Module 3

Storage Devices and Media
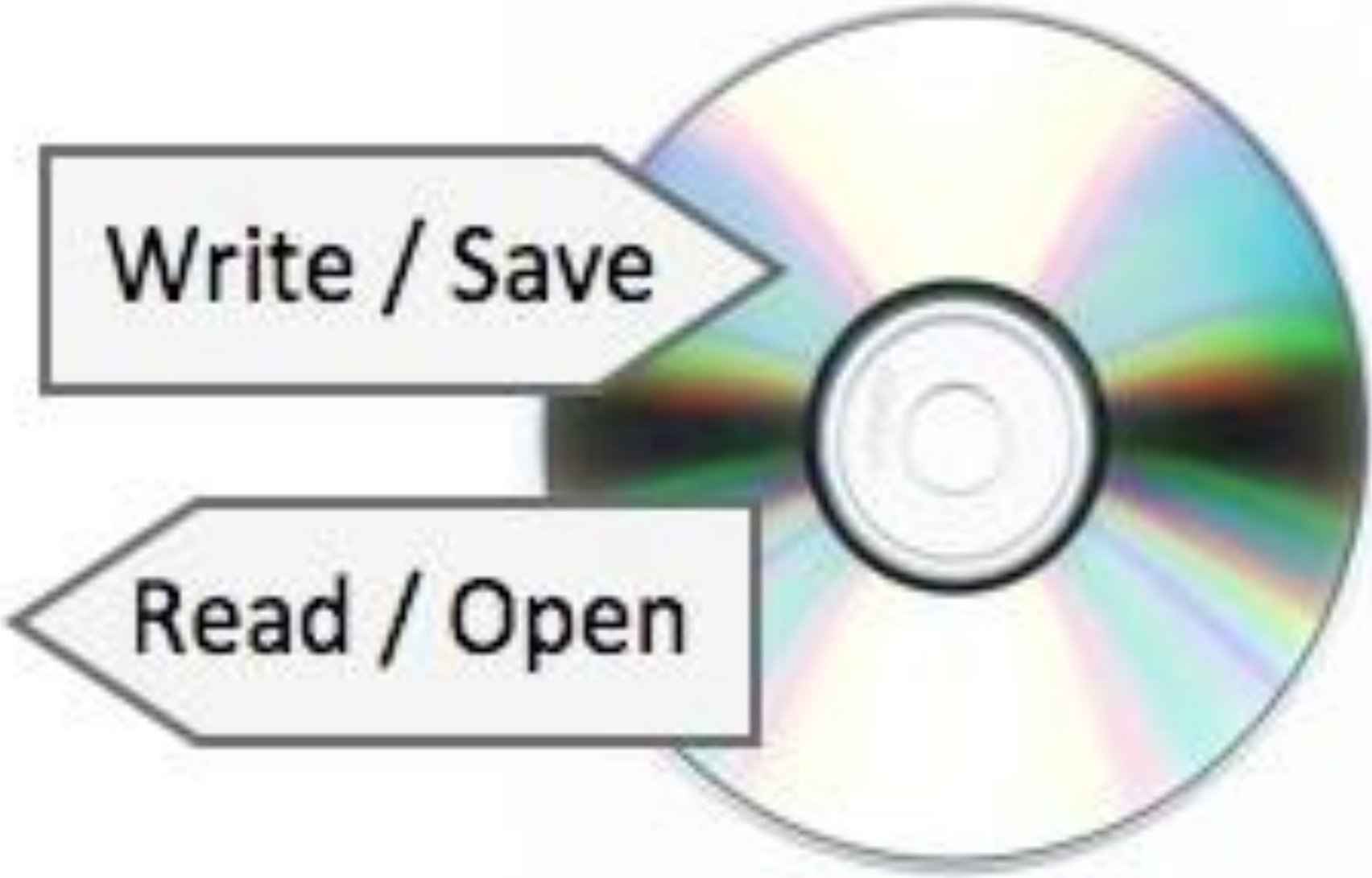
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OBJECTIVES

- describe common **backing storage media** and their associated **devices**:
  - magnetic tapes,
  - CDs (all types),
  - DVDs (all types),
  - DVD-RAM discs,
  - HD DVD discs,
  - Blu-Ray discs,
  - hard discs,
  - memory sticks,
  - flash memory
- identify **typical uses** of the storage media, including types of access (e.g. serial/sequential, direct/random) and access speeds;
- describe the comparative **advantages and disadvantages** of using different backing storage media;
- define the term **backup** and describe the need for taking backups;
- describe the **difference** between **main/internal memory** and **backing storage**, stating the relative benefits of each in terms of speed and permanence.

