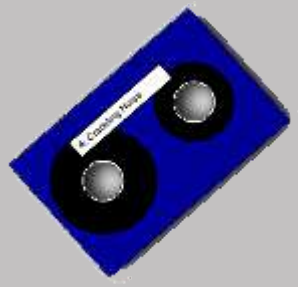
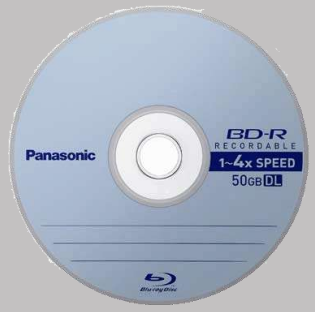
Backing Storage Media





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Key Words

The following words will crop up as part of the following presentation. You should use your notes sheet to log information about them when it is covered. You will be quizzed on these words later.

- Fixed Hard Disk
- Portable Hard Disk
- Floppy Disk Drive
- Magnetic Tape
- Optical Storage
- DVD-RAM
- Blu-Ray Disk
- Solid State Backing
- CD-ROM
- DVD-ROM
- Bits and Bytes
- Kilobytes and Megabytes
- Gigabytes and Terabytes
- CD-R
- DVD-R
- CD-RW
- DVD-RW
- Memory Sticks / Pen Drives
- Flash Memory Cards

NOTE:
Sections of the presentation where you see the key symbol contain information about these keywords. This is your cue to make notes.

Backing Storage Media

Definition:

"Internal or External devices that are used to store data either temporarily or permanently.".

Overview:

- Computers have always come with some sort of way to store data.
- There are two main types of storage:
  - Temporary Storage
    RAM which loses its data as soon as computer is turned off.
  - Permanent Storage
    Hard Disks and other forms of storage which do not lose their data even when computer is turned off.

NOTE:
ROM is also included in with the permanent storage category.
Remember – ROM is 'Read Only' which means users cannot add/delete data.

Permanent Storage

- Permanent storage devices do not lose their contents once the computer is switched off (unlike RAM which is temporary storage).

- Permanent storage devices can be either:
  - Internal (Located inside the computer)
  - External (Plugged into the computer via usb).

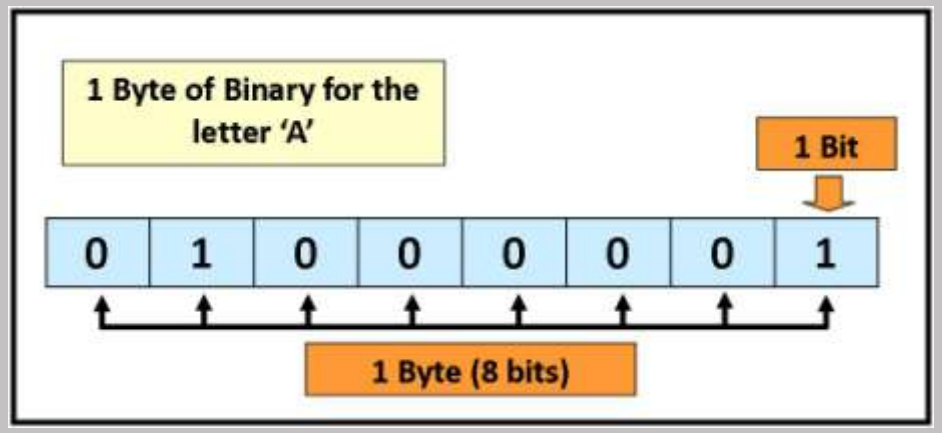
- There are three main types of permanent storage:
  1. Magnetic (like hard disks and magnetic tapes)
  2. Optical (like CD-ROMS and Blu-Ray Disks)
  3. Solid State

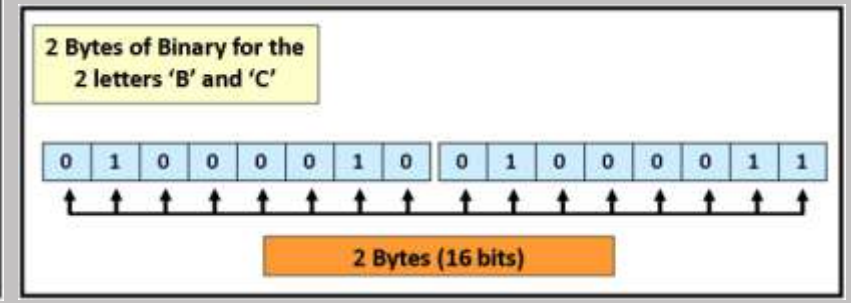
NOTE:

For more information about temporary storage and RAM refer back to Section 1 (Hardware and Software / Components).

Storage Capacity

- The amount of data and that can be stored on a storage device is measured in 'bytes'.
- One byte contains 8 'bits' (bits are short for Binary Digit). This is the smallest unit of data that can be stored. Each 'bit' is represented as a binary number, either 1 or 0.
- A single keyboard character such as the letters A or B takes one byte of storage. (Click here for a text to binary converter)





Storage Capacity

- Storage capacity is the maximum amount of data that the device can hold in Bytes.

- We normally refer to the capacity of a storage device in terms of:
  - Kilobytes
  - Megabytes
  - Gigabytes
  - Terabytes

Storage Sizes	
Quantity	**Information**
Bit	Smallest unit of data (either a 1 or a 0)
Byte	8 bits
Kilobyte (Kb)	Assumed to be 1,000 bytes (Actually 1024 bytes)
Megabyte (Mb)	1,000 kilobytes (1024 Kb)
Gigabyte	1,000 megabytes (1024 Mb)
Terabyte	1,000 gigabytes (1024 Gb)

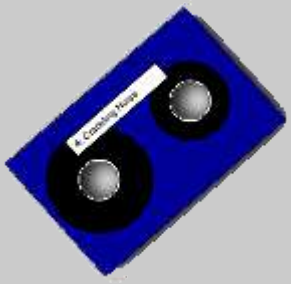
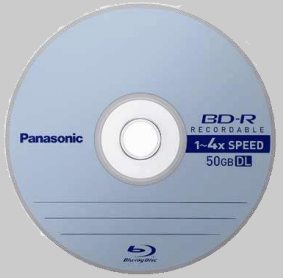
Storage Capacity – Quick Questions!

