication or division of a **signed integer** stored in the accumulator

Assembly Language

Assembly language: a low-level language related to machine code where opcodes are written as mnemonics and there is a character representation for an operand
Assembler: a program used to translate an assembly language program into machine code

The essence of assembly language is that for each **machine code instruction** there is an equivalent **assembly language instruction** which comprises:
a mnemonic (a symbolic abbreviation) for the opcode
a character representation for the operand
Assembly language special features:
1. comments
2. symbolic names for constants
3. labels for addresses
4. **macros** (a sequence of instructions that is to be used more then once in a program)
5. **directives** (an instruction to the assembler program)

Two-pass assembler: design to handle programs written in the style of the one illustrated.
This program contains **forward references**. Some of the instructions have a symbolic address for the operand where the location of the address is not known at that stage of the program. A two-pass assembler is needed so that in the first pass the location of the addresses for **forward references can be identified**.
When a symbolic address is met for the first time its name is entered into the **symbol table**.



Input and Output:
1. **IN**: stored in the ACC the ASCII value of a character typed at the keyboard.
2. **OUT**: display on the screen the character for which the ASCII code is stored in the ACC

Comparisons and jumps:

opcode	openand	exmpanation
JMP	<address>	Jump to the given address
CMP	<address>	Compare the contents of ACC with the contents of <address>
CMP	#n	Compare the contents of ACC with the number n
CMI	<address>	**Indirect addressing**. The address to be used is at the given address. **Compare the contents of ACC with the contents of this second address**
JPE	<address>	**Following a compare instruction**, jump to <address> if the compare was **True**
JPN	<address>	**Following a compare instruction**, jump to <address> if the compare was **False**

Bitwise logic operation:

opcode	openand	exmpanation
AND	#Bn	Bitwise AND operation of the contents of ACC with the binary number n
AND	<address>	Bitwise AND operation of the contents of ACC with the contents of <address>
XOR	#Bn	Bitwise XOR operation of the contents of ACC with the binary number n
XOR	<address>	Bitwise XOR operation of the contents of ACC with the contents of <address>
OR	#Bn	Bitwise OR operation of the contents of ACC with the binary number n
OR	<address>	Bitwise OR operation of the contents of ACC with the contents of <address>

Shift operations:
1. LSL #n : where the bits in the accumulator are shifted logically n places to the left
2. LSR #n : where the bits are shifted to the right.

ALevel CS C09 Security, privacy and data integrity

Data integrity: a requirement for data to be **accurate** and **up to date**
Data privacy: a requirement for data to be **available only to authorised users**
Data security: a requirement for data to be available for use when needed, ensures that **only authorised users have access to the system** and **data can be recovered if lost or corrupted**.
two primary aims of system security measures:
1. to ensure that the system continues to carry out the tasks users need
2. to ensure that only authorised users have access to the system.

The threats to the security of a system:
1. individual user not taking appropriate care
2. internal mismanagement
3. natural disasters
4. unauthorised intrusion into the system by an individual
5. malicious soft ware entering the system.

Malware: malicious software that has the intention of causing harm to a system or its contents
Types of malware-containing program code:
1. **virus**: tries to replicate itself inside other executable code
2. **worm**: runs independently and transfers itself to other network hosts
3. **logic bomb**: stays inactive until some condition is met
4. **Trojan horse**: replaces all or part of a previously useful program
5. **spyware**: collects information and transmits it to another system
6. **bot**: takes control of another computer and uses it to launch attacks.

Malware can be classified in terms of the activity:
1. **phishing**: sending an email or electronic message from an apparently legitimate source requesting confidential information
2. **pharming**: setting up a bogus website which appears to be a legitimate site
3. **keylogger**: recording keyboard usage by the legitimate user of the system.

Similarities between phishing and pharming:
1. both malware software
2. both collect personal data
3. via fake website
4. the data are then used illegally

Differences between phishing and pharming:
1. phishing use emails or direct users to fake website
2. pharming misdirected browser to a bogue website, by modifying entries on a DNS server. by being installed on your computer

System vulnerability arising from user activity
do not involve malware:
1. The use of **weak passwords** and particularly those which have a direct connection to the user.
2. A legitimate user not recognising a phishing or pharming attack and, as a result, **giving away sensitive information**.

actions that might introduce malware:
1. attaching a portable storage device
2. opening an email attachment
3. accessing a website
4. downloading a file from the Internet.

