*CS1101: Lecture 16*

# Computer Systems Organization: Secondary Memory

Dr. Barry O'Sullivan
b.osullivan@cs.ucc.ie


Course Homepage
http://www.cs.ucc.ie/~osullb/cs1101

Department of Computer Science, University College Cork

## Lecture Outline

- Memory Hierarchies
- Magnetic Disks
  - Disk Controller
  - Floppy Disks
  - IDE Disks
  - EIDE Disks
  - SCSI Disks
  - RAID
- Optical Disks
  - CD-ROM
  - CD-Recordables
  - CD-Rewritables
  - DVD
- **Reading**: Tanenbaum, Chapter 2, Section 3





## Secondary Memory

- No matter how big the main memory is, it is always way too small.
- The traditional solution to storing a great deal of data is a memory hierarchy.
- At the top are the CPU registers, which can be accessed at full CPU speed.
- Next comes the cache memory: 32 KB to a few megabytes.
- Main memory: 16 MB to tens of gigabytes.
- Magnetic disks: the current work horse for permanent storage.
- Finally, we have magnetic tape and optical disks for archival storage.





## Memory Hierarchies

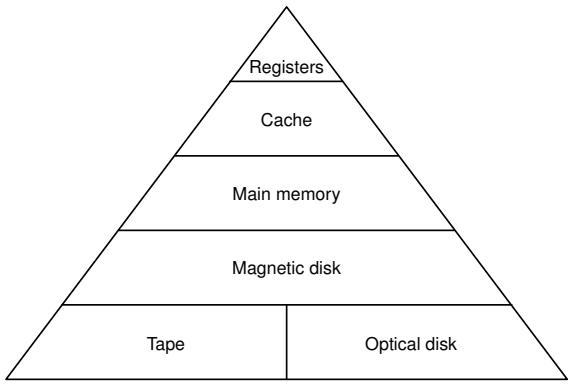


**Figure 2-18.** A five-level memory hierarchy.

## Memory Hierarchies

- As we move down the hierarchy, three key parameters increase.
- First, the access time gets bigger.
- Second, the storage capacity increases as we go downwards.
- Third, the number of bits you get per unit cost increases.



## Magnetic Disks

- A magnetic disk consists of one or more aluminum platters with a magnetisable coating.
- A disk head containing an induction coil floats just over the surface, resting on a cushion of air (except for floppy disks, where it touches the surface).
- When a current passes through the head, it magnetizes the surface just beneath the head.
- When the head passes over a magnetized area a current is induced in the head, making it possible to read back the previously stored bits.
- Thus as the platter rotates under the head, a stream of bits can be written and later read back.





## Magnetic Disks

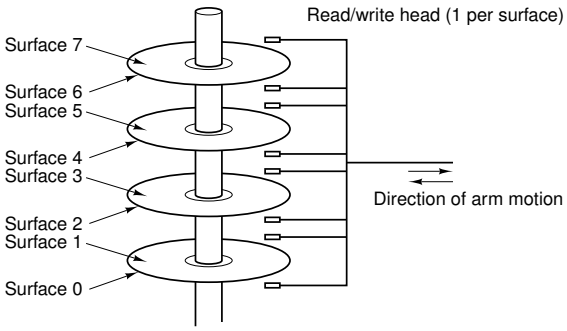


**Figure 2-20.** A disk with four platters.





## Disk Controller

- Associated with each drive is a **disk controller**.
- This is a chip that controls the drive.
- Some constrollers contain a full CPU.
- The controller's tasks include accepting commands from the software, such as READ, WRITE and FORMAT, controlling the arm motion, detecting and correcting errors, and converting 8-bit bytes read from memory into a special bit stream and vice versa.

## Floppy Disks

- With the advent of the personal computer, a way was needed to distribute software – the solution was found in the **diskette** or **floppy disk**.
- Unlike hard disks, where the heads float just above the surface on a cushion of rapidly-moving air, floppy disk heads actually touch the diskettes.
- As a result, both the media and the heads wear out comparatively quickly.
- To reduce wear and tear, personal computers retract the heads and stop the rotation when a drive is not reading or writing.
- Various sizes exist: 5.25 inch and 3.5 inch – and obsolete 8.5 inch.
- The 3.5-inch diskettes come in a rigid jacket for protection.



## IDE Disks

- Modem personal computer disks evolved from the one in the IBM PC XT, which was a 10-MB Seagate disk controlled by a Xebec disk controller on a plug-in card.
- The controller was capable of handling two drives.
- The operating system read from and wrote to a disk by putting parameters in CPU registers and then calling the **BIOS (Basic Input Output System)**, located in
- The move was then away from having the controller on a separate board, to having it closely integrated with the drives, starting with **IDE (Integrated Drive Electronics)** drives in the mid 1980s.
- Only 528MB could be addressed by the operating system.