- What is the difference between read and write?

What is Data Storage?

- When we talk about 'storing' data, we mean putting the data in a known place. We can later come back to that place and get our data back again.
- '**Writing**' data or '**saving**' data are other ways of saying 'storing' data.
- '**Reading**' data, '**retrieving**' data or '**opening**' a file are ways of saying that we are getting our data back from its storage location.

Backing Storage vs Main Memory

- **Main memory** (sometimes known as **internal memory** or **primary storage**) is another name for **RAM** (and **ROM**).

- Main memory is usually used to **store data temporarily**. In the case of RAM, it is **volatile** (this means that when power is switched off all of the data in the memory disappears).

- Main memory is used to store data whilst it is being **processed by the CPU**. Data can be put into memory, and read back from it, **very quickly**

Memory is fast to access, but only holds data temporarily...

Backing Storage

- **Backing storage** (sometimes known as **secondary storage**) is the name for all other **data storage devices** in a computer: hard-drive, etc.

- Backing storage is usually **non-volatile**, so it is generally used to **store data for a long time**.

Backing storage devices are slower to access, but can hold data permanently...

Magnetic Tape

Storage Media & Devices

- The device that actually holds the data is known as the **storage medium** ('media' is the plural).

- The device that saves data onto the storage medium, or reads data from it, is known as the **storage device**.

- Sometimes the storage medium is a **fixed** (permanent) part of the storage device, e.g. the magnetic coated discs built into a hard drive

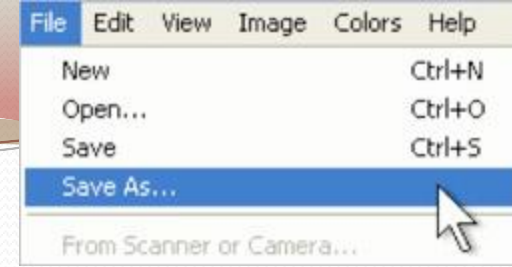- Sometimes the storage medium is **removable** from the device, e.g. a CD-ROM can be taken out of a CD drive.

Which one is the device and which one is the media?

Media

Device

Accessing Stored Data

- We refer to a collection of data stored in a computer system as a '**file**'. Files are often organised into '**folders**'.

- Whenever you click '**Save**' in an application, **burn** files to a CD-R, **copy** music onto your MP3 player, or **drag and drop** a file onto memory stick, you are using storage devices - devices that can **store** and **retrieve** data.

2 ways of accessing stored data

- Serial/Sequential access
- Direct/Random access

Serial / Sequential Access

- A serial (or sequential) access storage device is one that stores files **one-by-one** in a sequence.

- A non-computer serial access device that will be familiar to you is a VHS videotape. Because video is stored on a long piece of tape, when TV shows are recorded onto the tape, they go on **one-by-one**, in **order**...

- Systems that store things on tape (video, music, computer data, etc.) are always serial access