System vulnerability arising from within the system itself
1. Operating systems often **lack good security**. Operation system need regular update.
2. In the past, commonly used application packages allowed **macro viruses to spread**, but this particular problem is now largely under control.
3. A very specific vulnerability is **buffer overflow**.

Security measures for protecting data

Validation: a check that data entered is of the correct type and format; it does not guarantee that data is accurate
validation type:
1. presence check: an entry field is not left blank
2. format check: a date has to be dd/mm/yyyy
3. length check: a telephone number
4. range check: the month in a date must not exceed 12
5. limit check: a maximum number of years for a person's age
6. type check: only a numeric value for the month in a date
7. existence check: a file exists with the filename referred to in the data entry.

Security measures for protecting computer systems

Disaster recovery: to protect continuity of operation.
If an organisation has a full system always ready to replace the normally operational one, it is referred to as a 'hot site'.
Safe system update: A special case of system vulnerability arises when there is a major update of hardware and/ or soft ware. Organisations may need to have the original system and its replacement running in parallel for a period to ensure continuity of service.
User authentication
Authentication: verification of a user's identity
methods of authentication:
1. biometric methods
2. security tokens

Good practice:
1. not leaving the computer switched on when unattended
2. not allowing someone else to observe you accessing the computer
3. not writing down details of how you access it.
4. a policy banning the use of such devices or at least limiting their use.

Firewall: **hardware** or **software** that **monitors and controls network traffic**
Data must enter the system, but it can be inspected immediately. A firewall can inspect the system addresses identified in the transmission of data, but can sometimes also inspect the data itself to check for anything unusual or inappropriate.
Firewall protect method:
1. Prevents unauthorised access to the data
2. Monitors incoming and outgoing traffic
3. Blocks transmissions from unauthorised sources / websites / ports
3. Maintains an allow list / deny list of IP addresses

Digital signature: check the identity of the sender.
Anti-virus software and intrusion detection:
1. **anti-virus software**: This carries out regular scans to detect any malware and to remove or deactivate it.
2. **intrusion detection system**: take as input an audit record of system use and look for examples that do not match expected system activity.

Security measures for protecting data

Recovering from data loss:
reasons for accidental loss of data:
1. a disk or tape gets corrupted
2. a disk or tape is destroyed
3. the system crashes
4. the file is erased or overwritten by mistake
5. the location of the file is forgotten.

backup procedure:
1. a full backup is made at regular intervals, perhaps weekly
2. at least two generations of full backup are kept in storage
3. incremental backups are made on a daily basis.

backup program: effectively freezes the file store while data is being copied.
disk-mirroring strategy: data is simultaneously stored on two disk systems during the normal operation of the system.
Restricting access to data
authorisation policy: definition of a user's access rights to system components
Protecting data content
Data can be **encrypted** to ensure data security.

Verification: confirmation of data received by a system. verification means getting the user to confirm that the data entered was what was intended to be entered.
one-bit parity check:
1. At the transmitting end, the number of 1s in the seven-bit code is counted.
2. If the count gives an even number, the parity bit is set to 0.
3. If the count gives an odd number, the parity bit is set to 1.
4. This is repeated for every byte in the transmission.
5. At the receiving end, the number of 1s in the eight-bit code is counted.
6. If the count gives an even number, the byte is accepted.
7. This is repeated for every byte in the transmission.

two bits to be flipped in an individual byte, which would mean that the transmission is incorrect but the parity check is passed.
checksum:
1. At the transmitting end a block is defined as a number of bytes.
2. The sum of these binary numbers in a block is calculated and supplied as a checksum value in the transmission.
3. The receiver does the same calculation and checks the sum of the numbers with the checksum value transmitted for each block in turn.

an error can be detected but its position in the transmission cannot be determined.

