

Computer Hardware Week-6

Storage

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EFC-109, Monday10:40 - 12:30

Storage

- ☐ Holds data, instructions, and information for future use
- ☐ **Storage medium** is physical material used for storage
 - Also called secondary storage
- ☐ The two primary storage technologies are magnetic and optical



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Storage Device Types

- ☐ Floppy Disk Drive/ FDD - Legacy to Historical
- ☐ Hard Disk Drive/ HDD
 - Magnetic Disks
- ☐ Solid State Disk / SSD
- ☐ Optical Disks
 - CD/DVD/Blu-Ray
- ☐ Removable/Backup Storage
 - Tape Drive
 - Solid State (Flash, SD Card, USB)
 - External CD/DVD or Hard Drive

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Storage

- ☐ Capacity
 - Number of bytes (characters) a storage medium can hold

Kilobyte (KB)	1 thousand	→
Megabyte (MB)	1 million	→
Gigabyte (GB)	1 billion	→
Terabyte (TB)	1 trillion	→
Petabyte (PB)	1 quadrillion	→
Exabyte (EB)	1 quintillion	→
Zettabyte (ZB)	1 sextillion	→
Yottabyte (YB)	1 septillion	→

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FDD - Legacy

- Type of Magnetic Disk used in older computer systems



1.44 Megabytes (MB) on a single 3.5" (90 mm) disk

Hard Disk Drives - HDD

- The magnetic hard disk
 - High-capacity storage
 - Consists of several inflexible, circular platters that store items electronically
 - Components enclosed in airtight, sealed case for protection



HDD - Magnetic Disks

- Magnetic disks provide bulk of secondary storage of modern computers
 - Drives rotate at 60 to 200 times per second - 5400, 7200, 10000 rpm
 - Transfer rate is rate at which data flow between drive and computer
 - Positioning time (random-access time) is time to move disk arm to desired cylinder (seek time) and time for desired sector to rotate under the disk head (rotational latency)



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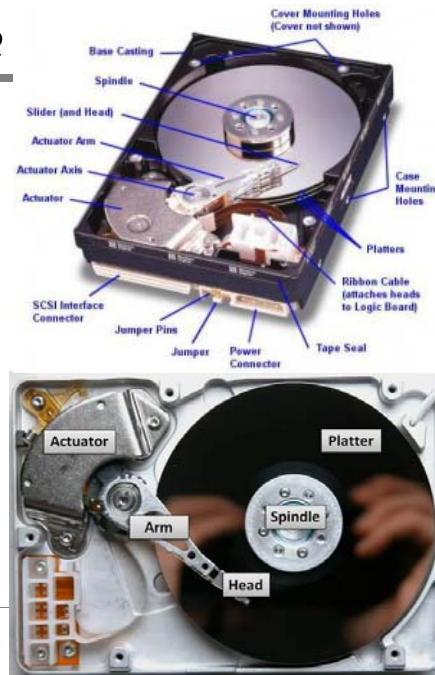
HDD - Magnetic Disks

- Drive attached to computer via I/O bus
 - Busses vary including;
 - EIDE - ATA
 - SATA
 - SCSI
 - USB
 - Host controller in computer uses bus to talk to disk controller built into drive or storage array



HDD - Magnetic Disk

- The HDD components available in all types of magnetic disks include
 - Platters where the data is written on
 - Spindle to the platters
 - Head to read and write
 - Arm to move the head to the desired location
 - Actuator to move the arm