| TV Show 1 | TV Show 2 | TV Show 3 | TV Show 4 | etc... |

Shows recorded in order, one-by-one...
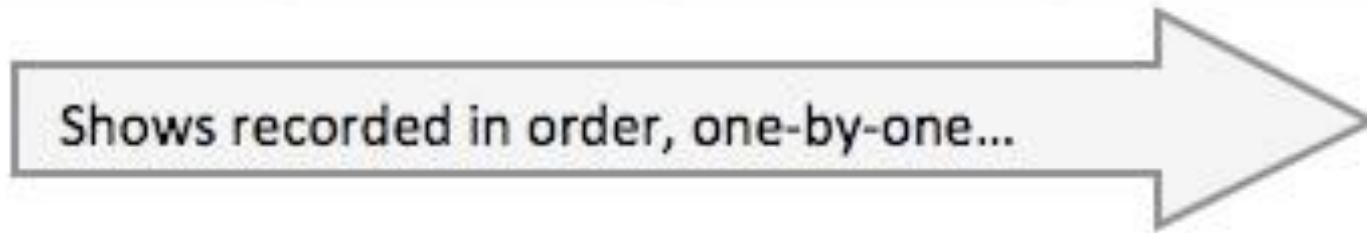
- If you want to watch a show that you recorded earlier, you have to **rewind / fast-forward** through all other shows until you find it.

- The shows are only accessible in the **same order** that you recorded them. This type of one-by-one storage and access is called **serial access**.

Direct / Random Access
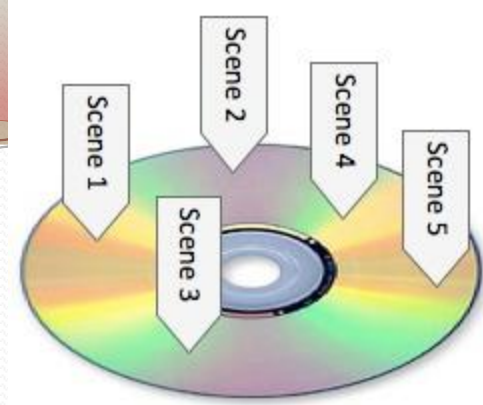
- A direct (or 'random') access storage device is one that stores files so that they can be **instantly accessed** - there is no need to search through other files to get to the one you want.

- An example of a direct access device would be a DVD movie. Unlike the VHS videotape movie, you can **jump** to any scene on a DVD.

- aAll parts of the DVD are **directly** accessible. This type of file storage is called **direct access**.

750,000 Floppy Discs!

