

COMPUTING GSCE REVISION

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FUNDAMENTALS OF COMPUTER SYSTEMS

COMPUTER SYSTEMS

DEFINE A COMPUTER SYSTEM

A combination of hardware and software components that allow input, processing and output of data

DESCRIBE THE IMPORTANCE OF COMPUTER SYSTEMS IN THE MODERN WORLD

Computer systems are used in every aspect of our lives from entertainment to health care. If they go wrong it can cause massive problems.

EXPLAIN THE NEED FOR RELIABILITY IN COMPUTER SYSTEMS

Reliability - The probability that a computer will produce the correct output in a given time frame. Can be measured using uptime as a percentage of hours the system has been available. Expected reliability of individual parts of the system can be measured in MTBF (Mean Time Before Failure).

Safety/Life Critical systems – A system where failure may result in death, loss or severe damage to equipment that may lead to death or injury

To improve reliability:

- the system must have a clear design that satisfies user requirements
- the system must be designed with safety and possible failure in mind
- the design must make testing easy and include test plans
- the design must be developed according to defined standards
- testing should be carried out throughout development
- maintenance should be carried out after the system goes live
- systems can have failsafe mechanisms built in
- the system must be designed and created according to defined standards.

In safety critical systems have redundancy plans with multiple backup computers running in parallel with the main system. In the case of a failure the switch to backup can happen without any interruption.

EXPLAIN THE NEED FOR ADHERENCE TO SUITABLE PROFESSIONAL STANDARDS IN THE DEVELOPMENT, USE AND MAINTENANCE OF COMPUTER SYSTEMS

Having hardware that conforms to standards means that a device bought for one computer will work on any other

ISO (International Organisation for Standardisation) – The world's largest standards development organisation

PROPRIETARY STANDARDS

These are standards owned by a company. For example, software running on windows that must work in a certain way. The advantages of this are:

- look and feel familiar to users and will speed up learning new systems
- work in a predictable way which will improve reliability
- be maintained by one company

INDUSTRY STANDARDS

Standards agreed across the industry to allow easy interconnection between devices. E.g. USB

DE FACTO STANDARDS

Standards that develop through common usage. For example, Microsoft word .doc has become the de facto standard for word processed documents.

OPEN STANDARDS

Standards that are publically available. E.g. TCP/IP (Transmission control protocol/internet protocol)

EXAMPLES

Hardware:

Wi-fi: 802.11 b/g/n; Bluetooth, USB, SCSI (obsolete), HDMI (not just computers), E-IDE.

Software:

TCP/IP, HTML, SQL, JASON, ASCII, Unicode.

EXPLAIN THE IMPORTANCE OF ETHICAL, ENVIRONMENTAL AND LEGAL CONSIDERATIONS WHEN CREATING COMPUTER SYSTEMS.

ENVIRONMENTAL

- Electrical items are marked as not for waste
- Many computers contain toxic and carcinogenic components and so in the USA old computers are classified as hazardous waste
- Many electronical items also contain useful metals that can be reused and recycled
- However, the cost of recycling drives companies to export their waste abroad or dump it
- Computer systems use more energy than the aviation industry
- This is a concern as supplies of energy are finite and expensive
- So they should be switched off when not in use

ETHICAL

- Some electrical waste is donated to developing countries
- Codes of values are needed as computer professionals have access to a lot of sensitive information that could be misused
- BCS (British Computer Society) provides a code of conduct that its members must adhere to
- Privacy

LEGAL

DATA PROTECTION ACT 1998

Governs how people and organisation have to look after the data they hold about us

- If a company wishes to hold information about individuals they must register with the information commissioner's office (ICO) and adhere to the principles:
 - Data must be processed fairly
 - It can only be used for its intended purpose
 - They should only hold data they need
 - Data must accurate and up to date
 - Data must not be held longer than it is needed for
 - Data will be used in accordance with your rights
 - Data will be kept safe
 - Data will not be transferred to any country where they don't have similar laws

THE COPYRIGHT, DESIGNS AND PATENTS ACT 1998

Protects work from being copied without permission

THE COMPUTER MISUSE ACT 1998

- Illegal to attempt to access data that you are not authorised to
- Illegal to attempt to access data with the intention of committing a crime
- Illegal to attempt to access data with the intention to change the data or impair the running of the computer; can have up to 10 years in jail

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HARDWARE

CPU

The system bus connected to the CPU is made of three buses: address, data and control

The address bus carries memory addresses between the CPU and primary memory.

The data bus carries data which could be an instruction e.g. add or it could carry a piece of data e.g. a number.

The control bus carries control signals from the control unit. These coordinate CPU activity.

Typical bus speeds are between 66MHz and over 800MHz.

The CPU carries out the fetch, decode and execute cycle over and over again

ALU (Arithmetic Logic Unit) – Performs all the arithmetic and logical operations within the CPU

Control Unit – The control unit works with the CPU to control the flow of data within the system

Registers - very fast, small areas of memory in the CPU where specific items are stored while executing in the CPU such as program counter

Program counter – Holds the address in RAM of the next instruction to be executed

CPU Clock - produces a regular pulse that the control unit uses to generate control signals to coordinate the running of programs

STATE THE PURPOSE OF THE CPU

- Controls the operations of the computer
- Fetch instructions from main memory
 - Fetch data from main memory
 - Decode the instructions
 - Execute the instructions
 - Performs calculations
 - Manages the movement of instructions and data to and from peripheral devices

DESCRIBE THE FUNCTION OF THE CPU AS FETCHING AND EXECUTING INSTRUCTIONS STORED IN MEMORY

EXPLAIN HOW COMMON CHARACTERISTICS OF CPUS SUCH AS CLOCK SPEED, CACHE SIZE AND NUMBER OF CORES AFFECT THEIR PERFORMANCE

Clock speed – indicates how many clock cycles/operations are executed each second

Overclocking can be used to increase the clock speed of the CPU.

