

Topic 4 : I/O Devices

I/O Devices and Techniques
Reference : See contained but see web-links

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I/O Devices

- Examples of input devices:
 - keyboard
 - optical character reader
 - microphone
- Examples of output devices:
 - video screen
 - printer
 - loudspeaker

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I/O Devices

- Some devices can be used for both input and output:
 - magnetic disks
 - magnetic tapes
 - other computers
- Devices which store large amounts of information such as tapes and disks are called secondary storage.

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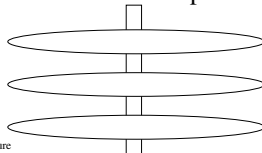
Hardware Device Differences

- Speed
 - Locating data
 - Transferring data
- Unit of transfer
 - character
 - block
- Permissible operations
 - whether or not device is read only
 - whether device supports random or sequential access

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Magnetic Disks

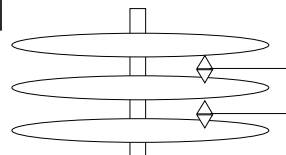
- A magnetic disk consists of one or more circular metal plates coated with a material which can be magnetised.
- There may be more than one of these plates mounted on a common spindle.



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Magnetic Disks

- The disks rotate continuously.
- Information is stored on the disk using a set of read/write heads.



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Tolerances and Head Crashes

- The disks rotate at high speed: 3,600 – 15,000 rpm.
- To avoid wear on the disk the heads float above the surface of the disk in the air currents close to the surface.
- If the surface is contaminated the heads crash and the disk is damaged hence disks are normally sealed.



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So Just How Close Is Close ?

Heads



0.2 μm

Disk Surface

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So Just How Close Is Close ?

Heads



0.2 μm

Smoke



0.6 μm

Disk Surface

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So Just How Close Is Close ?

Heads



0.2 μm

Smoke



0.6 μm

Human Hair

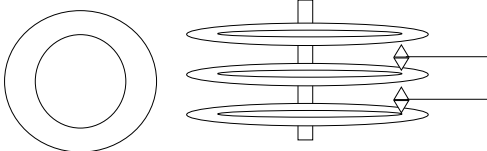
70 μm

Disk Surface

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Data Layout on Magnetic Disks

- As the disk rotates, the read/write heads trace out a circular path or track on each surface.
- On disks with more than one plate, the heads trace out a cylinder.



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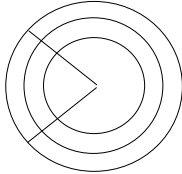
Data Layout on Magnetic Disks

- Each track is divided up into a fixed number of sectors.
- Each sector holds a fixed number of bytes of information.

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Data Layout on Magnetic Disks

- Each track is divided up into a fixed number of sectors.
- Each sector holds a fixed number of bytes of information.



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Data Layout on Magnetic Disks

- Each track is divided up into a fixed number of sectors.
- Each sector holds a fixed number of bytes of information.
- The specification of how many tracks, how many sectors, sector size etc. is called the disk format.

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Reading and Writing Data

- Smallest unit which may be read/written is the sector.
- Two sources of delay before a specified sector can be accessed and transfer commence
 - rotational delay (or latency)
 - seek time (time for r/w head to move radially)
- Measure these as averages...
 - Average rotational delay (or latency)
 - Proportional to the drive's rpm
 - Average seek time (also called average access time)
 - Time (on average) to move to a particular cylinder

For some interesting numbers on modern HDs see:
www.storagereview.com/articles/200407/20040729revisit_sp.html

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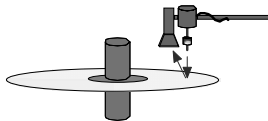
Optical Storage: CD-ROMs

- CD-ROM emerged as a key component in modern computer systems.
- Initially CD-ROMs were read-only (as with audio CDs).
- CD-ROMs can store approx 660 Mbytes
- They are cheap to produce, easy to transport and relatively error-free.

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Optical Storage: CD-ROMs

- CD-ROMs read data using a laser which scans the surface of the disk.
- The laser doesn't touch the surface of the disk so there is no wear.



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Optical Storage: CD-ROMs

- CD-ROMs contain tracks which may be either data, audio or video tracks (disks which contain both types of tracks are called mixed-mode disks).
- Historically moved from CD-ROM to write once (CD-R) and then (CD-RW)
- Comparatively slow access times (cf HD)
 - Mass of head-assembly
- Data track on a CD is one long, continuous spiral
 - The track advances outward from centre of disk
- CD-ROMs have sectors (large frames)...