Data Storage Capacity

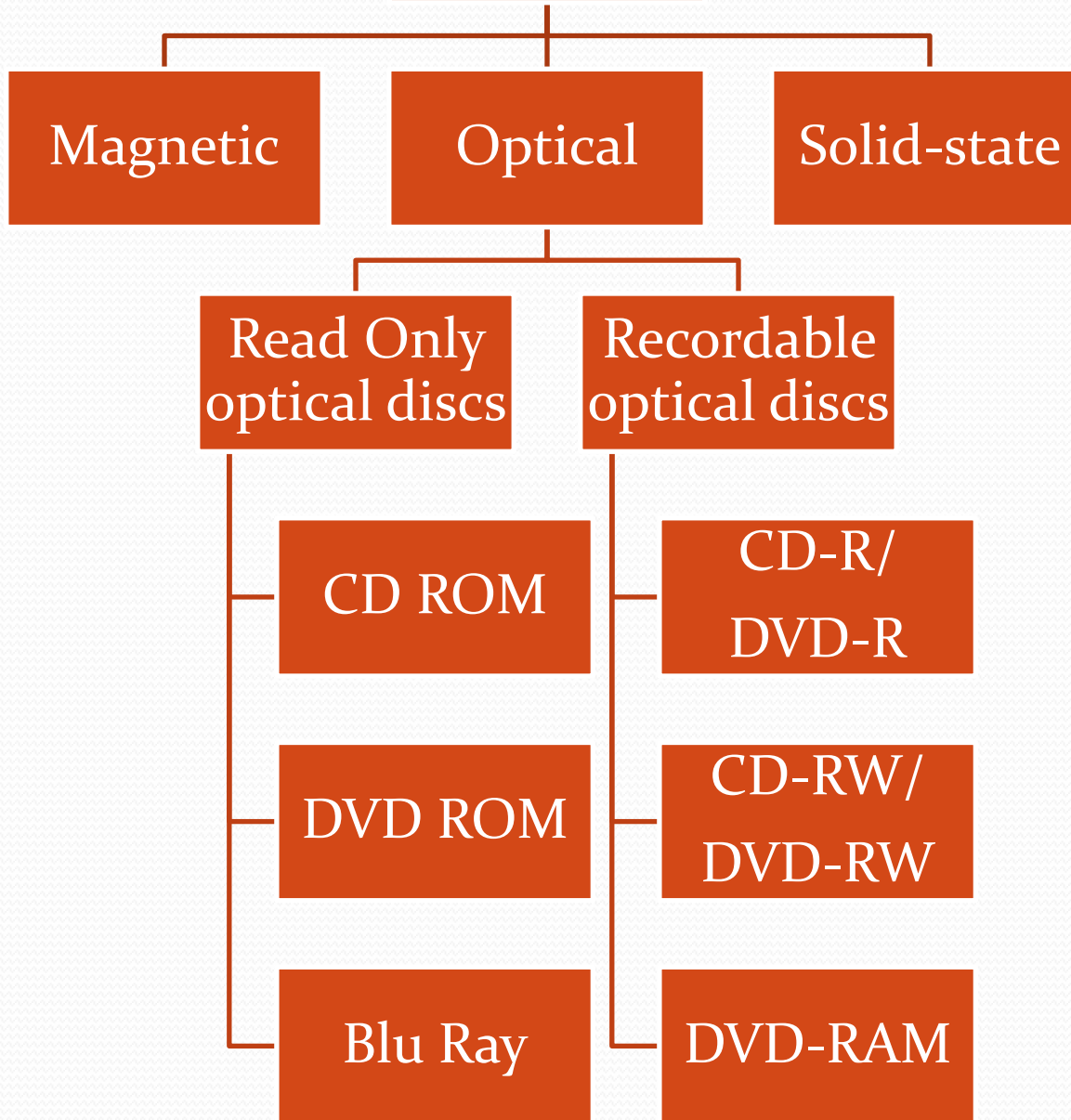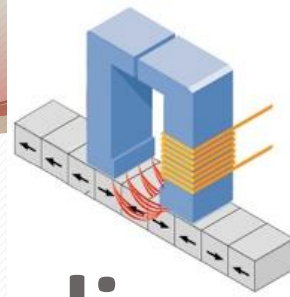|		
Floppy disc	1.44MB	*Small data capacity*
CD-ROM	800MB	
DVD	4.7GB = 4,700MB	
USB memory stick	16GB = 16,000MB	
Backup tape	800GB = 800,000MB	
Hard drive	1TB = 1,000,000MB	*Huge data capacity*
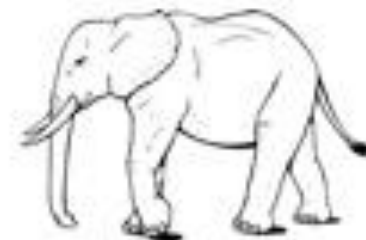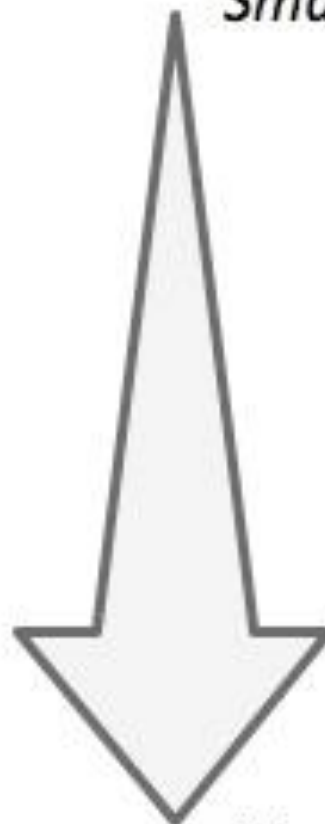
Data Access Speeds

- Some storage devices can access data very quickly, whilst others are extremely slow...