Overclocking can cause instability and will generate more heat reducing the life of the CPU

Cores - Independent processing units inside the CPU that work simultaneously

Cache – Special high speed memory used by a computer. The more cache the less often the CPU needs to retrieve data from RAM which is further away and slower.

BINARY LOGIC

EXPLAIN WHY DATA IS REPRESENTED IN COMPUTER SYSTEMS IN BINARY FORM

So that computers can be based on logic circuits.

Each part of the circuit can be in one of two states – on/off or true/false

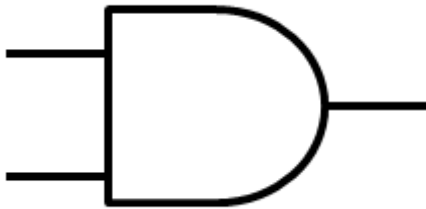
As there are only two states computers use the binary system which has two digits – 0 and 1.

It is faster to determine if it is on or off than the analogue property

UNDERSTAND AND PRODUCE LOGIC DIAGRAMS USING THE OPERATIONS NOT, AND AND OR

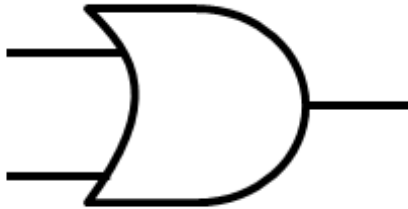
PRODUCE A TRUTH TABLE FROM A GIVEN LOGIC DIAGRAM.

AND



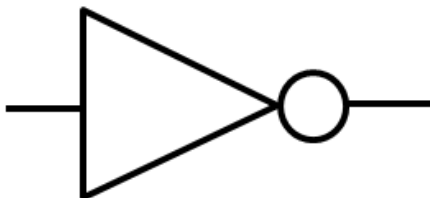
INPUT		OUTPUT
A	B	A AND B
0	0	0
0	1	0
1	0	0
1	1	1

OR



INPUT		OUTPUT
A	B	A OR B
0	0	0
0	1	1
1	0	1
1	1	1

NOT



INPUT	OUTPUT
A	NOT A
0	1
1	0

MEMORY

DESCRIBE THE DIFFERENCE BETWEEN RAM AND ROM

RAM (Random Access Memory)	ROM (Read Only Memory)
Read and Write	Read Only
Volatile	Non-Volatile
Stores in use programs and data	Stores the boot up sequence

EXPLAIN THE NEED FOR ROM IN A COMPUTER SYSTEM

ROM permanently stores the programs and data needed to boot the system. An example being the BIOS in a PC.

DESCRIBE THE PURPOSE OF RAM IN A COMPUTER SYSTEM

It is where the program instructions are stored after they have been loaded from the disk so that they can be accessed more quickly by the CPU. Instructions and data are stored in binary format at specific locations called memory addresses which can be accessed in any order. The main memory is made of dynamic RAM which is slower than static RAM as it constantly needs to be refreshed.

EXPLAIN HOW THE AMOUNT OF RAM IN A PERSONAL COMPUTER AFFECTS THE PERFORMANCE OF THE COMPUTER

The more RAM a computer has the less virtual memory is needed and so the speed will be slowed down less by the Hard Drive Disk. So adding more RAM will speed up the computer.

The computer will be able to multitask more programs as there is more space to use without using virtual memory

EXPLAIN THE NEED FOR VIRTUAL MEMORY

Virtual Memory – A section of the hard drive used to store items in RAM which are not currently being used

When the RAM is full, the OS will swap out pages from the RAM on the hard disk drive called virtual memory. Virtual memory creates a swap file/paging file in unused disk storage locations and swaps the least used pages of a fixed size. The OS keeps track of what has been swapped using a page table and any errors that occur are called page faults. If memory is very low pages will have to be continually swapped in and out called disk thrashing. Having to use virtual memory slows down the computer as swapping pages takes a long time so the more memory a computer has the less virtual memory it will use and the faster it will run.

DESCRIBE CACHE MEMORY

There are three levels of cache memory L1, L2 and L3 referring to the distance they are from the CPU with L1 the closest and smallest and L3 the largest and furthest. Cache uses static ram that does not lose its charge and can store data while they have power without being refreshed. This makes accessing the data much quicker, however it is also very expensive to buy.

DESCRIBE FLASH MEMORY

EEPROM (Electrically Erasable Programmable Read-Only Memory)

It is non-volatile storage that contains no moving parts and so is very reliable. It is very compact and fast. It wears out of time after a million writes. More expensive and much lower capacity than normal hard drives.

DISCUSS HOW CHANGES IN MEMORY TECHNOLOGIES ARE LEADING TO INNOVATIVE COMPUTER DESIGNS

Devices can be made smaller, lighter and more compact when their storage is based on flash memory. The storage within it needs to be small, light and have low power consumption. It must also be able to withstand being carried around and potentially moved quite suddenly. As the price of solid state memory falls, its capacity is increased and it becomes physically smaller, meaning new designs of computer based products will be possible.