ALevel CS C10 Ethics and ownership

BCS(British Computer Society) guidance:
1. Public Interest
2. Professional Competence and Integrity
3. Duty to Relevant Authority
4. Duty to the Profession

IEEE/ACM (Institute of Electrical and Electronics Engineers)/Association for Computing Machinery eight principles:
1. **PUBLIC** – Software engineers shall act consistently with the public interest.
2. **CLIENT AND EMPLOYER** – Software engineers shall act in a manner that is in the best interests of their client and employer consistent with the public interest.
3. **PRODUCT** – Software engineers shall ensure that their products and related modifications meet the highest professional standards possible.
4. **JUDGEMENT** – Software engineers shall maintain integrity and independence in their professional judgement.
5. **MANAGEMENT** – Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance.
6. **PROFESSION** – Software engineers shall advance the integrity and reputation of the profession consistent with the public interest.
7. **COLLEAGUES** – Software engineers shall be fair to and supportive of their colleagues.
8. **SELF** – Software engineers shall participate in lifelong learning regarding the practice of their profession and shall promote an ethical approach to the practice of the profession.

As a professional you could be guided in your thinking by referring to the eight principles listed above from the IEEE-CS/ACM Joint Task Force Software Engineering Code of Ethics.

Artificial intelligence(AI): AI concerns the use of a computer or computer-controlled device to perform tasks normally associated with intelligent behaviour by humans.

AI usages:
1. the use of a language
2. carrying out a mathematical calculation or function
3. recognising a person's face
4. the ability to operate machinery, such as a car, an aeroplane or a train
5. analysing data to predict the outcome of a future event, such as weather forecasting.

AI covers areas:
1. autonomous (driverless) vehicles
2. artificial limb technology
3. drones, used to carry out dangerous or unpleasant tasks such as bomb
4. disposal, welding, or entering nuclear disaster areas
climate change predictions
5. medical procedures, such as eye operations where extreme precision is required.

The impacts of AI:
1. 99% of all jobs could be eliminated since the increase in the use of AI is exponential
2. An increase in AI will leave people with more time to pursue their hobbies and have a better lifestyle.
3. Improvements in AI technology can have a positive impact on the environment.

Copyright: a formal recognition of ownership of a created and published work

Copyright can apply to any of:
1. a literary (written) work
2. a musical composition
3. a film
4. a music recording
5. a radio or TV broadcast
6. a work of art
7. a computer program.

Commercial software

Shareware: software provided **free of charge for a limited period** but **no source code provided**

Freeware: software provided **free of charge with no time limit** for its use but **no source code provided**

Open or free licensing:

Open source software: software **provided with the source code**

Free software: software provided with the source code when the user is **free to use it as they wish**

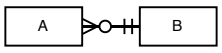
ALevel CS C11 Database

Limitation of a file-based approach

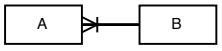
Data integrity problems in a single file:
Database approach can prevent the lack of in-built control when data is entered.
The data privacy issue with a single file:
The problem is that there cannot be any control of access to part of a file. Data privacy would be properly handled by a database system.
Data redundancy and possible inconsistency in multiple files:
One of the primary aims of the database approach is the elimination of data redundancy.
Data dependency concerns:
In a database scenario the existing programs could still be run even though additional data was added.

Entity-relationship modelling

one-to-one 1:1
one-to-many 1:M
many-to-one M:1
many-to-many M:M

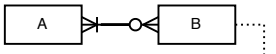


One A is for one B (There must be a B and there cannot be more than one) and one B can be used for many A

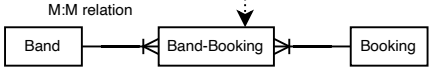


The M:1 relationship

A belong to B and a B must have more than oneMember



M:M relation



M:M relation

The Database Management System (DBMS)

Three-level model:
1.**The external level**: The individual's view(s) of the database
2.**The conceptual level**: Describes the data as seen by the applications making use of the DBMS. Describes the 'views' which users of the database might have
3.**the internal level**: Describes how the data will be stored on the physical media
Data management system (DBMS): software that controls access to data in a database
Database administrator (DBA): a person who uses the DBMS to customise the database to suit user and programmer requirements