- How many single text characters (letters) could we store (roughly) if our storage device had the following capacities.
  - 1 kilobyte?
  - 10 kilobyte?
  - 1 megabyte?
  - 1 Gigabyte?
  - 1 Terabyte?

1,000 characters **or half a page of text**
10,000 characters **or 5 pages of text**
1,000,000 characters (1 million) **or 500 pages of text**
1,000,000,000 characters (1 billion) **or 500,000 pages**
1,000,000,000,000 characters (1 trillion) **or 1,000,000 thick books**

Storage Sizes	
Quantity	**Information**
Bit	Smallest unit of data (either a 1 or a 0)
Byte	8 bits
Kilobyte (Kb)	Assumed to be 1,000 bytes (Actually 1024 bytes)
Megabyte (Mb)	1,000 kilobytes (1024 Kb)
Gigabyte	1,000 megabytes (1024 Mb)
Terabyte	1,000 gigabytes (1024 Gb)

Examples of Storage Devices

Fixed Hard Disc 	Magnetic Tape 	Flash Memory 	Micro Flash Memory 
Memory Stick 	Floppy Disc 	DVD-RAM 	External Hard Disc 
CD-ROM 	DVD-ROM 	Solid State Hard Disc 	Blu-Ray Disc 

Magnetic Storage

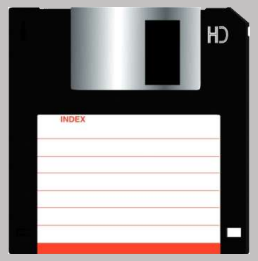
Fixed Hard Disc

(Direct Access)

External Hard Disc

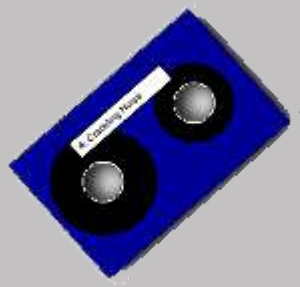
(Direct Access)

Floppy Disc



(Direct Access)

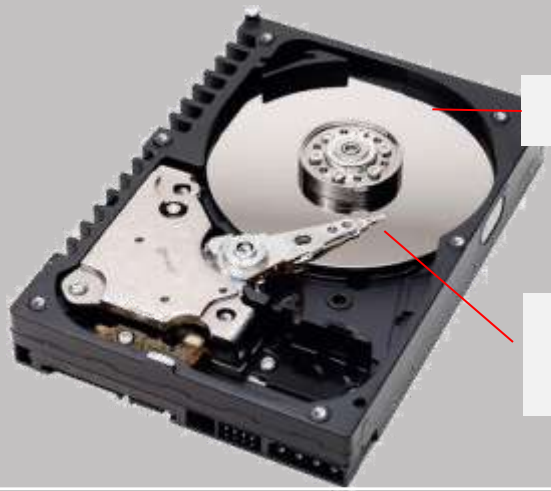
Magnetic Tape



(Serial Access)

Fixed Hard Disc

- Used on all computers and are the main method of storing data.
- The disc surface (Platter) is coated in a magnetic film which is where the data is stored.
- These have read/write heads which allow data to be written to (saved) or read (used) from the disc. Allows very fast read/write times.
- Hard Discs are used to store Operating Systems, Software Applications and all other files.
- Typical storage spaces are 250 gigabytes up to 1 terabyte (1,024 gigabytes).