INPUT AND OUTPUT DEVICES

UNDERSTAND THE NEED FOR INPUT AND OUTPUT DEVICES

Input Device - Enter data into a computer system

Output Device - Present data to the user

DESCRIBE SUITABLE INPUT DEVICES FOR A WIDE RANGE OF COMPUTER CONTROLLED SITUATIONS

INPUT DEVICES

KEYBOARD

The keyboard, along with the mouse, is one of the most used input devices. Once you get the hang of where the keys are, it allows people to enter text-based data quickly into the computer. A numerical keypad (found on most keyboards on the right) provides a fast way for accountants and people who work in finance to enter numbers.

MOUSE

The computer mouse is another common input device. It allows the user to interact with the software on screen. The mouse is quite versatile, with at least two buttons and the ability to move in any direction. However, it can be difficult to be precise – e.g. drawing using the mouse is quite hard!

SCANNER

Scanners convert physical documents and photos into digital format. They can be used in conjunction with special software to automatically read handwriting and convert it into computer text. This is called Optical Character Recognition. Some tick-box forms are scanned in, like the Census form or your multiple choice Science exams; this is called Optical Mark Recognition. This is a form of automated input which is much quicker and more reliable than human input.

TOUCHSCREEN

Touchscreens have been around for years in one form or another. The latest versions, like the Apple iPad interface use multi-touch technology to allow greater control.

MICROPHONE

Microphones convert analogue sounds into a digital format that the computer can understand and playback. Sounds are usually recorded as .wav or .mp3 files (the latter uses compression to make the file size smaller and is more likely to be used to store music tracks).

DIGITAL CAMERA

Digital cameras convert live images into digital format. Photos are usually stored as JPEG files. The quality and size of the picture is determined by the number of megapixels the camera is capable of detecting, e.g. photos taken with an 8 megapixel camera are made up of 8 million pixels.

SENSORS

Sensors measure the physical world and translate that into a digital format that a computer can understand. There are various sensors that detect all manner of things: movement, light, heat, moisture, gases (e.g. carbon monoxide levels), location (GPS), etc. For example, the iPhone has an accelerometer so it knows which way round it is to ensure the screen is rotated the correct way. These can be used for automated input or store values to be analysed (data logging).

DESCRIBE SUITABLE OUTPUT DEVICES FOR A WIDE RANGE OF COMPUTER CONTROLLED SITUATIONS

PRINTER

Printers produce physical documents and photos from digital files. Most photo printing is done by inkjet printers which can be expensive to run. Laser printers use toner cartridges which are more expensive initially but can print more pages before being replaced.

MONITOR

Monitors/screens provide the visual output from the computer system. Most computer monitors and mobile phones use colour LCD (liquid crystal display).

SPEAKERS

Working the opposite way to the microphone input, the speaker converts digital sound into analogue waves.

MOTOR

A motor can be driven with precision by a computer system. Often used in manufacturing, e.g. building cars, motors are used to control robotic arms.

DISCUSS INPUT AND OUTPUT DEVICES FOR USERS WITH SPECIFIC NEEDS.

PUFF-SUCK SWITCH

Suck or puff down the tube to activate a switch that can be interpreted as input

FOOT MOUSE

Can be used by someone with limited use of their upper arms.

EYE TYPER

A camera mounted on the computer determines where the user is looking and movements made by the eye. They can click with slow eye blinks.

BRaille KEYBOARD

Allows user to type and enter text in Braille

BRaille DISPLAY

Reads screen text and presents it via a refreshable Braille display

BRaille PRINTER/EMBOSSER

Presses pins into one side of paper in order to create raised dots on the other side of the paper printing in Braille.

SPEAKERS

Can be useful for visually impaired. Text can be converted into speech and can be output via the speaker in a sound format using screen readers. The computer generated voice can be difficult to understand. Speakers can also signal when something has been successful or not.

MICROPHONE

Speech can be converted from sound to text using specialist programs

MAGNIFIERS

The zoom tool in software can be useful for people with poor eyesight

Screen magnifiers (hardware) can also be used to magnify what is displayed on screen

PREDICTIVE TEXT

Allows words to be entered quicker by predicting the most likely word. This reduces the number of keystrokes that you make helping people with typing difficulties

STICKY KEYS

Sticky keys allows the user to press a 'modifier' key such as Shift, Ctrl, Alt and have it remain active until another key is pressed.

SECONDARY STORAGE

EXPLAIN THE NEED FOR SECONDARY STORAGE

To store data permanently.

DESCRIBE COMMON STORAGE TECHNOLOGIES SUCH AS OPTICAL, MAGNETIC AND SOLID STATE

SOLID STATE

Uses banks of EEPROM chips that can be read and written to many times. The chips do have finite lifetime but this type of storage has not been around long enough to know how long. It is small and light weight making it ideal for portable devices. It also has faster read and write times due to the lack of moving parts. However, it is much more expensive than other types of secondary storage

MAGNETIC

A magnetised rigid plate with heads to read the data as the platters spin around. Slow access times as have to wait for moving parts. If jugged while spinning it can damage the disk and it is affected by heat and magnetic fields. Provides large storage space at low cost.

OPTICAL

Uses light from lasers to detect reflections from the surface of the disk medium. They are made rewritable by using a laser to change the colour of a dye layer in the disk. Very cheap and robust but not permanent as the dye layer deteriorates over time. Very easy to scratch.

SELECT SUITABLE STORAGE DEVICES AND STORAGE MEDIA FOR A GIVEN APPLICATION AND JUSTIFY THEIR CHOICE USING CHARACTERISTICS SUCH AS CAPACITY, SPEED, PORTABILITY, DURABILITY AND RELIABILITY.