Floppy disc drive

CD-ROM drive

DVD drive

USB memory stick

Backup tape drive*

Hard drive

Very slow access speeds
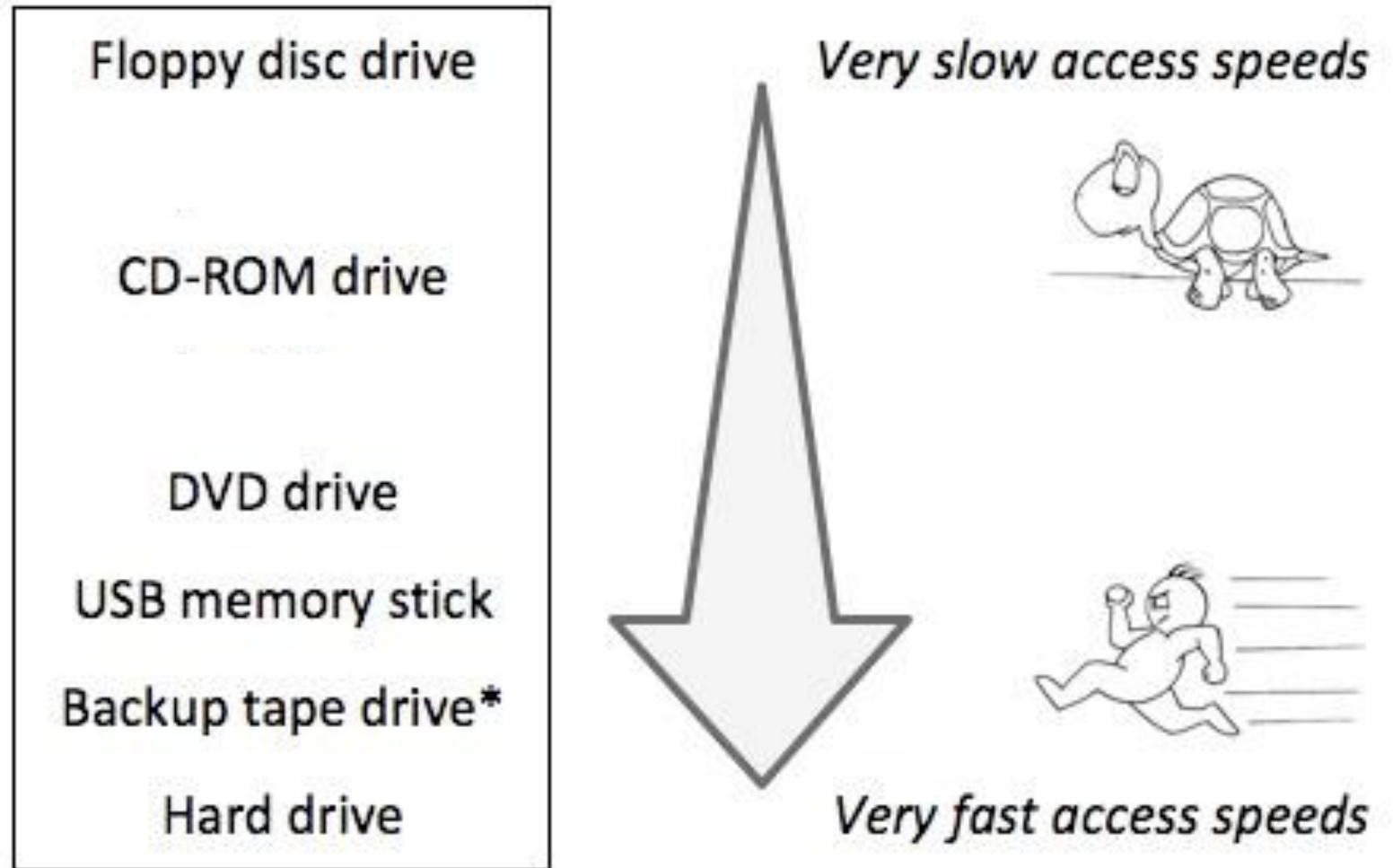
Very fast access speeds

Magnetic Storage Devices / Media

- **Why Magnetic?**
- Magnetic storage media and devices store data in the form of tiny **magnetised dots**. These dots are created, read and erased using magnetic fields created by very tiny **electromagnets**.
- In the case of magnetic tape the dots are arranged along the length of a **long plastic strip** which has been coated with a magnetisable layer (audio and video tapes use a similar technology).
- In the case of magnetic **discs** (e.g. floppy disc or hard-drive), the dots are arranged in **circles** on the surface of a **plastic, metal or glass** disc that has a magnetisable coating.

