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 that can not be directly accessed by the CPU.
This includes hard drives, CDs and DVDs and memory sticks. These can be inside the computer (such as a hard drive) or they can be removable. The key is that data can be stored on them but that the data needs to be moved into main memory before it can be used by the CPU.
Secondary storage is used:

- to store lots of data and instructions in a non-volatile way so that they can be accessed once the computer system boots
- to allow long-term storage
- to be portable

In von Neumann's day secondary storage was paper tape or punched cards. These could be fed into the computer and data read from there. They would last as long as the paper roll or card did.

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.
Like RAM, data stored in secondary storage can be changed, deleted and over-written. Unlike RAM it is non-volatile and can be used to store data when the computer is turned off.

Three Types of Secondary Storage

There are three main types of secondary storage:

- magnetic storage
- optical storage
- solid-state storage

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

You need to know the technical details of how each works as well as the pros and cons of using each one.

1. Magnetic Storage:

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.

RPM means Revolutions Per Second

Because magnetic disks have moving parts they are vulnerable to damage – eventually they break, with the data on them being lost.
Data transfer is relatively slow and putting them near a powerful magnet can destroy the data on them.

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.

On the plus side, hard disks are cheap, are reliable, can be very large (1TB+ is common) and are easy to install because they are so standard.

2. Optical Disks

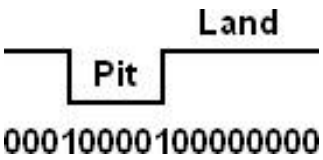
Optical disks include CDs, DVDs and Blu-ray disks.

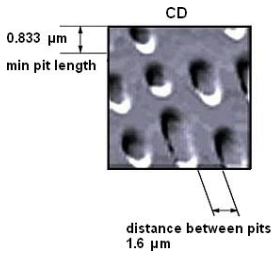
Each of these is read using a beam of light from a laser. This scans the disk and retrieves data.

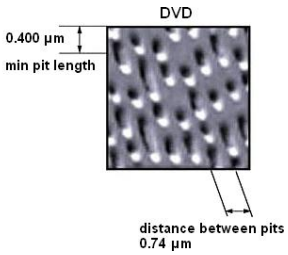
Data is stored by creating pits in the surface of the disk, which is coated in a reflective alloy. The pits are used to represent data: each start or end of a pit doesn't reflect light very well. When the laser shines on that section of the disk, light isn't reflected. On other sections light is reflected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







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.

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.

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 – representing either 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.

The problem of obsolescence

Data stored on secondary storage devices should last a long time. One problem is caused by the hardware used to read the data becoming obsolete. I have lots of floppy disks, for example, but none of my computers can read them as they don't has suitable disk drives.

For an example, see: http://tinyurl.com/y38m4jbm

Activities:

a) Explain the differences between secondary storage and main memory

b) Create a table to summarise the pros and cons of each of the three types of secondary storage media