Capacity: How much space there is

Speed: How quickly data can be read from it

Portability: How easily it is carry around

Durability: How easily it is damaged

Reliability: How long it will last

SOFTWARE

EXPLAIN THE NEED FOR THE FOLLOWING FUNCTIONS OF AN OPERATING SYSTEM: USER INTERFACE, MEMORY MANAGEMENT, PERIPHERAL MANAGEMENT, MULTI-TASKING AND SECURITY

MEMORY MANAGEMENT

The operating system controls the memory of the computer by loading programs into memory when started and providing the processor with the address of the start of it. It also keeps track of the programs and data using address

MULTI-TASKING

The operating system allows multiple programs to be run at the same time and makes sure that each one gets enough processor power giving priority to more important processes. Processes are designated running for the current process, runnable if they can be attended to next and waiting if they must wait for the signal that sets them to runnable,

PERIPHERAL MANAGEMENT

Peripherals – Any component outside of the process and memory

The operating system has to manage these and make sure they work with optimal efficiency. An example of this is using buffers to ensure that data is not lost when outputting or storing data to slower peripherals. Device drivers are written to allow the operating system to interact with each peripheral. When a device is required an interrupt code is sent to the CPU switching its attention. The device drivers are different on every operating system as they have different interrupt codes. Most operating systems provide the ability to fine tune peripherals such as control panel.

SECURITY

The operating system protects processes from each other by dividing memory into pages and recording which process is using which pages to avoid conflicts. It also marks files with the privileges each user has regarding it to prevent unauthorised access to data.

USER INTERFACE

COMMAND LINE

This allows greater customisation of the operating system and makes administering a network less of an effort.

GRAPHICAL USER INTERFACES (GUI)

These reduce the need to learn commands but are less easily customisable

DESCRIBE THE PURPOSE AND USE OF COMMON UTILITY PROGRAMS FOR COMPUTER SECURITY (ANTIVIRUS, SPYWARE PROTECTION AND FIREWALLS), DISK ORGANISATION (FORMATTING, FILE TRANSFER, AND DEFRAGMENTATION), AND SYSTEM MAINTENANCE (SYSTEM INFORMATION AND DIAGNOSIS, SYSTEM CLEANUP TOOLS, AUTOMATIC UPDATING)

SECURITY

ANTIVIRUS SOFTWARE

This prevents harmful programs being installed on the computer, prevents important files such as the operating system, being changed or deleted. If a virus does manage to install itself the software will detect it when it performs regular scans. Any virus detected will be removed (inoculated). New viruses are found regularly so it is important that any antivirus software gets regular updates.

FIREWALL

Restrict outgoing and incoming access to certain network addresses. This prevents hackers from infiltrating the network but can also be used to restrict access for certain users (e.g. blocking games for students).

FILE MANAGEMENT

Windows explorer and other utilities provide a logical view of how the files are organised to make it easier for the user

DISK DEFRAGMENTATION TOOL

After a while files on a hard drive disk become fragmented from the deletion of data and insertion of new data wherever there is space. This means that files get broken up and written to the disk in bits which makes it slower to read and open the file. A disk defragmenter improves the efficiency of the computer by moving separate parts of the files around so they can be stored together making it quicker to access them. It also groups all the free space together so any new files can be stored in one place.

MAINTENANCE

SYSTEM INFORMATION AND DIAGNOSIS

Utility usually provided by the operating system that gives information about the hardware, statistics about its use and information that will help diagnosis problems with the computer.

SYSTEM CLEAN-UP TOOLS

Searches for and removes files that are no longer needed. This will free up disk space, speed up how quickly the system boots and improve performance.

AUTOMATIC UPDATING

Makes sure any software installed on the computer is up to date by regularly checking the internet for updates.

DISCUSS THE RELATIVE MERITS OF CUSTOM WRITTEN, OFF THE SHELF, OPEN SOURCE AND PROPRIETARY SOFTWARE.

OPEN SOURCE

- Means the source code is available to the public so other developers can be make changes
- Open source software is not always free

Pros:

- You can adapt and modify the software to suit your needs
- Many developers, testers and maintainers working on the code can make rapid progress
- Software is constantly evolving which means the quality keeps improving
- A community of dedicated enthusiasts will provide free support

Cons:

- The software is likely to develop according to the needs of the developer rather than a user
 - So less attention may be paid to the development of a user interface
- Multiple developer may produce competing solutions, diluting development and maintenance efforts that a single supplier can bring to bear
- Users might have to pay for external support to use the software even though the software may be free

PROPRIETARY

- Means the source code is closed meaning the developers can keep control and earn more money by charging a premium price

Pros:

- The vendors can limit the number of licences given out, hence close control and monitoring distribution
- Good system support can be provided
- Software can be guaranteed by the vendor

Cons:

- Manufactures are usually under commercial pressure which may lead to reduced functionality and too early release of the software
- Any improvement would require additional cost and may not be allowed

OFF-THE-SHELF

- Ready-made software that you can buy from a store or the internet

Pros:

- Easily available
- Easily installed
- No intensive training needed
- Lots of support and resources
- Regular updates and bug fixes from the company

Cons:

- May not meet the need of the user exactly
- Some features of the software may never be used

CUSTOM-WRITTEN

- Specially developed for a user or organisation

Pros:

- User is able to control the result of the software because their personal needs are taken into consideration during the development of the software
- Most features of the software will be used
- The features and output will meet the exact needs of the user

Cons:

- Software development takes a long time
- Users require training
- It is very expensive to develop this type of software
- No support or resources available

