Character Sets

- Allow computers to understand letters, numbers, and other characters
- Logically ordered, the value for A is lower than B
- ASCII
  - American Standard Code for Information Interchange
  - Each character is given a unique binary code
  - A = 065 = 01000001
  - Code is 8 bits (1 byte) long
  - 256 possible characters
- Unicode
  - Uses 2 bytes giving many more characters.
  - Accommodates languages such as Arabic with thousands of characters

Storing Sound

- Computers only understand binary so sound must be encoded
- Broken down into thousands of samples per second, each is stored as binary data
- Sample rate
  - Measured in Hz
  - How many samples per second
  - more samples = more detail = clearer sound = more space needed
- Bit Depth
  - Number of bits available for each sample
  - Higher bit depth = higher quality = more space needed
- Duration
  - Higher duration = longer audio = more space needed

Storing Images

- Images are stored as a series of pixels in binary
- Each pixel has a specific colour, represented by a specific code
- Also contains metadata
  - Structure of the file
  - Size of the grid
  - Other info such as date
- Resolution is the number of pixels in the image
  - Higher resolution = more pixels = clearer image = more space needed
- Colour depth is the number of bits used to store the colour for each pixel
  - 1 bit allows 2 values, 2 bits allow 4 values etc.
  - Higher colour depth = more realistic colours = more space needed

Compression

- Encoding data so that is needs fewer bits/bytes to represent it
- Reduces space needed for storage
- Must be decompressed to be used
- Lossless Compression
  - Compresses data files without losing any of the information
  - Reversible - that the original data can be reconstructed
  - Not all files can be compressed in this way
- Lossy Compression
  - Does lose some of the information
  - Used where this is acceptable e.g. audio
  - Produces smaller files
  - Poorer accuracy

Units of Data Storage

- Bit
- Nibble - 4 bits
- Byte - 8 bits
- Kilobyte (KB) - 1,000 bytes
- Megabyte (MB) - 1,000 KB
- Gigabyte (GB) - 1,000 MB
- Terabyte (TB) - 1,000 GB
- Petabyte (PB) - 1,000 TB

Converting Binary to Hex

8	**4**	**2**	**1**
0	1	1	0

4 + 2 = 6

6

8	**4**	**2**	**1**
1	1	0	1

8 + 4 +1 = 13

D

Converting Between Denary and Binary

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

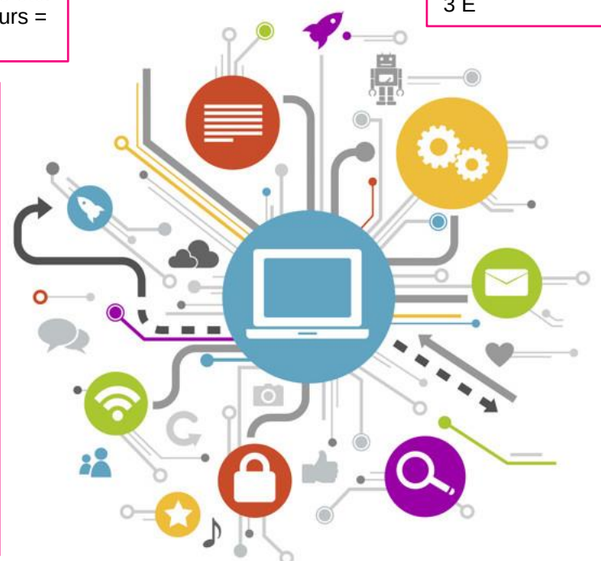
Converting Denary to Hexadecimal

62 ÷ 16 = **3** R 14

3 ÷ 16 = **0** R 3

3 14

3 E



Binary

- Binary is a number system made up of 1s and 0s
- There are only two possibilities, so this is a base two number system
- Computers use binary because the CPU contains transistors, which are either on or /off

Hexadecimal

- Hexadecimal is a number system using 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F
- There are 16 possibilities, so this is a base sixteen number system
- Binary strings are long and difficult to work with. Hex is shorter
- Hex is easily converted to binary as there is 1 hex digit per nibble.
- Hex is less prone to error