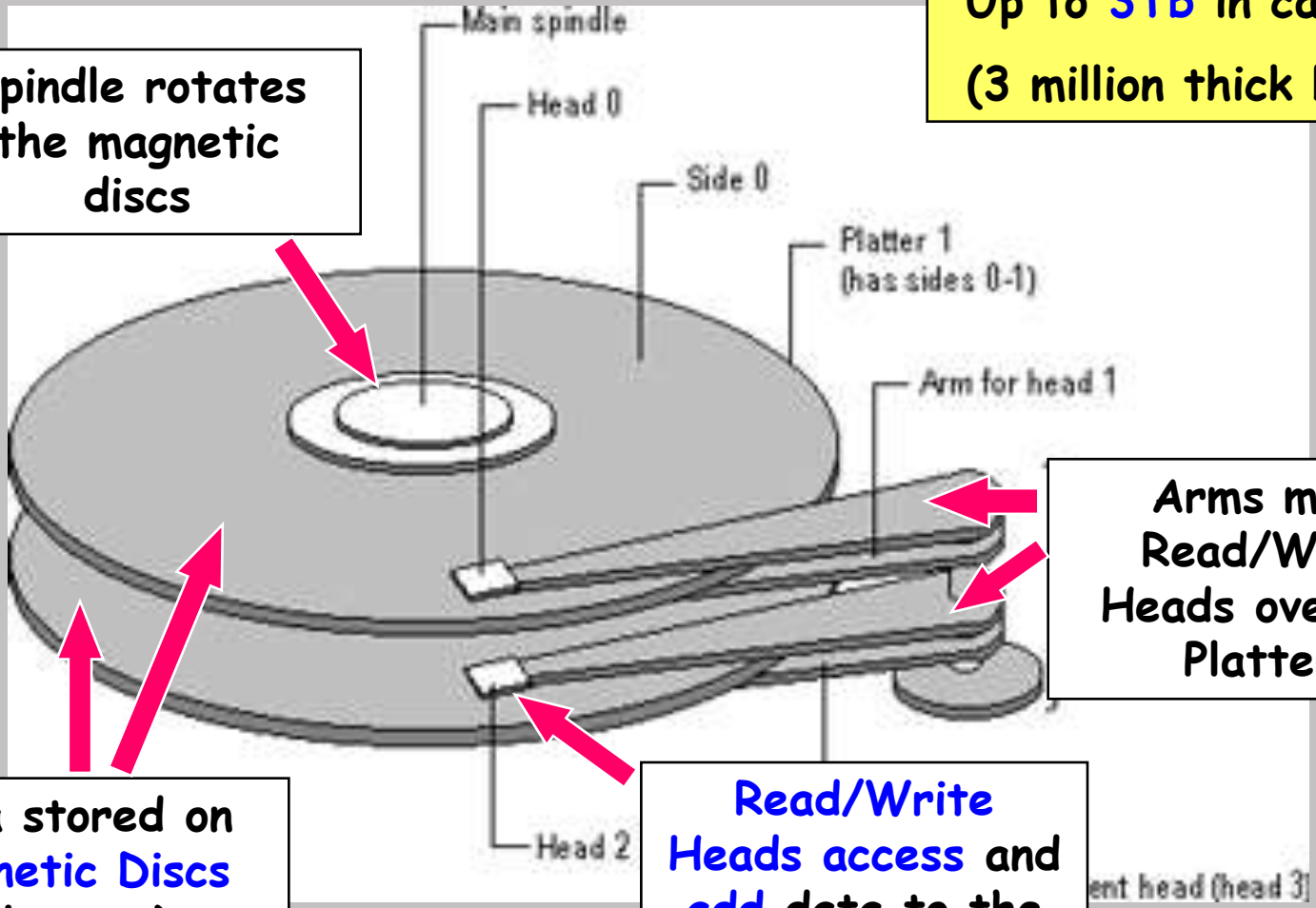


Fixed Hard Disc

Up to 3Tb in capacity

(3 million thick books)

Spindle rotates the magnetic discs



Arms move Read/Write Heads over the Platters

Data stored on Magnetic Discs (platters)

Read/Write Heads access and add data to the platters

Fixed Hard Disc Drives

Uses:

- Used to store the Operating System and Applications Software (Windows, Word, Excel etc).
- Used for storing Files and Documents (music and homework for example).
- Real-time systems (Robots, Chemical Plant Control Systems) and Online Systems (Booking airline tickets etc) use hard disc drives to store data.
- Used in File-Servers on computer networks to store files (Like the student Z: drive in our school is used to store your work).

Advantages 	Disadvantages 
• **Fast read/write times** (Saves data to disk and reads back from it quickly).	• **Can be damaged easily** when computer is not shut down properly (Disc crash!).
• **Huge capacities** (Can store thousands of movies and music files).	• **Not portable** as they are designed to be 'fixed' into computer and not removed.
• **Very easy to update/delete files**	

Portable Hard Disc Drives

- Works in a similar way to fixed hard discs but are connected to the computer externally via a Universal Serial Bus (USB) port.
- Portable Disc Drives are designed to be transportable.
- They come with a USB Cable to allow for easy attachment to other computers which allows for easy backing up / sharing of files and data between 2 or more people.
- Because they are used outside of the computer they come with protective casing to avoid physical damage to the disc drive.
- Typical storage spaces are 250 gigabytes up to 1 terabyte (1,024 gigabytes).

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Portable Hard Disc Drives

Up to 3Tb in capacity
(3 million thick books)

Small and Light… ideal for carrying around.

Protective Casing

USB Connectivity

Portable Hard Disc Drives

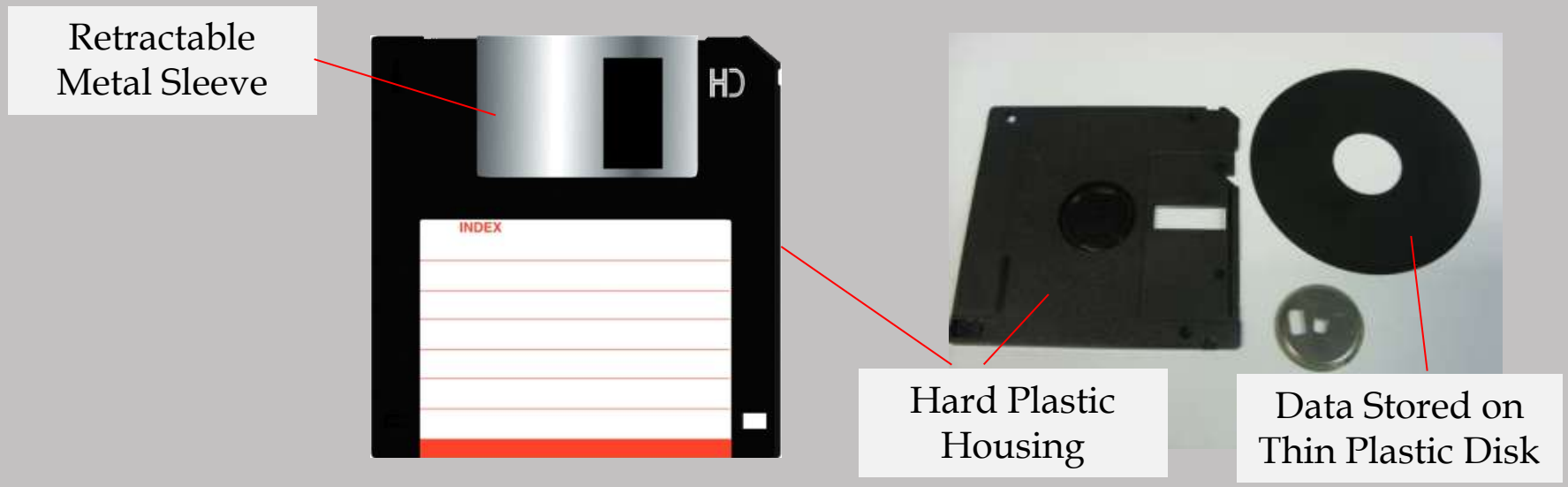
Uses:

- Can be used as portable back-up systems to avoid loss of data.
- Used to transfer data, files and software between computers via USB connectivity.