REPRESENTATION OF DATA IN COMPUTER SYSTEMS

UNITS

DEFINE THE TERMS BIT, NIBBLE, BYTE, KILOBYTE, MEGABYTE, GIGABYTE, TERABYTE

- **Bit** – A single binary digit – 1 or 0
- Nibble 4 bits
- Byte 8 bits or 2 nibbles
- Kilo 1,000 (3 zeros) bytes
- Mega 1,000,000 (6 zeros) bytes or 1,000 kilobytes
- Giga 1,000,000,000 (9 zeros) bytes or 1,000 megabytes or 1,000,000 kilobytes
- Tera 1,000,000,000,000 (12 zeros) bytes or 1,000 gigabytes, or 1,000,000 megabytes or 1,000,000,000 kilobytes

UNDERSTAND THAT DATA NEEDS TO BE CONVERTED INTO A BINARY FORMAT TO BE PROCESSED BY A COMPUTER.

Circuit only needs to check for two states: electricity flowing or not flowing (on or off) resulting in more reliable circuits.

NUMBER

EXPLAIN THE USE OF HEXADECIMAL NUMBERS TO REPRESENT BINARY NUMBERS

Hexadecimal numbers are used to represent binary as they are easier to read for humans, they are shorter and they are easier to reference and compare for error analysis.

CHARACTER

EXPLAIN THE USE OF BINARY CODES TO REPRESENT CHARACTERS

Each character including symbols, digits, upper and lower case is given a unique character identifier code stored in binary. Some codes are reserved for control characters (e.g. TAB, Carriage Return)

EXPLAIN THE TERM CHARACTER SET

All the characters which are recognised/can be represented by the computer system

DESCRIBE WITH EXAMPLES (FOR EXAMPLE ASCII AND UNICODE) THE RELATIONSHIP BETWEEN THE NUMBER OF BITS PER CHARACTER IN A CHARACTER SET AND THE NUMBER OF CHARACTERS WHICH CAN BE REPRESENTED.

Unicode has a much larger character set and can represent many more characters from all alphabets. Because Unicode uses 16 bits and ASCII uses fewer (7/8 bits) which can only represent 256 distinct characters. Many more characters are needed for coping with all languages and so ASCII does not contain characters used in some languages.

IMAGES

EXPLAIN THE REPRESENTATION OF AN IMAGE AS A SERIES OF PIXELS REPRESENTED IN BINARY

Each pixel is represented by a binary code that tells the computer the colour it has as a mixture of red, green and blue

EXPLAIN THE NEED FOR METADATA TO BE INCLUDED IN THE FILE SUCH AS HEIGHT, WIDTH AND COLOUR DEPTH

Metadata such as height, width and colour depth allow a computer to display an image file correctly.

DISCUSS THE EFFECT OF COLOUR DEPTH AND RESOLUTION ON THE SIZE OF AN IMAGE FILE

- Colour depth describes how many bits are taken by each pixel to display colours
- 1 bit colour is essentially black and white with no grey
- 8 bit colour can show a maximum of 256 different colours
- "True colour" is 24 bits per pixel with one byte of red, green and blue
- Resolution is the number of pixels used to display an image. Measured by the number of pixels wide and high it is (1280x768) or in pixels per inch (ppi).
- The higher the resolution and colour depth the larger the file size

SOUND

EXPLAIN HOW SOUND CAN BE SAMPLED AND STORED IN DIGITAL FORM

- The sample rate is the frequency at which the sound is sampled, or measured the more frequently the more accurate
- Bit depth is the number of bits used to store each sample or sample resolution

EXPLAIN HOW SAMPLING INTERVALS AND OTHER CONSIDERATIONS AFFECT THE SIZE OF A SOUND FILE AND QUALITY OF ITS PLAYBACK.

- The higher the sample rate and bit depth the larger the sound file and the better the quality of the recording
- Sound synthesis is the recreation of sound from the sound file through a speaker
- Interpolation is the process used for filling in the gaps between samples to give full continuous sound

INSTRUCTIONS

EXPLAIN HOW INSTRUCTIONS ARE CODED AS BIT PATTERNS

- The op-code is the instruction that the CPU must carry out and operand is the data or address

EXPLAIN HOW THE COMPUTER DISTINGUISHES BETWEEN INSTRUCTIONS AND DATA.

- The op-code is the instruction that the CPU must carry out and operand is the data or address
- Instructions and data are fetched at different points of the fetch execute cycle and program counter points to address of instruction and they are kept in separate parts of memory by the OS

DATABASES

DATABASE CONCEPT

DESCRIBE A DATABASE AS A PERSISTENT ORGANISED STORE OF DATA

Database – A persistent and organised store of data

EXPLAIN THE USE OF DATA HANDLING SOFTWARE TO CREATE, MAINTAIN AND INTERROGATE A DATABASE.

Data handling software helps users to create, maintain and interrogate a database

DBMS

DESCRIBE HOW A DBMS ALLOWS THE SEPARATION OF DATA FROM APPLICATIONS AND WHY THIS IS DESIRABLE

DBMS – Database Management System

- Separation of data called program-data independence
- It allows different applications to access the data at the same time
- It controls access to data providing security features to limit access
- It can force referential integrity, preventing any operation that could damage relationships
- It controls concurrency by locking records for editing to prevent conflicting updates

DESCRIBE THE PRINCIPAL FEATURES OF A DBMS AND HOW THEY CAN BE USED TO CREATE CUSTOMISED DATA HANDLING APPLICATIONS.

