Secondary Storage

Remember that non-volatile means that data persists even when the machine is turned off

Secondary storage is the slow external memory part of the von Neumann architecture

Secondary storage is any non-volatile storage mechanism that can not be directly accessed by the CPU.
By "storage mechanism" we just mean a place that data can be stored. This includes files, programs and the Operating System.
It includes hard drives, CDs and DVDs and USB memory sticks. These can be inside the computer (such as a hard drive) or can be removable.

Why is secondary storage required?

Secondary storage is needed:

- to store lots of data and instructions in a non-volatile way so that they can be accessed once the computer system boots
- for long-term storage, including to back up and archive data
- to make data easily portable

The difference between secondary storage and main memory

The definition of main memory is "any form of memory that is directly accessible by the CPU, expect for caches and registers – i.e. RAM and ROM

Data is stored using secondary storage. For it to be used it has to be moved into main memory – the RAM on the motherboard. Then the CPU can access it directly and fetch it as required.
So, data in main memory can be used directly by the CPU; data in secondary storage can't be.
Secondary storage is long term, non-volatile storage, it so can be used to store data when the computer is turned off. Main memory is volatile – anything stored there is lost when the computer is turned off.
Secondary storage is usually much cheaper than main memory but has much slower access speeds – and it takes time for the data to be moved from the secondary storage to main memory.

Three Types of Secondary Storage

There are three main types of secondary storage you need to know.

1. Magnetic Storage:

Floppy disks work in the same way – the central disk part spins and a fixed read head reads data

RPM means Revolutions Per Second

High speed tape is often used for backing up servers. It's cheap and can be stored easily. Tapes tend to run overnight when servers aren't being used

This includes hard disk drives (HDDs), floppy disks and magnetic tape.
Data is stored magnetically. Iron particles are magnetised as either north (0) or south (1). Data can then be read off.
Hard disk drives use rigid disks which rotate. Each disk is divided into sectors and a read head (like the arm of a record turntable) moves in or out to find the sector required. The disks rotate at speeds of up to 10,000 RPM (very quickly). This allows data to be read fairly quickly.
Because magnetic disks have moving parts they are vulnerable to damage – eventually they break. Data transfer is relatively slow and putting them near a powerful magnet can destroy the data on them.
On the plus side, hard disks are cheap, are well established technology, can be very large (1TB+ is common) and are easy to install because they are so standard.

2. Optical Disks

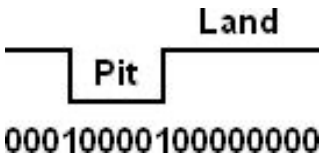
Optical disks include CDs, DVDs and Blu-ray disks.

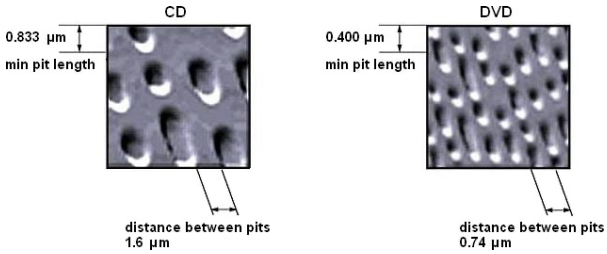
Each of these is read using a beam of light from a laser. This scans the disk and retrieves data.

Data is stored by creating pits in the surface of the disk, which is coated in a reflective alloy. The pits are used to represent data: each start or end of a pit doesn't reflect light very well. When the laser shines on that section of the disk, light isn't reflected. On other sections light is reflected – so we have two possible values: 1 and 0.

For example, CD-RW disks are coated with a silver-indium-antimony-tellurium alloy

The sections between the pits are called lands. These reflect light





DVDs store more data than CDs and Blu-ray store more again. Different types of disk exist: some are read only and others can be read/write

Optical disks can be used to store lots of data and are cheap to produce. But the disks can easily be damaged by scratches and degrade after a period of time, especially in sunlight. The laser itself is also likely to fail eventually. All are easily portable but the amount of storage space is limited by the size of the disk and the wavelength of the laser – for a CD this is 700MB, DVDs have 4.7GB and Blu-ray 25GB.

3. Solid-state

This includes solid-state drives (SSDs) which fulfil the same function as a hard drive, USB memory sticks (flash drives) and memory cards,

Solid-state technology uses electrical cells to store data. The cell can have an electrical charge or have no charge – a 1 or a 0.

Solid-state technology is more expensive per MB and so disk drives tend to be smaller than traditional hard drives. But data transfer speeds are quicker so data can be moved into main memory more efficiently.

There are no moving parts so solid-state drives are more reliable than magnetic hard drives and solid-state storage is much smaller, so is good for use in laptops or in portable storage devices.

USB drives have to be dismounted from a computer carefully. If they are just pulled out an electrical surge can make them unreadable

Data transfer speeds are quicker because there are no moving parts in solid state drives

Activities:

a) Write a definition of secondary storage. Explain what the terms "non-volatile" and "storage mechanism" mean
b) Write a list of examples of secondary storage mechanisms that you've used
c) Explain why secondary storage is required
d) Explain the differences between secondary storage and main memory
e) Create a table to summarise the three types of secondary storage that you need to know about – magnetic storage, optical storage and solid state storage.
Include how each works (briefly) and the pros and cons of each