Advantages	Disadvantages
• **Fast read/write times**.	• **Can be damaged easily** when computer is not shut down properly (Disk crash!).
• **Huge capacities**. (Thousands of movies and music files).	• Protective casing will only protect against minor bumps. **If the device is dropped it can still become damaged**. **NOTE:** This is always a risk when transporting data externally!
• **Small and light** with **protective casing** makes them **perfect for transporting data** between computers very easily.	
• Designed to **plug into almost any computer** via USB ports.	• **More expensive** than other forms of storage.

Floppy Disc Drives

- Old method of external data storage where information is held on a thin plastic disc which rotates.
- As the disc rotates, a read/write head is used to add or read data.
- The disc of plastic is protected by a retractable metal sleeve and hard plastic housing. A small notch provides write protection (prevents accidentally copying over work).
- Maximum storage on a floppy disc is about 1.44 Mb (700 pages of text).



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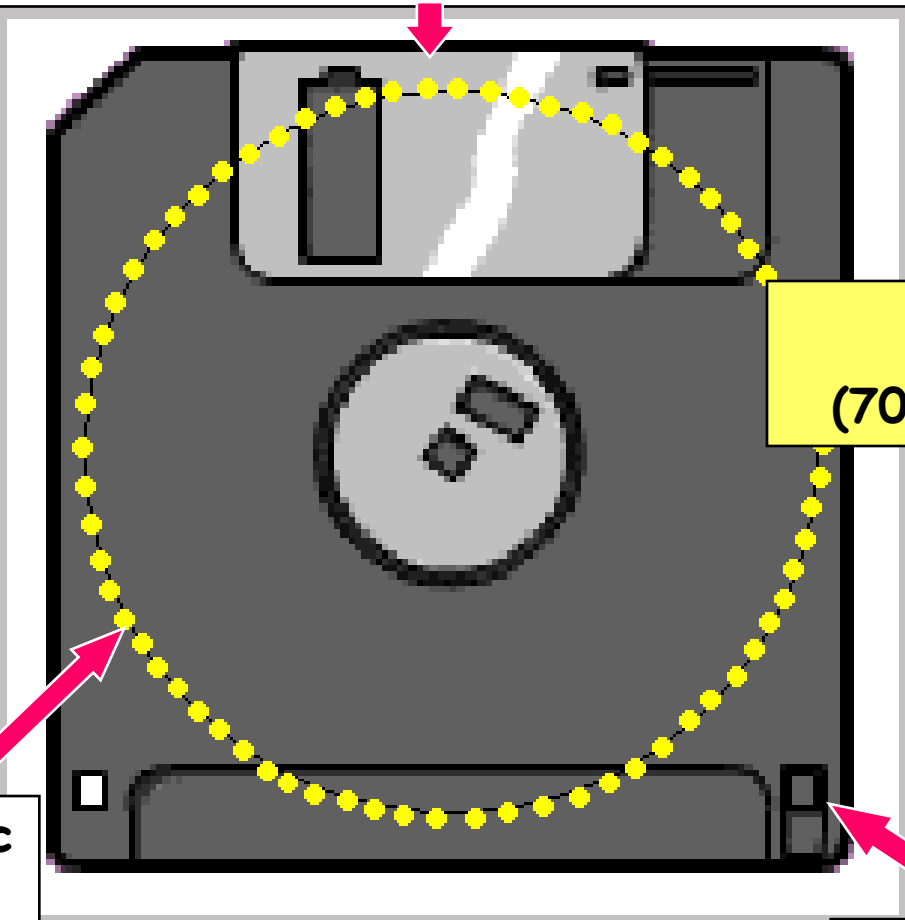
Floppy Disc Drives

Retractable Metal Sleeve.

Covers a window where data on plastic disk is accessed.



1.4Mb in size

(700 pages of text)

Disc inside plastic case.

Rotates.

Write Protect Notch

Floppy Disc Drives

Uses:

- Still used where very small files need to be transferred/stored (e.g. small word processed documents).
- Write protect facility is useful to prevent accidental overwriting of data.

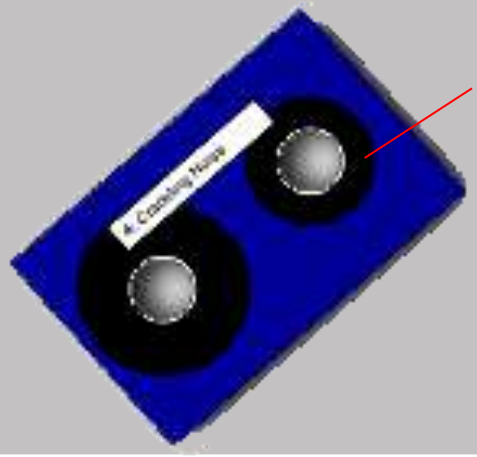
Advantages	Disadvantages
• **Cost very little to buy**.	• **Very low storage capacity** when compared to other methods (1.44 Mb).
• **Can be write protected easily** which protects against accidentally copying over files.	• **Very few modern computers have floppy disc drives** (device used to read the disk).
	• **Floppy discs are very delicate** and easy to damage **(Not robust)**.
	• **Slow data transfer rate** (Takes a long time to save/read from the disk).

Magnetic Tapes

- Thin strip of magnetic coated plastic which is wrapped onto a reel.
- Data is stored on the magnetic plastic in the form of 1's and 0's (binary).
- Data is written to and read from in sequence (i.e. in order) which is also known as Serial Access.

REMEMBER: Serial Access works a bit like a video tape. To access something in the middle of the tape you need to start at the beginning then fast-forward until you get to the part you need.

- This type of storage is useless for Real-Time Applications (where what is stored is constantly being updated) because it is very slow.