- May use SQL/ allows database to be queried
- It provides backups and the ability to restore from backup in the event of a disaster
- Provides facilities for creating tables/inserting data/viewing data/reporting
- Allows data structure to be independent of programs
- Allows relationships to be created between tables/maintains integrity
- Provides security features/levels of access

RELATIONAL DATABASES

UNDERSTAND THE RELATIONSHIP BETWEEN ENTITIES AND TABLES

Entity – A real world item about which data is stored in a database. Corresponds to tables in the database

UNDERSTAND THE COMPONENTS OF A RELATIONAL DATABASE, SUCH AS TABLES, FORMS, QUERIES, REPORTS AND MODULES

- On-screen forms are usually provided for users so that the information needed is easy to see and modify
- Reports are the printed output of data from the database usually resulting from a query

UNDERSTAND THE USE OF LOGICAL OPERATORS IN FRAMING DATABASE QUERIES

EXPLAIN THE USE OF KEY FIELDS TO CONNECT TABLES AND AVOID DATA REDUNDANCY

Primary Key – Field that holds data unique for each record (unique identifier). Two records cannot have the same primary key but can have duplicated data for other fields

Foreign Key – Primary key from another table linking the two. This means data relating to the record in this table can be retrieved from the table with the foreign key with no duplication of data. Preventing data redundancy.

DESCRIBE METHODS OF VALIDATING DATA AS IT IS INPUT

Check Digit – A calculation is performed on a number that generates another digits which is appended to the number. This is common on account numbers, bar codes and book ISBNs. When the data is entered the calculation is repeated and if the same check digit is not generated the input is rejected.

Format Check- Data must conform to a particular pattern such as registration plate

Length check – Data must be within certain limits. Telephone number might be set up to be no longer than 12 digits

Lookup check – Checks that the entered data exists in a database

Presence check – Checks that something has been entered

Range check – Checks data is within a given sensible range

Type Check – Checks that the data entered is the correct type

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EXPLAIN THE ADVANTAGES OF NETWORKING STAND-ALONE COMPUTERS INTO A LOCAL AREA NETWORK

- Sharing resources
 - Folders and files can be shared across a network
 - Peripheral devices such as printers and scanners can be shared
 - An internet connection can be shared across a network
 - Databases can be shared across a network so everyone has access to the latest correct version of the data
- Communication
 - Email can be used to communicate with colleagues
 - Using messaging systems to chat
 - Transferring files across a network
- Centralised management
 - User profiles and security can all be managed centrally
 - Software can be distributed across a network rather than having to install it on each individual computer
 - Users can use any PC on the network but still see their own files and permissions
- Distributed systems with networked computers it is possible to divide a problem into parts and solve the parts independently on different computers
- Needs expertise to set up and maintain which can be expensive
- Security is an issue as networks can help unauthorised people gain access to data. Prevented by:
 - Using strong passwords
 - Changing passwords often
 - Not installing software from unknown sources
 - Not visiting certain websites – reinforced using firewall
 - Logging out after use

DESCRIBE THE HARDWARE NEEDED TO CONNECT STAND-ALONE COMPUTERS INTO A LOCAL AREA NETWORK, INCLUDING HUB/SWITCHES, WIRELESS ACCESS POINTS

- In a wired network you need cat 5 cables to connect the workstations and peripherals required
 - Coaxial Cable or Fibre optic cable can also be used
 - Copper cable is very versatile but also susceptible to interference from power cables
 - Attenuation means that a maximum length of 100m on a LAN
 - Fibre optic cables contain very thin glass filaments that carry a light signal and the signal fades much less rapidly than a copper cable lasting for 2km
- Wireless networks use far fewer cables so can be cheaper to install; useful for mobile devices
- Network Interface Card (NIC) generates the signals that are carried through the network
 - Formats the data into a form required by the protocols of the network
- A hub boosts the signal and retransmits it to all the devices connected
 - This means that all the data is sent to all computers even if it is only meant for one
- Switches inspect the destination address of data packets and compare it to known MAC addresses and connect the sender directly to the receiver

- This means that no other computers receive the message unnecessarily and no data collisions occur
- They are more efficient than hubs
- Bridges separate network segments and filter incoming traffic by checking if the packet being sent has a MAC address on a different segment or not. If the device is on the same segment it discards the packet.
- Wireless Access Points generate wireless signals and connect to the LAN. Usually have some security

EXPLAIN THE DIFFERENT ROLES OF COMPUTERS IN A CLIENT-SERVER AND A PEER-TO-PEER NETWORK

- Server centrally holds all data, files, mail and intranet the clients need to request
 - Gives central control of security
 - Prevents duplication of data
 - Easier to supervise network performance
 - Easier to perform software upgrades
 - Faster performance with fewer data collisions
 - Client machines freed up to perform their jobs
 - Easier to perform back-ups
 - A knowledgeable administrator is needed
 - More infrastructure to set up with wiring cabinets to install and possible building work
 - If the server goes down it has more of an impact than if one peer is lost
- Peer-to-peer network has no central server with all the computers equal and request files and data off each other when needed
 - Often make use of a hub
 - No network wide security in place
 - Machines slow down when being accessed from another
 - A user might restart a machine when someone else is accessing it
 - Backup becomes complicated
 - No dependency on server if one peer goes down it is not an issue