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Sector Structure in CD-ROMs

- CD-ROMs contain 333,000 sectors/blocks
 - 74 minutes of audio
- In the original spec, frames read at 75 sectors per second (single speed).
- Each block/sector contains 2352 bytes:
 - 12 bytes to mark the start of the block
 - 4 bytes for a header
 - 2048 bytes of user data
 - 4 bytes for error detection
 - 8 unused bytes
 - 276 bytes for error correction

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CD-ROM Capacity Calculations

- Capacity is calculated as follows:
 $333,000 \text{ blocks} * 2048 \text{ bytes per block} = 681,984,000 \text{ bytes}$
 $681,984,000 \approx 660 \text{ Mbytes}$

◆ Data rate is:

- $2048 \text{ bytes} * 75 \text{ blocks per second} \approx 150 \text{ Kbytes/sec (1x)}$
(or at 40 speed...)
 $40x \approx 6000 \text{ Kbytes/sec or } 6 \text{ Mbytes/sec}$

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The High Sierra Format

- Defines how to organise data into files
- Worked out by a group of industry representatives at the High Sierra Hotel and Casino in Nevada.
- Basis for ISO 9660 standard.
- Describes the logical data format for CD-ROMs, e.g.
 - the directory structure
 - the table of contents

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DVD – Digital Versatile Disk

- Digital Versatile Disk
- Closely resembles CD-ROM technology
 - Information as pits, arranged along concentric, circular tracks embedded in reflective material
 - But, laser has shorter wavelength, so can detect smaller pits, giving more pits per track and so more tracks per disk.
 - Can read standard CD-ROMs.
 - DVD-ROM, movies etc.
 - DVD-RAM, high-capacity read/write storage.

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DVD Formats

- Different formats...
 - Single-sided, single-layer 4.7 Gb
 - Double-sided, single-layer 9.4 Gb
 - Storage for approx two feature length films.
 - Single-sided, double-layer 8.5 Gb
 - Effectively two disks bonded together
 - Upper disk has partially transmissive surface
 - Lower disk has fully reflective surface
 - Laser can focus on either surface
 - Double-sided, double-layer 17 Gb

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The need for greater capacity...

- Can achieve higher capacities still by using finer laser
 - Blue laser – 405 nm wavelength
- Blue-ray
 - Hitachi, Pioneer, Philips, Sony (PS3) etc.
 - Up to 27 GB per layer
 - Thicker than current DVDs
- HD DVD (originally called Advanced Optical Disc)
 - 15 GB per layer per side

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Other Peripherals

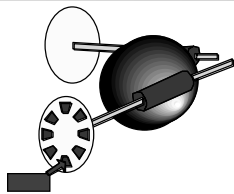
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A Common Input Device: The Mouse

- Mouse was devised by Prof. Englebart of Stanford University.
- Popular types of mice are:
 - mechanical
 - optical.
- The difference depends on how they detect position.

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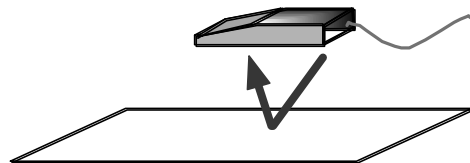
Mechanical Mice



- Movement is detected using electrical contacts on disks rotated by movement of the ball.

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Optical Mice



- Optical mice detect movement by sensing the patterns of light reflected from surface

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Output Devices: Printers

- Printers can be classified as either:
 - Impact, or,
 - Non-impact.
- Examples of impact printers are:
 - Dot matrix printers
 - Daisy wheel printers
- Examples of non-impact printers are:
 - Ink jets
 - Laser printers

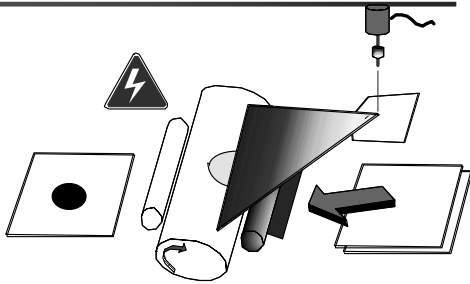
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Laser Printers

- Non-impact technology: laser printers work in a very similar fashion to photocopies.
- A drum is charged. The image is then projected onto the drum in such a way that different parts of the drum have different charges.
- Toner is charged and attracted to the drum.
- The drum is rolled against the paper and the toner set using heat.

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Laser Printers



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Summary

- Listed examples of I/O devices.
- Looked at the construction of:
 - Magnetic Disks
 - CD-ROMs
 - Mice
 - Printers

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Coming Next Week

- Interfacing to I/O devices, DMA etc..

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