Hard Drives

- Hard-drives have a **very large storage capacity** (up to 1 TB). They can be used to store vast amounts of data.

- Hard-drives are **random access** devices and can be used to store all types of films, including **huge files** such as movies. Data **access speeds** are **very fast**.

- Data is stored inside a hard-drive on rotating metal or glass discs (called 'platters').

Fixed Hard Drive

- A hard-drive **built into the case** of a computer is known as 'fixed'. Almost every computer has a fixed hard-drive.

- Fixed hard-drives act as the **main backing storage device** for almost all computers since they provide almost instant access to files (**random access** and **high access speeds**).

Portable Hard Drive

- A portable hard-drive is one that is placed into a **small case** along with some electronics that allow the hard-drive to be accessed using a **USB** or similar connection.

- Portable hard-drives allow very **large amounts of data** to be **transported** from computer to computer.

- Many portable music players (such as the iPod classic) contain tiny hard-drives. These miniature devices are just not much bigger than a stamp, but can still store over 100MB of data!

Magnetic Tape

- Magnetic tape is a **large capacity**, **serial access** medium. Because it is a serial access medium, accessing individual files on a tape is **slow**.

- Tapes are used where **large amounts of data** need to be stored, but where quick access to individual files is not required. A typical use is for **data back-up** (lots of data, but rarely only accessed in an emergency)

- Tapes are also used and in some **batch-processing** applications (e.g. to hold the list of data that will be processed).

Optical Storage Devices / Media

- **Why 'Optical'?**

- Optical storage devices save data as patterns of **dots** that can be read using **light**. A **laser beam** is the usual light source.

- The data on the storage medium is read by bouncing the laser beam off the surface of the medium. If the beam hits a dot it is **reflected** back differently to how it would be if there were no dot. This difference can be detected, so the data can be read.

- Dots can be created using the laser beam (for media that is **writable** such as CD-Rs). The beam is used in a high-power mode to actually mark the surface of the medium, making a dot. This process is known as '**burning**' data onto a disc
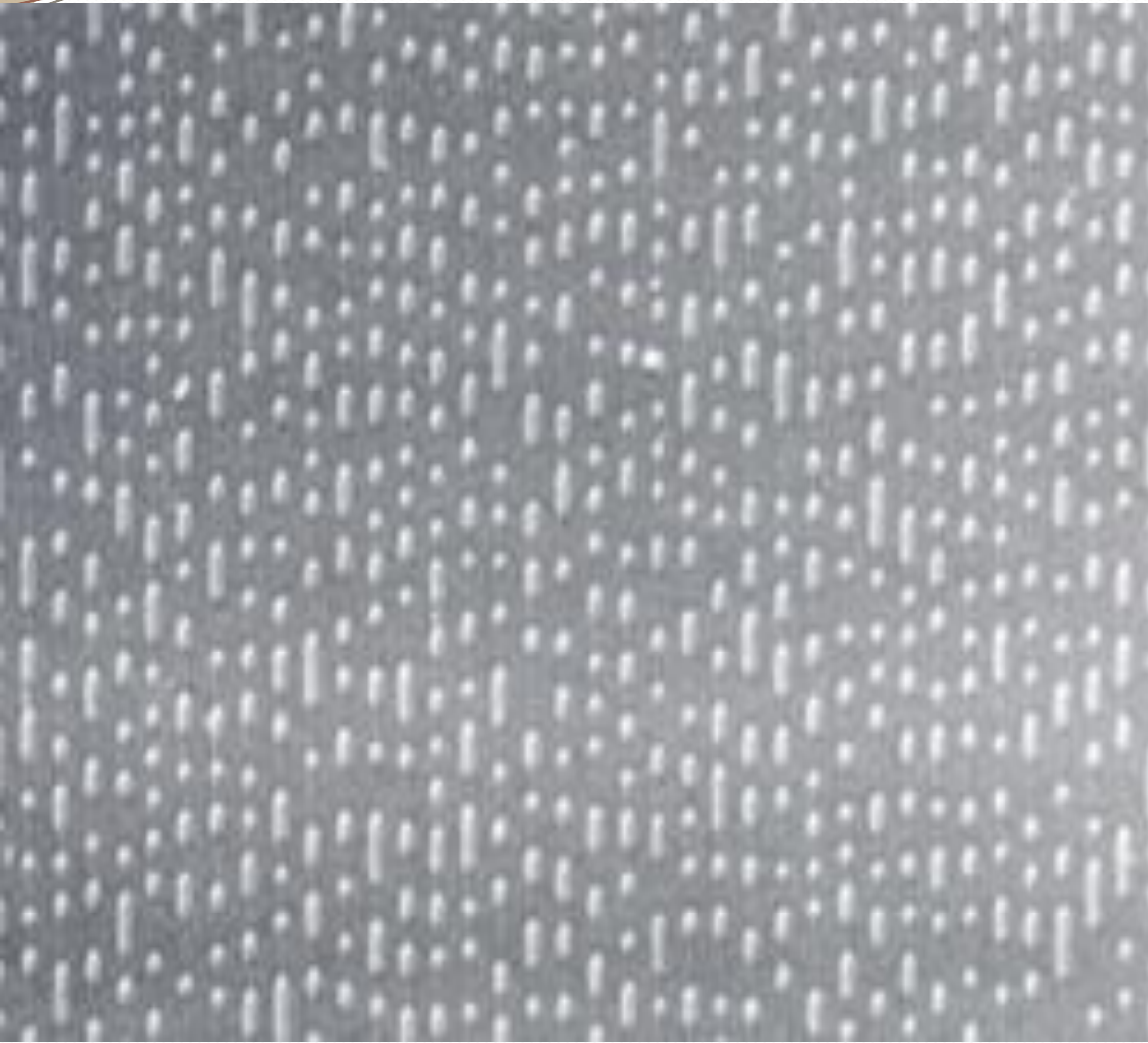
This is a magnified view of the dots on the surface of a CD.