DESCRIBE, USING DIAGRAMS OR OTHERWISE, THE RING, BUS AND STAR NETWORK TOPOLOGIES

- Computers are connected in a ring and data is sent in one direction until it finds the computer it was sent to. A token is passed around the ring with computers modifying it to send data and to acknowledge delivery.
 - No reliance on a central server to coordinate traffic
 - If any node breaks the whole network is jeopardised
 - Quite difficult to add new computers
 - Insecure as every computer can monitor all traffic
- All computers connected individually to central computer that controls the network
 - If one cable fails only that computer is affected
 - Consistent performance even with high levels of network traffic
 - Easy to add new computers
 - More secure as messages go from a computer directly to the centre
 - Can be costly to install because of lots of cabling
 - Dependence on central computer, if it fails the whole network goes down
- Each computer is connected to a single cable with terminators at the end to prevent bouncing signals
 - Easy and cheap to install with less cabling than a star network

- Easy to add a new computer
- If the main cable fails then the whole network goes down
- Cable failures are hard to isolate because it affects all of the computers attached
- Performance slows down as the amount of traffic increases

DESCRIBE THE DIFFERENCES BETWEEN A LOCAL AREA NETWORK AND A WIDE AREA NETWORK SUCH AS THE INTERNET

- WAN is a collection of computers and networks over a geographically remote area
- LAN a collection of computers connected together within a single site

EXPLAIN THE TERMS IP ADDRESSING, MAC ADDRESSING, PACKET AND PROTOCOLS

- Each computer on a TCP/IP network has an IP address
- IPv4 is a 32 bit number arranged into octets that can store numbers ranging from 0 to 255
- IPv6 is a 128 bit number with 64 bits for host ID and 64 for the network and subnet bits
- IP addresses can be permanently allocated to a device (static addressing) which requires the network administrator to manually enter the correct IP addresses into each device
- DHCP (Dynamic Host Configuration Protocol) the server provides an IP address to any new computers joining the network
- DNS (Domain Name System) provides a link between URL and IP addresses
 - DNS is hierarchical with top level domains, domain names and server names
- MAC (Media Access Control) address is burned into the ROM of the NIC and is unique containing the manufacturer's code and serial number
 - Used by switches and wireless access points to identify the device
- Protocol – A set of rules that govern the transmission of data
 - Tells the computer what sized packets to send, how they can recognise each other and how to cope with lost packets
- TCP (Transmission Control Protocol) sends synchronisation packets to ensure destination is online and ready to receive. Then sends some packets and waits for acknowledgement requesting the next ones. If they did not receive them all the source still receives acknowledgement and knows to slow down transmission. The packets each have a sequence number so even if they are received out of order they can be reassembled.

EXPLAIN THE NEED FOR SECURITY MEASURES IN NETWORKS, SUCH AS USER ACCESS LEVELS, SUITABLE PASSWORDS AND ENCRYPTION TECHNIQUES

- Network policies reduce risk of unauthorised access to data
- User access levels prevent users from accessing data that they are not authorised to
 - It can also make files read-only for some users
- Suitable passwords prevent hackers from breaking in by guessing or brute forcing passwords
- Encryption prevents hackers from being able to utilise stolen information

DESCRIBE AND JUSTIFY NETWORK POLICIES SUCH AS ACCEPTABLE USE, DISASTER RECOVERY, FAILOVER, BACK UP, ARCHIVING

- Acceptable use policies prevent the employees from accidentally jeopardising a network
- Disaster recovery plans involve prevention, detection and correction
 - Prevention just involves locking doors, using strong passwords and employing security guards

- Detection is often done automatically as software can log accesses and report suspicious activity
- Backups will be made regularly with incremental backups supporting complete ones
 - Lots of the time data is replicated off site
- Many systems of redundant hardware that comes online in the event of a failure
 - This is called failure
 - An example is two switches working at 50% and if one breaks the other operates at 100%
- Archiving is for data that is no longer in regular use such as the records of pupils that have left the school
 - Frees up space

INTERNET

DESCRIBE THE NATURE OF THE INTERNET AS A WORLDWIDE COLLECTION OF COMPUTER NETWORKS

- The internet is a huge network of networks

DESCRIBE THE HARDWARE NEEDED TO CONNECT TO THE INTERNET INCLUDING MODEMS, ROUTERS

- Modems (Modulator Demodulator) are the cheapest and slowest type of connection
 - It converts signals from digital to analogue and connects to the ISP
 - ADSL has greatly improved the speed of download speeds by utilising the fact that most of the bandwidth is used for download and making it asymmetric unlike the old POTS
- Router allows all the different devices to connect to the internet and share resources
 - It decides where data packets should go based on a configuration table containing:
 - Which connections lead to a particular group of address
 - Priorities for connections
 - Rules for handling traffic
 - Routers use part of the phone line using broadband technology that allows digital transmission allowing the use of computers and phone line at the same time

EXPLAIN THE NEED FOR IP ADDRESSING OF RESOURCES ON THE INTERNET AND HOW THIS CAN BE FACILITATED BY THE ROLE OF DNS SERVICES

- Domain Name System is made of name servers
- When a DNS server is given a domain name it looks it up in its database
 - If it is in their it returns the ip address that the site is found at
 - If not the request is passed on until it finds the authoritative server (they one set by the person who owns the site)

EXPLAIN THE IMPORTANCE OF HTML AND ITS DERIVATIVES AS A STANDARD FOR THE CREATION OF WEB PAGES

- HTML (Hyper Text Markup Language) is used to describe page content
- CSS (Cascading Style Sheet) allows developers to change the look and feel of a web page without the need to edit the HTML code
- XML (Extensible Mark-up Language) allows exchange of data across the internet
- JavaScript is a programming language that can be imbedded into web pages