An important aspect of the provision of views is that they can be used by the DBA as a mechanism for ensuring security. Individual users or groups of users can be given appropriate access rights to control what actions are allowed for that view.
Developer interface: gives access to software tools provided by a DBMS for creating tables
task:
1. create table
2. set up relationship between tables
3. create / design a form
4. create / design a report
5. create / design a query
Query processor: software tools provided by a DBMS to allow creation and execution of a query
Query: used to select data from a database subject to defined conditions
Data dictionary: contains metadata about the data. This includes details of all the definitions of tables, attributes and so on but also of how the physical storage is organised.
1. table name
2. field name // attribute
3. data type
4. type of validation
5. Primary Key
6. Foreign Key
7. relationships
index: a small secondary table used for rapid searching which contains one attribute from the table being searched and pointers to the tuples in that table

Database Security:
1. Issue usernames and passwords
2. Access rights
3. Create backups
4. Encryption of data
5. Definition of different views
6. Usage monitoring

The relational database

Relation: the special type of table which is used in a relational database
Attribute: a column in a relation that contains values
Tuple: a row in a relation storing data for one instance of the relation
Primary key: an attribute or a combination of attributes for which there is a value in each tuple and that value is unique
Candidate key: a key that could be chosen as the primary key
Secondary key: a candidate key that has not been chosen as the primary key
Foreign key: an attribute in one table that refers to the primary key in another table
Referential integrity: the use of a foreign key to ensure that a value can only be entered in one table when the same value already exists in the referenced table

Normalisation

1NF:
1. Ask if there is repeating group attributes.
2. For each table that the attributes are dependent on the primary key
2NF:
1. Examine each non-key attribute and ask if it is dependent on both parts of the component key.
2. it either has a single primary key or it has a compound primary key with any non-key attribute dependent on both component.
3NF:
1. see if there any non-key dependencies
2. look for any non-key attribute that is dependent on another non-key attribute
Repeating group: a set of attributes that have more than one set of values when the other attributes each have a single value

Structured Query Language (SQL)

Data Definition Language: provide for creating or alter tables.
CREATE DATABASE BandBooking;
CREATE TABLE Band (
BandName varchar(25),
NumberOfMembers integer);
ALTER TABLE Band ADD PRIMARY KEY (BandName);
ALTER TABLE Band-Booking ADD FOREIGN KEY (BandName
REFERENCES Band(BandName);
ALTER TABLE Band ADD Gender CHAR(1); // add an attribute
Data type : character, varchar, boolean, integer, real, date, time
Data Manipulation language(DML):
1. The insertion of data into the tables when the database is created
2. The modification or removal of data in the database
3. The reading of data stored in the database
Insert:
INSERT INTO Band ('ComputerKidz', 5);
INSERT INTO Band-Booking (BandName, BookingID) VALUES ('ComputerKidz', '2016/023');
Select:
SELECT BandName FROM Band;
SELECT BandName, NumberOfMembers FROM Band;
SELECT * FROM Band;
Order and Group:
SELECT BandName, NumberOfMembers FROM Band ORDER BY BandName;
SELECT BandName FROM Band-Booking GROUP BY BandName;
SELECT BandName FROM Band-Booking WHERE Headlining = 'Y' GROUP BY BandName;
SELECT BandName, NumberOfMembers FROM Band WHERE NumberOfMembers > 2 ORDER BY BandName;
Aggregate functions (SUM,COUNT,AVG):
SELECT Count(*) FROM Band;
SELECT AVG(NumberOfMembers) FROM Band;
SELECT SUM(NumberOfMembers) FROM Band;
Join condition:
SELECT VenueName, Date FROM Booking WHERE Band-Booking.BookingID = Booking.BookingID AND Band-Booking.BandName = 'ComputerKidz';
INNER JOIN:
SELECT table1.column1, table2.column2... FROM table1 INNER JOIN table2 ON table1.common _ field = table2.common _ field;
DML UPDATE:
UPDATE Band SET NumberOfMembers = 6 WHERE BandName = 'ComputerKidz';
DML Delete:
DELETE FROM Band-Booking WHERE BandName = 'ITWizz'; DELETE FROM Band WHERE BandName = 'ITWizz'