The different patterns of dots correspond to the data stored on the disc.

Read-Only Optical Discs

- Read-only optical discs have data written onto them when they are **manufactured**. This data **cannot be changed**.

- **CD-ROM**

- Compact Disc - Read-Only Memory (CD-ROM) discs can hold around **800MB** of data. The data cannot be altered (non-volatile), so cannot be accidently deleted. CD-ROMs are **random-access** devices.

- CD-ROMs are used to **distribute** all sorts of data: **software** (e.g. office applications or games), **music**, electronic **books** (e.g. an encyclopaedia with sound and video.)

DVD-ROM

- Digital Versatile Disc - Read-Only Memory (DVD-ROM) discs can hold around **4.7GB** of data (a dual-layer DVD can hold twice that). DVD-ROMs are **random-access** devices.

- DVD-ROMs are used in the same way as CD-ROMs (see above) but, since they can hold more data, they are also used to store high-quality **video**.

High Capacity Optical Discs Blu-Ray

- Blu-Ray disks are a recent replacement for DVDs. A Blu-Ray disc can hold **25 - 50GB** of data (a dual-layer Blu-Ray disc can hold twice that). Blu-Ray discs are **random-access** devices.

- Blu-Ray discs are used in the same way as DVD-ROMs but, since they can hold more data, they are also used to store very high-quality, **high-definition (HD) video, movies and computer games.**

HD DVD

- High-definition DVD (HD-DVD) discs can hold around **15GB** of data (a dual-layer HD-DVD can hold twice that). HD-DVDs are **random-access** devices.

- HD-DVD discs are used in the same way as DVD-ROMs but, since they can hold more data, they are also used to store very high-quality, **high-definition (HD) video**.
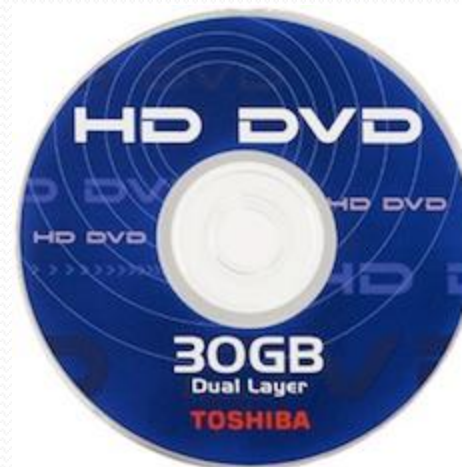
Recordable Optical Discs

- Recordable optical discs can have **data written** onto them ('**burnt**') by a computer user using a special disc drive (a disc '**burner**').