DESCRIBE COMMON FILE STANDARDS ASSOCIATED WITH THE INTERNET SUCH AS JPG, GIF, PDF, MP3, MPEG

- Using standard file types makes sure that everyone can access your documents
- JPEG (Joint Photographic Experts Group) can store complex images in small file size
 - Lossy format that throwing away information
- GIFs better for simple images such as icons, logos or simple animations
 - Uses lossless bitmap image compression but can only use 256 colours so are no good for photos but small file size makes them good for the web
- PNG (Portable Network Graphics) designed to replace gif you can use it for photos but the file size will usually be bigger than JPEG
 - Uses lossless compression
- MP3 is lossy
- MPEG-4 is designed to work well over narrow broadband and contain media such as graphics and subtitles as well as video and audio and is lossy
- PDF (Portable Document Format) de-facto standard for documents by converting documents to pdf they can be shared with people that do not have the software and it is lossless

EXPLAIN THE IMPORTANCE OF COMPRESSING FILES THAT ARE TRANSMITTED VIA THE INTERNET

- It is necessary to compress files in order to speed of download times, reduce congestion on the network and save space

DESCRIBE THE DIFFERENCES BETWEEN LOSSY AND LOSSLESS COMPRESSION

- Lossy compression loses quality of the sound/image but can reduce the size of the file significantly
 - It sometimes works by identifying sound frequencies that are not obvious and deleting them
 - This means removing frequencies that we can't hear or soft sounds at the same time as loud ones
- Lossless compression retains the quality but cannot compress images down 11 fold
 - This works by looking for repetitions or patterns in the file and simplifying them by substituting repetitions with references
 - Replacing repeated words with numbers for a lookup table
 - Video compression only recording things that change in a frame not everything

PROGRAMMING

PROGRAMMING LANGUAGES

EXPLAIN THE DIFFERENCE BETWEEN HIGH LEVEL CODE AND MACHINE CODE

- High level code is human oriented code written by programmers that contains words for commands close to the English language.
 - It is machine independent and portable to different systems
 - Needs to be translated before it can be run
 - It is problem based
 - One command equates to many machine code instructions
- Machine code is binary instructions for the CPU to execute that are not readily understandable by humans
 - Specific to a particular computer and does not need to be translated

EXPLAIN THE NEED FOR TRANSLATORS TO CONVERT HIGH LEVEL CODE TO MACHINE CODE

- To translate the high level code into machine code so the CPU can run it
- To pick up syntax errors

DESCRIBE THE CHARACTERISTICS OF AN ASSEMBLER, A COMPILER AND AN INTERPRETER

- An assembler converts assembly code mnemonics into machine code by using a lookup table
 - Difficult to code with few commands
 - Gives precise access for increased performance
- A compiler converts all the high-level source code to machine code before running the program
 - Errors must be fixed before the program can execute
 - Will generally run faster as does not need translator present taking up less memory
 - Code is difficult for other people to modify without source code
 - Initial compilation is slow
- An interpreter converts every line of source code one instruction at a time into machine code then runs it before translating the next instruction
 - Does not produce machine code and must be translated every time it is run
 - Will run until it comes across an error – useful for developing programs
 - Code segments can be run and tested independently to identify errors
 - Can step through the code checking variables and using breakpoints
 - Must have interpreter present to run program
 - Slower as has to translate each instruction before running

DESCRIBE COMMON TOOLS AND FACILITIES AVAILABLE IN AN INTEGRATED DEVELOPMENT ENVIRONMENT (IDE): EDITORS, ERROR DIAGNOSTICS, RUN-TIME ENVIRONMENT, TRANSLATORS, AUTO-DOCUMENTATION.

- Text editor helps to organise code by managing the layout:
 - Indenting structures
 - Colour-coding command words, variables and comments
 - Autocomplete wizards
- Error diagnostics include an errors and warnings list to identify any problems in the code

- Run time environment allows the developer to run code during development and can be used to check for logical errors by stepping through the code or using breakpoints to check the variables
- Translator compiles or interprets the source code into machine code so it can be run
- Auto documentation takes a note of all the variables, modules, subroutines and comments as the project is developed and tidies this up into a text file that can be used during any maintenance

HANDLING DATA IN ALGORITHMS

DEFINE THE TERMS VARIABLE AND CONSTANT AS USED IN AN IMPERATIVE LANGUAGE

- A constant is a value that does not change while the program is running
- A variable is a location in memory to store a value that may change

USE VARIABLES AND CONSTANTS

DESCRIBE THE DATA TYPES INTEGER, REAL, BOOLEAN, CHARACTER AND STRING

- Integers are whole number values, positive or negative with no decimal or fractional parts
- Real numbers will also store decimal or fractional parts
- A character is a single alphabetic or numeric character
- String is a chain of characters
- Boolean is a value that can only be true or false

SELECT AND JUSTIFY APPROPRIATE DATA TYPES FOR A GIVEN PROGRAM

PERFORM COMMON OPERATIONS ON NUMERIC AND BOOLEAN DATA

USE ONE-DIMENSIONAL ARRAYS

TESTING

DESCRIBE SYNTAX ERRORS AND LOGIC ERRORS WHICH MAY OCCUR WHILE DEVELOPING A PROGRAM

- A syntax error is an error in the rules/grammar of the language
 - Misspelt keywords or missing brackets
- A logic errors are when the logical structure of the program produces unexpected results

UNDERSTAND AND IDENTIFY SYNTAX AND LOGIC ERRORS

SELECT AND JUSTIFY TEST DATA FOR A PROGRAM, STATING THE EXPECTED OUTCOME OF EACH TEST.