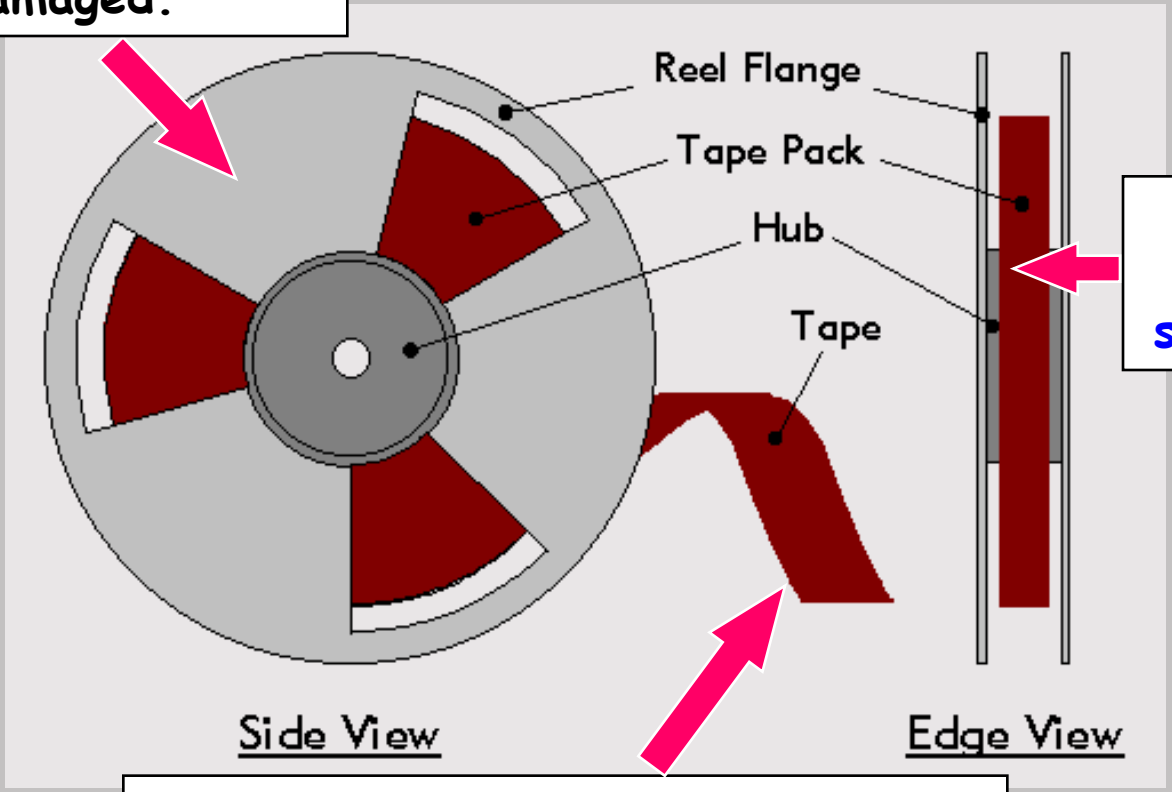
Magnetic Tape on a reel

Magnetic Tapes

Up to 5Tb in capacity

(5 million thick books)

Robust and not easily damaged.



Magnetic tape provides huge storage capacity

Tape read back in sequence from beginning to end (slow)

Magnetic Tapes

Uses:

- Used where extremely large amounts of data need to be backed up.
- Used where speed of reading/writing of data is NOT a priority.
- Used in Batch Process applications such as clearing bank cheques and producing payslips. (See more information about batch processing here)
- Used for backups of File Servers on computer networks in Schools and Business. (For example – your files are backed up on the school network)

Advantages	Disadvantages
• **Generally less expensive** than the equivalent capacity hard disk drive.	• **Very slow data access/transfer** (Reading data back from the tape is slow).
• **Very robust** (Not easily damaged).	• **Needs another tape to update data** (i.e. original tape + tape with the changes = updated tape)
• **Very large storage capacities** (Up to 5 terabytes or 5 trillion characters)	

Optical Storage

CD-ROM

(Direct Access)

DVD-ROM

(Direct Access)

CD-R

(Direct Access)

DVD-R

(Direct Access)

CD-RW

(Direct Access)

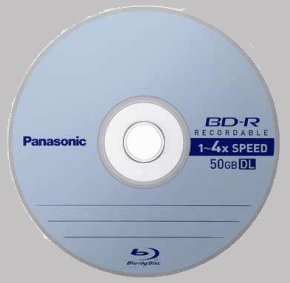
DVD-RW

(Direct Access)

DVD-RAM

(Direct Access)

Blu-Ray Disc



(Direct Access)

Optical Storage Devices

- Optical Storage Devices are all those mediums that use light to read/write the information. Optical Devices include:

CD-ROMS	**DVD-ROMS**	**CD-R**
DVD-R	**CD-RW**	**DVD-RW**
DVD-RAM	**BLU-RAY**	

- Data is stored as a number of data dots that can be read using light (usually a laser beam). Each dot represents 1's and 0's (Bits of information) Video of a CD/DVD Player reading a disk

- Data is read by shining the laser beam onto the surface of the disc. If the light hits one of the dots it is reflected back differently than it would be if there was no dot. This difference is read as data by the computer.