- When CD-Rs and DVD-Rs are burnt, the laser makes **permanent** marks on the silver-coloured metal layer. This is why these discs cannot be erased.

- When CD-RWs and DVD-RWs are burnt the laser makes marks on the metal layer, but in a way that can be undone. So these discs can be erased.

- **CD-R and DVD-R**

- When CD-Rs and DVD-Rs are burnt, the laser makes **permanent** marks on the silver-coloured metal layer. This is why these discs cannot be erased.

- **CD-RW and DVD-RW**

- When CD-RWs and DVD-RWs are burnt the laser makes marks on the metal layer, but in a way that can be undone. So these discs can be erased.

DVD-RAM

- DVD-Random Access Memory (DVD-RAM) discs are a type of **re-writable** DVD. They often come in a floppy-disc style **case** (to protect the disc).

- DVD-RAM discs have a similar capacity to a normal DVD, holding **4.7GB** of data. DVD-RAM discs are **random-access** devices.

- DVD-RAM discs are used in many **camcorders** (video recording cameras).

- The discs are much higher quality than normal DVD-RWs and can reliably store data for up to 30 years. This means that they are often used for video and data **back-up** and **archiving**.

'Solid-State'?

- The term 'solid-state' essentially means 'no moving parts'.
- Solid-state storage devices are based on **electronic circuits** with **no moving parts** (no reels of tape, no spinning discs, no laser beams, etc.)
- Solid-state storage devices store data using a special type of **memory** called **flash memory**…
- **<u>Flash Memory</u>**
- Flash memory is **non-volatile** (like ROM) but the data stored in it can also be **erased** or **changed** (like RAM).
- Flash memory can be found in many data storage devices like USB memory sticks and Memory cards

USB Memory Sticks

- Memory sticks (or 'thumb-drives') have made many other forms of portable storage almost obsolete (why burn a CD or DVD when you can more easily copy your files onto a memory stick?).

- Memory sticks are **non-volatile**, **random-access** storage devices.

- Each of these small devices has some **flash memory** connected to a **USB interface**. Plug it into your computer and it appears as a drive. You can then add files, erase files, etc. You can use it to **move any type of file** between computers.

- Flash memory used to be very expensive, but in recent years it has become much **cheaper** and you can now buy a 16GB memory stick for just a few dollars.

Memory Cards

- Many of our digital devices (**cameras**, **mobile phones**, **MP3 players**, etc.) require **compact**, **non-volatile** data storage. Flash memory cards provide this and come in a variety of shapes and sizes.

- One of the most common formats used by digital cameras is the SD Card. The cards store the digital images taken by the camera.

- Mobile phones contain a Subscriber Identity Module (**SIM**) card that contains the phone's number, the phonebook numbers, text messages, etc.

- Many phones also have extra memory cards to store music, video, photos, etc. (e.g Tiny Micro-SD cards).

What is a Backup?

- A backup simply means making **one or more copies** of your data.

- For example, if you have a folder of photos stored on the hard-drive of your laptop, you might back them up by copying them to a CD-R.
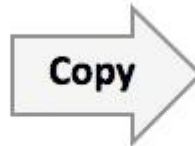
Original data   Copy   Backup(s)

How Are Backups Created?

- **Personal** backups of the data on your hard-drive can be made by...
  - Burning files to a **CD-R**
  - Copying files to an **external hard-drive**
  - Copying the files to **another computer** on a network

- **Businesses** backup essential data by...
  - Making copies of data **very regularly**
  - Using large-capacity media such as **magnetic tape**
  - Keeping **old copies** of backups, just in case
  - **Automating** the system so that nobody forgets to do it!
  - Keeping backup media **off-site** (in case of fire or theft)