## EIDE Disks

- Eventually, IDE drives evolved into **EIDE drives (Extended IDE)**, which also support a second addressing scheme called **LBA (Logical Block Addressing)**
- Still only 528MB could be addressed.
- EIDE drives and controllers also have other improvements, such as the ability to control four drives instead of two, a higher transfer rate, and the ability to control CD-ROM drives.





## SCSI Disks

- SCSI stands for (Small Computer System Interface) and is pronounced ”scuzzy.”
- SCSI disks have a different interface and much higher transfer rates than IDE/EIDE disks.
- They are the standard disk in most UNIX workstations, Macintoshes and high-end Intel PCs.
- SCSI is more than just a hard disk interface – it is a bus to which a SCSI controller and up to seven devices can be attached.
- These can include one or more SCSI hard disks, CD-ROMS, CD recorders, scanners, tape units, and other SCSI peripherals.
- Each SCSI device has a unique ID, from 0 to 7 (15 for wide SCSI) and two connectors: one for input and one for output for “daisy-chaining” allowing all the devices to run at once.

## RAID

- CPU performance has been increasing exponentially over the past decade, roughly doubling every 18 months.
- Not so with disk performance.
- It was realised that parallel IO might be a good idea.
- This has led to a new class of IO device called a **RAID**.
- The originator defined RAID as **Redundant Array of Inexpensive Disks**, but industry redefined the I to be **"Independent"** rather than **"Inexpensive"**



## CD-ROM

- Optical (as opposed to magnetic) disks have become available.
- They have much higher recording densities than conventional magnetic disks.
- CD-ROM stands for **Compact Disk - Read Only Memory**
- A CD is prepared using a molding process from a "burned" (using a laser) master disk.
- Data is physically stored on the CD-ROM surface as a series of depressions called **pits** and unburned areas between the pits called **lands**.
- In play-back, a low-power laser diode shines infrared light and reads the disk by reflection.
- A pit/land transition represents 1, its absence a 0.





## CD-ROM

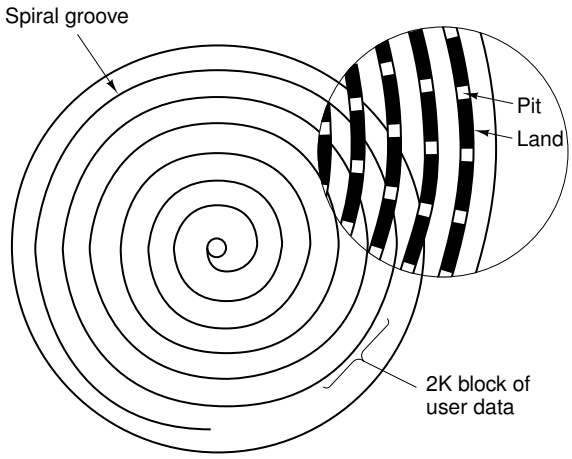


**Figure 2-24.** Recording structure of a Compact Disc or CD-ROM.





## CD-Recordables

- A **CD-Recorder (CD-R)** is now a common peripheral which is similar in size to a CD-ROM drive
- These devices are different from magnetic disks because once written, CD-ROMs cannot be erased.
- Useful for backup purposes and for making copies of CDs.

## CD-Rewritables

- Although people are used to other write-once media such as paper and photographic film, there is a demand for a rewritable CD-ROM.
- One technology now available is CD-RW (CD-ReWritable), which uses the same size media as CD-R.
- However, CD-RW uses a different alloy for the recording layer.
- The reason CD-RW has not replaced CD-R is that that the CD-RW blanks are much more expensive than the CR-R blanks.
- Also, for applications consisting of backing up hard disks, the fact that once written, a CD-R cannot be accidentally erased is a big plus.



## DVD

- **DVD**, originally an acronym for **Digital Video Disk**, but now officially **Digital Versatile Disk**.
- Looks like a CD-ROM.
- What is new is the use of
  - Smaller pits (0.4 microns versus 0.8 microns for CDs).
  - A tighter spiral (0.74 microns between tracks versus 1.6 microns for CDs).
  - A red laser (at 0.65 microns versus 0.78 microns for CDs).
- Together, these improvements raise the capacity sevenfold, to 4.7 GB.
- Four formats have been defined – max capacity possible would be 17 GB.