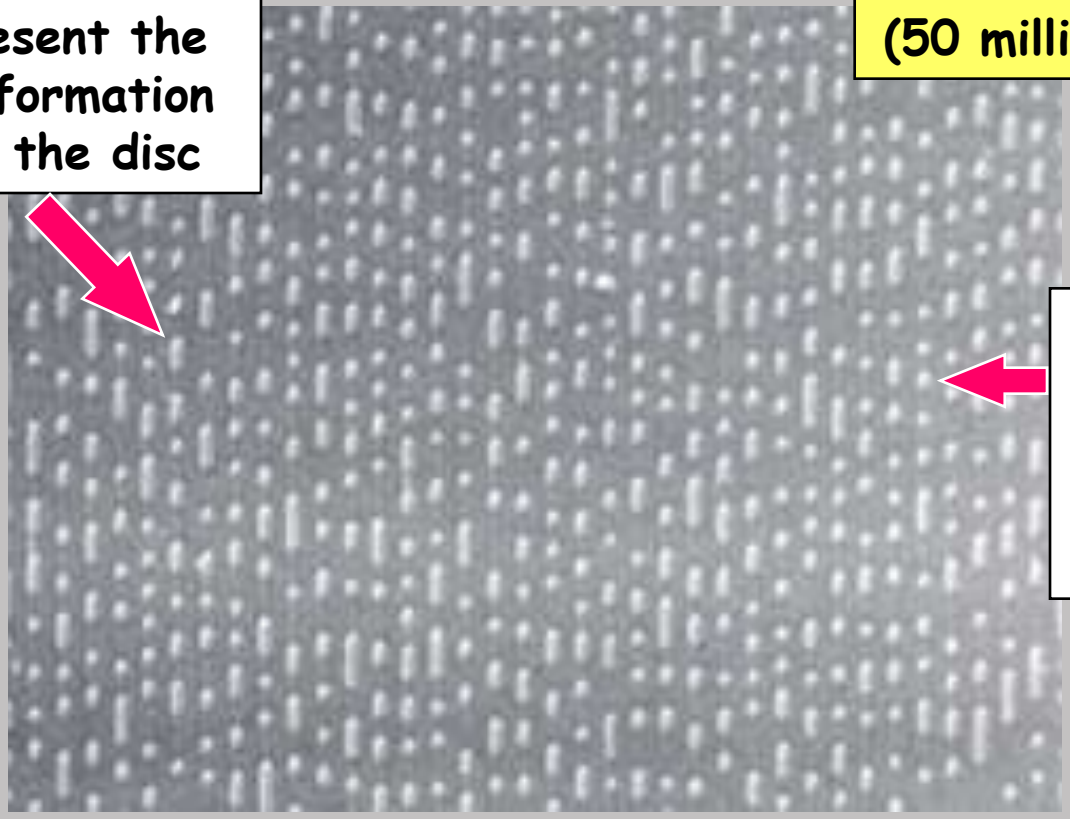
- Some Optical Disks (such as CD-R's) allow you to write data to the disc as well as read it. This works by using the laser beam to 'burn' dots onto the surface of the disk (creating the data) and then reading them back again. This process is known as 'burning'.

Optical Storage Devices

Different patterns of dots represent the type of information stored on the disc

Up to 100Gb in capacity

(50 million pages of text)



Store data as 'dots' which are read using low-level laser beam light.

Some optical discs allow 'burners' to replace the dots with other dots. This is known as 're-writing' information.

Read Only Optical Discs

CD-ROM and DVD-ROM

- CD-ROMS and DVD-ROMS are classed as Read Only Memory. This means that the data cannot be Written Over (added to) and can only be Read.

Uses:

- **CD-ROMS** are used by manufacturers to store smaller files (up to 800MB) such as:
  - Music CD's, Electronic Books etc
  - Software such as Microsoft Word etc

- **DVD-ROMS** have much larger storage capacities (up to 4.7 GB) than CD-ROMS and are used to store bigger files such as:
  - Movies
  - Larger games such as COD.

Advantages	Disadvantages
• Hold **far more data** than Floppy Discs.	• **Very slow data access/transfer** when compared to a Hard Disc Drive (Reading data back from the CD/DVD is slow).
• **Less expensive** than Hard Disc Drives.	

CD-ROMS and DVD-ROMS

Stores about 800Mb of data

(400,000 pages of text)

Stores about 4.7Gb of data

(2.4 million pages of text)

Recordable Optical Discs

Recordable CD-R and DVD-R

- The letter 'R' means that the disc is recordable ***once*** only.
- Once the disc has been recorded on it becomes a CD/DVD ROM (Read Only).
- Data is 'burnt' onto the discs using a special drive (disc burner).
- Data can be added to the disc but **NOT** erased.
- Thin layer of metallic dye is used to record the data onto.
- When CD-R's and DVD-R's are burnt, the laser makes permanent marks (dots of data which represent 1's and 0's) onto the metallic dye.
- These marks (1's and 0's) cannot be erased (Which is why what you add to the disk is permanent).

CD-R and disk burner

Recordable CD-R and DVD-R

CD-R – (up to 800Mb)

Data stored on metallic dye

DVD-R – (4.7Gb)

Slightly different dye (allows more dots and so greater capacities)

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Recordable CD-R and DVD-R

Uses:

- Used to create home recordings of music (CD-R's) and movies (DVD-R's)
- They can be used to transfer data from one computer to another.
- Useful for situations where the accidental deletion of data is out of the question (Important personal records for example).

Advantages	Disadvantages
• **Cheaper** than RW discs and Hard Disk Drives.	• **Only recordable once.** This means updating disc is impossible.
• **Physically impossible to accidentally delete** important information stored on them.	• **If an error occurs during 'burning'** the disc is damaged and must be thrown away (wasted).
• **Easy to transport** information from one computer to another (Can take the disc out of one machine and use in another)	• Not all CD/DVD players can read CD-R and DVD-R discs.

Re-Recordable Optical Discs

Recordable CD-RW and DVD-RW

- The letters 'RW' (Re-Writeable) means that the disc can be recorded over again and again.
- Unlike CD/DVD-R's these discs **DO NOT** become ROMS (not read only)
- The dye used to record data is 'special' and it allows the bumps of data to be 'undone' (which erases the data).
- This process of allowing bumps of data to be erased is known as 'Phase Change'.
- Data can be added to the disc **AND** can also be erased.

CD-RW

CD-RW and DVD-RW

CD-RW (up to 800Mb)

DVD-RW (4.7Gb)

Data stored on 'Phase Changing' dye which allow data to be erased and re-added

CD-RW and DVD-RW

Uses:

- Used to record television programmes and can be recorded over many times.
- Used in Closed Circuit Television (CCTV) to allow security to keep an eye on businesses and what is happening on the streets:

CD/DVD-RW's are perfect for these uses as they can be updated over and over.

Advantages	Disadvantages
• Can be **re-used** many times.	• **More expensive** to buy than CD/DVD-R disks.
• **Not as wasteful as the –R format**. Even if burning fails, the disk can still be recorded on later and not thrown away.	• It is possible to **accidentally overwrite data** (since RW disks can be updated).