Choosing Storage Media

When choosing a storage media there are several factors to consider:

Capacity
- How much data the storage media can hold
- Larger files such as videos/ music/ pictures will require larger amounts of storage

Speed
- How quickly the data can be written and read back
- Some situations, such as a live website, will need data to be accessible quickly
- In other situations, such as a backup, it is acceptable for the process to take longer

Portability
- How easy it is to move the storage media from one device to another.
- The size of the media itself and the compatibly of the media

Durability
- The length of time the storage media is expected to last
- How easily damaged the storage media is

Reliability
- How likely the storage media is to fail and how likely errors are to occur.

Cost
- How expensive the storage media and any required hardware is.

1.2 Memory and Storage

Primary Storage

- Much faster than secondary storage
- Holds data and instructions needed by the CPU

ROM (Read Only Memory)

- Values stored in ROM remain when the computer is switched off (non volatile).
- Virus attacks are unlikely.
- Values stored cannot be accidentally changed.
- Data is written permanently when the computer is built.
- Holds the instructions for booting the computer.

RAM (Random Access Memory)

- Loses its data when the computer is switched off (volatile)
- Used to save data about programs that are currently open.
- Much faster than a HDD or SSD, and so the CPU has to spend less time in the "fetch" part of the "fetch-decode-execute".
- It is more expensive per GB than a HDD or SSD. This limits our usage of RAM, and the amount that can be installed.

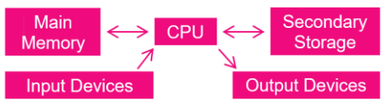
Virtual Memory

- Virtual memory is simulated memory that is written to a file on the hard drive.
- It lets more memory be used than there is in the system.
- This is useful when you need to run more applications on the computer than RAM can support.

Virtual Memory Implementation

1. The Operating system sets up virtual memory using the Virtual Memory Manager (VMM).
2. The VMM creates a file on the hard disk large enough for the extra memory needed.
3. The Operating System can then address the virtual memory as if it were real memory stored in RAM.
4. Swapping or paging is the process used by the operating system to move data between RAM and virtual memory.
5. Data which processes do not need immediately is moved out of the RAM to virtual memory.

Memory Data Flow



Calculating File Sizes

- sound file size = sample rate x duration (s) x bit depth
- image file size = colour depth x image height (px) x image width (px)
- text file size = bits per character x number of characters

Secondary Storage

- Storage devices which are not constantly connected to the computer.
- Storage devices not directly accessible by the system's CPU.
- Used to back up data stored in primary storage.
- Useful when there is a need for larger storage capacity.

Types of Secondary Storage

Optical Storage
- Data is written and read using a laser beam
- Examples include CDs and DVDs
- Inexpensive, reliable, robust, relatively large capacity

Magnetic Storage
- Uses different magnetic patterns to store data
- Examples include tape cartridge and hard drive
- Large capacity, can be used to store operating system and other files and programs, reliable, cost-effective

Solid State Storage
- Data is stored within flash chips
- Examples include USB drives and SSDs
- Flexible, faster access to data, can be used for portable devices, generally smaller in size, robust, easy to use

Examples of Choosing Storage Media

A portable barcode scanner uses solid state flash media

- **Capacity:** barcodes do not consume much data so high capacity is not required.
- **Speed:** flash media is quick and delays when scanning would affect the device's operation
- **Portability:** flash media is small and light and so will easily fit within the scanner
- **Durability**: flash media has no moving parts so the device can be moved without damage
- **Reliability**: flash media is highly reliable
- **Cost:** flash media is more expensive than other storage, but this is outweighed by the above factors

Films are sold on DVD and BluRay disks

- **Capacity:** high capacity to allow for longer, higher quality movies
- **Speed:** slower access speeds than flash memory but sufficient for the task
- **Portability:** lightweight, small and commonly used
- **Durability**: durable if stored correctly
- **Reliability**: reliable if stored correctly
- **Cost:** very cheap to produce in high quantities