DVD RAM

DVD-Random Access Memory

- Also known as DVD-RAM. It is a new addition to the optical media group.
- Writing and Reading of data can happen at the same time.

This means that you could watch a programme at the same time that another one is being recorded – (Read and Write at the same time).

- Use a similar Phase Changing Recording Dye to CD/DVD-RW's which allows DVD-RAM Disks to be recorded over many times.
- Can store up to 4.7Gb of data.
- Data can be reliably stored on DVD-RAM for many years due to their high quality.

DVD-RAM

DVD-Random Access Memory (DVD-RAM)

DVD-RAM (4.7Gb)

Data stored on 'Phase Changing' dye which allows data to be erased and re-added

Can *Read* and *Update* data at the same time

DVD-Random Access Memory (DVD-RAM)

Uses:

- Because DVD-RAM are so reliable they are used in Video and Data Archiving (Safe store for important files and records).
- Used in recording devices such as satellite receivers (SKY TV) to allow simultaneous recording and playback:
- Used in camcorders to store films (Reliably and for many years).

Advantages	Disadvantages
• **Long life** - last at least 30 years.	• **Pretty expensive**. Cost about times as much as DVD-RW Disks.
• **Can be written over 100,000 times** (RW Disks only allow 1,000 re-writes).	
• **Very fast access** to stored files.	• Don't work in as many devices as the –R or –RW disks.
• Offer **very large storage capacity** compared to CD's (Up to 4.7Gb).	
• Can read data at the same time it is being written.	

High Capacity Optical Discs

Blu-Ray Discs

- Largest capacity of all the optical media. They can store up to 100Gb of data.
- Work in a similar way to DVD ROMS but the laser used to read the data is Blue rather than Red (Red lasers used to read the other disc types).

This blue laser colour is why the name 'Blu-Ray' was used.

- Blue lasers are capable of reading data dots that are positioned closer together on the disk surface. As a result, more data dots can be stored and read.
- More data dots = higher capacity. 50 million pages of text.
- Blu-Ray-RW discs can be rewritten to in much the same way as RW disks.

Blu-Ray Disc

Blu-Ray Drive

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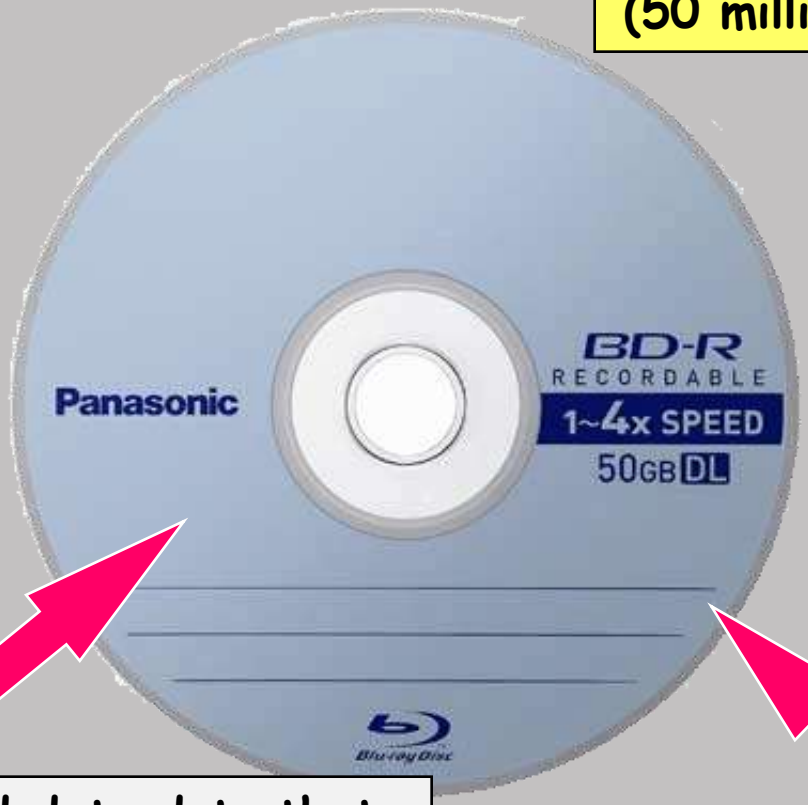
Blu-Ray Discs

Up to 100Gb in capacity

(50 million pages of text)



Blue Laser can read data dots that are positioned very closely.

This means that more data can be squeezed onto the disks surface.

Are used to store high quality video (High Definition)

Blu-Ray Discs

Uses:

- Used to store High Definition Video (Like high quality movies).
- Used in some Home Video Consoles (Like Playstation 3)
- Used to back up Hard Disk Drives in PC's.
- Camcorders use Blu-Ray Discs to store large amounts of high quality footage.

Advantages	Disadvantages
• **Huge storage capacity.** Perfect for high definition movies.	• Blu-Ray **Disks are very expensive** compared to other types of disk.
• **Data can be read/transferred** very fast when compared to other optical media.	• **Only work in Blu-Ray drives/players** which are expensive. (Means that not many people have them which limits the use of the disks).

Solid State Storage

Solid State Hard Disc

(Direct Access)

Memory Stick

(Direct Access)

Flash Memory

(Direct Access)

Micro Flash Memory

(Direct Access)

Solid State Storage

- Solid State Drives have no moving parts.

  No reels of tape, no spinning disks, no moving laser beams etc.

- Solid State technology is known as 'Flash memory' and examples include Memory Sticks/Pen Drives and Memory Cards.

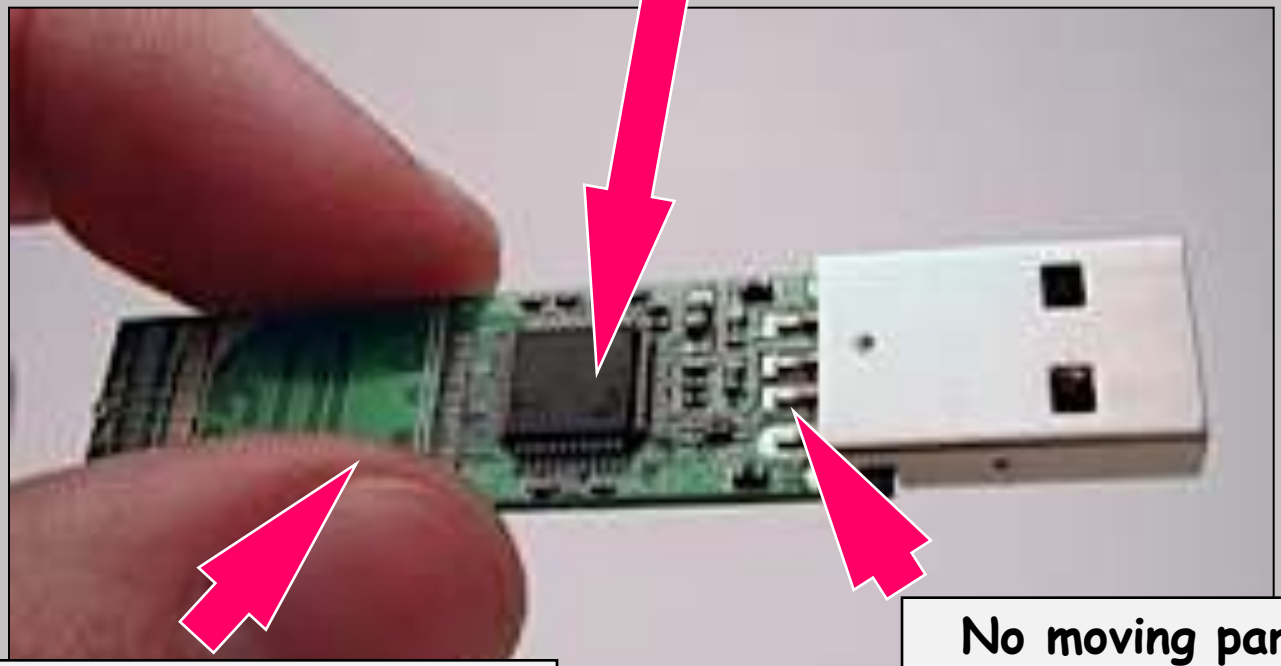
- They store data as 1's and 0's (Just like Magnetic and Optical storage devices) within millions of mini transistors instead of on films of magnetic substance.

  If the transistor conducts an electric current, this equates a **1**.
  If it does not conduct a current, this equates a **0**.

- They hold several advantages over Magnetic Disc Drives:
  - Smaller physical size.
  - Consume much less power (No moving parts to use energy)
  - Much faster data access/transfer times.
  - More robust (No moving parts makes them harder to damage)

Solid State Storage

Microchip containing the transistors which 'symbolise' 1's and 0's (Computer data)



Much smaller in size compared to Hard Disk Drives, Magnetic Tape and CD's/DVD's.

No moving parts meaning less energy needed and more robust.

Memory Sticks/Pen Drives

- Memory sticks are small, portable external Storage devices.
- Can be used to transfer/backup many Gb's of data/files between computers.
- Memory sticks use Solid State technology and are usually connected to the computer via USB ports.

These are making other forms of portable storage (Like CD's and DVD's) redundant as they are simply much easier and quicker to transfer data.

- Data can be quickly read (used) or written (updated) to the drive.
- Memory Sticks used to very expensive but they have become very cheap.

A few pounds will get you 16 Gigabytes of storage (50 million pages of text)

USB Connectivity

Memory Sticks/Pen Drives

Protective casing helps protect the internal parts (robust)

Up to 64Gb in capacity

(34 million pages of text)

Smaller in size…
easy to transport

Easy to connect to any computer via USB

Memory Sticks/Pen Drives

Uses:

- Used for easily transporting files/data between computers.
- Used for backing up data quickly and easily.
- Can be used as a security device (a dongle) to prevent software piracy.

Advantages 	Disadvantages 
• Very **small** and **easy** to **transport** data.	• **No write-protect feature**. This means that it is possible to accidentally copy over data.
• **Robust** and not easily damaged (No moving parts).	• **Small physical size** means that they are easy to misplace or lose.
• **Work in any PC** using USB connectivity.	

Secure Digital Cards (Flash Memory)

- These are a form of Electronically Erasable Programmable Read Only Memory (EEPROM).
- Also known as Secure Digital cards (SD Cards)
- These are Solid State Storage.
- Micro SD cards are smaller versions of the normal SD card.

- SD Cards current maximum capacity = 64 Gigabytes
- Micro SD Cards current max capacity = 32 Gigabytes

SD Card (Flash Memory)

Micro SD Card (Flash Memory)

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Secure Digital Cards (Flash Memory)

Can lock the card to prevent accidentally overwriting information

Up to 64Gb in capacity

(34 million pages of text)

Easy to connect to Computers, Digital Cameras, Mobile Phones and MP3 Players via SD Slots

Very Small in size… easy to transport

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Secure Digital Cards (Flash Memory)

Uses:

- Used to store photos on digital cameras.
- Used in mobile phones as memory cards.
- Can be used by MP3 players to store music files.
- Used in hand held devices (like PDA's) to store files and data.

Advantages	Disadvantages
• **Very small** so they are **easy to transport** files from one device to another (Camera to Camera for example).	• **More expensive per Gigabyte** when compared to Hard Disc Drives.
	• **Lower storage capacity** than Hard Disc Drives.
• **Robust** and not easily damaged (No moving parts).	• **Small size** makes them quite easy to lose.
• **Easy to connect to devices** through SD Slots.	• Have a **limited number of times** that they can be **read/written to**.

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Storage Device Capacity - Overview

Floppy Disc	1.44 MB
CD-ROM	800 MB
DVD-ROM	4.7 GB (4,700 MB)
SD Card	64 GB (32,000 MB)
USB Memory Stick	64 GB (64,000 MB)
Blu-ray Disc	100 GB (100,000 MB)
Magnetic Hard Drive	3 TB (3,000,000 MB)
Magnetic Tape	5 TB (5,000,000 MB)