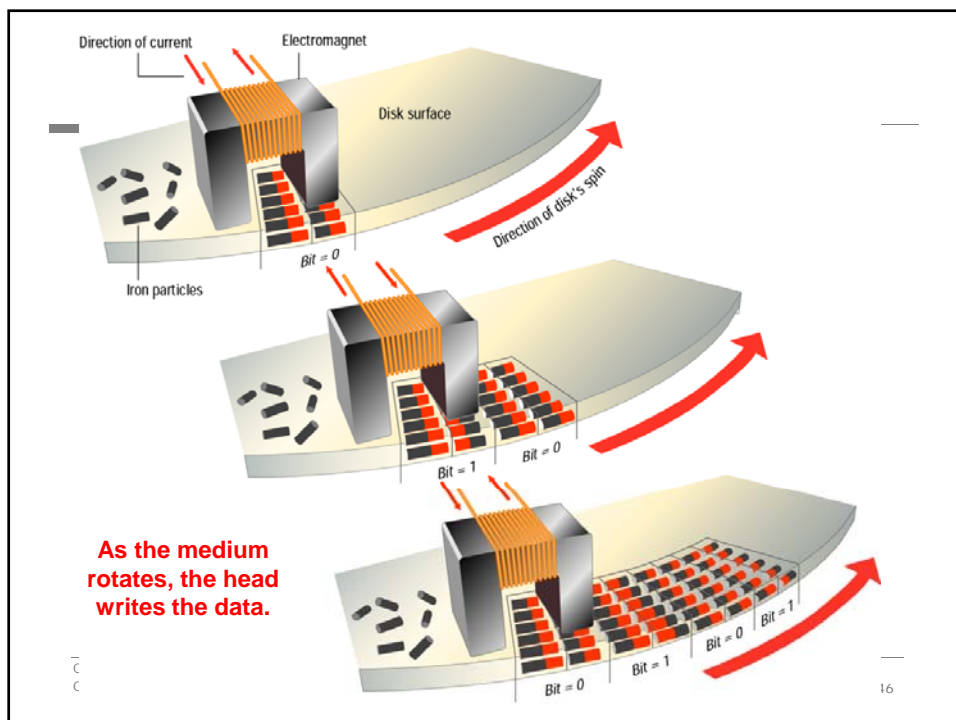
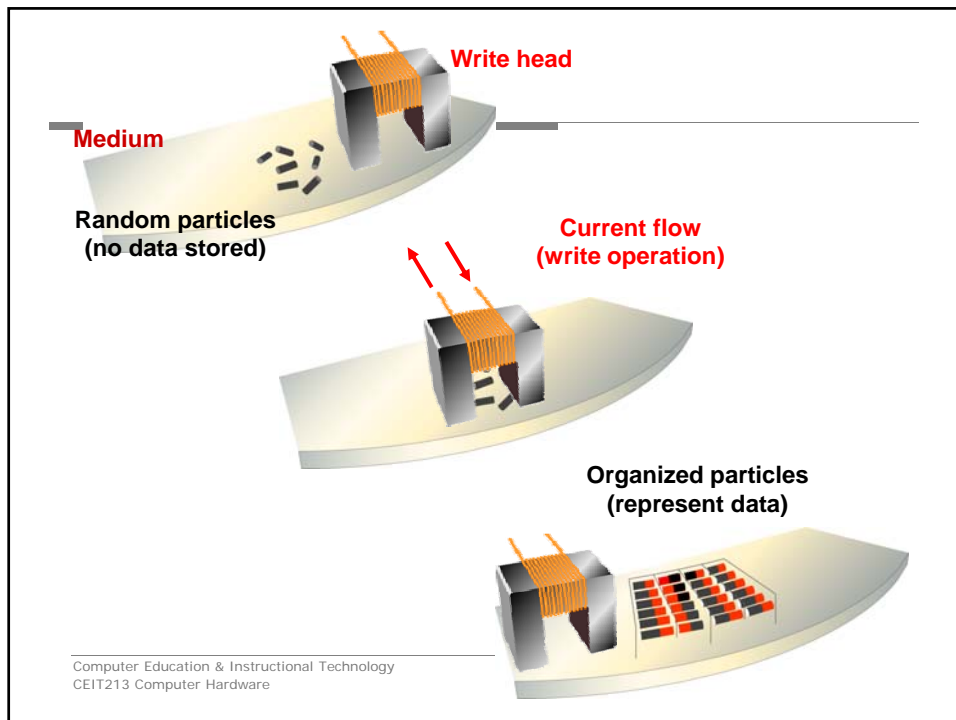
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Magnetic Disks – How it works

- A magnetic disk's medium contains iron particles, which can be polarized—given a magnetic charge—in one of two directions.
- Each particle's direction represents a 1 (on) or 0 (off), representing each bit of data that the CPU can recognize.
- A disk drive uses read/write heads containing electromagnets to create magnetic charges on the medium.

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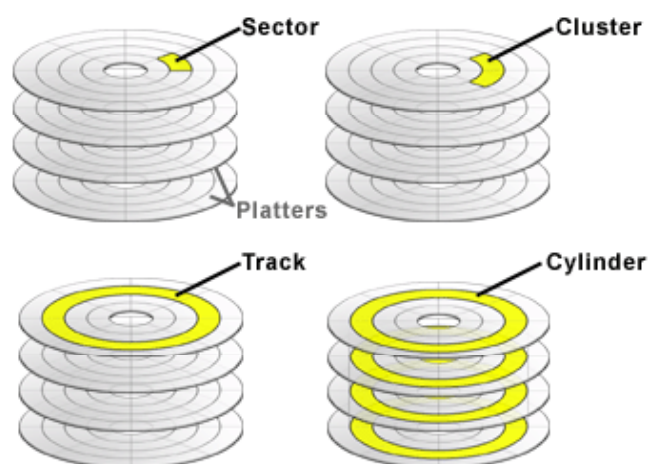
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Magnetic Disks – How it works

- ❑ Before a magnetic disk can be used, it must be formatted—a process that maps the disk's surface and determines how data will be stored.
- ❑ During formatting, the drive creates circular tracks around the disk's surface, then divides each track into sectors.
- ❑ The OS organizes sectors into groups, called clusters, then tracks each file's location according to the clusters it occupies.

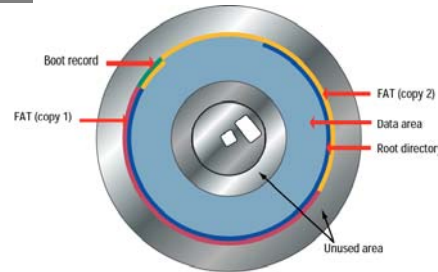
Magnetic Disks -Tracks and Cylinders



Magnetic Disks – How it works

When a disk is formatted, the OS creates four areas on its surface:

1. **Boot sector** - stores the master boot record (MBR), a small program that runs when you first start (boot) the computer
 - The first sector of the hard drive, usually 512 bytes
 - Contains table of primary partitions, disk signature and instructions on allocating and starting the operating system.



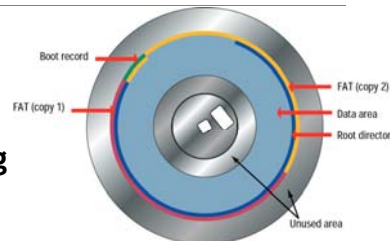
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Magnetic Disks – How it works

When a disk is formatted, the OS creates four areas on its surface:

2. **File allocation table (FAT)** - a log that records each file's location and each sector's status
3. **Root folder** - enables the user to store data on the disk in a logical way
4. **Data area** - the portion of the disk that actually holds data

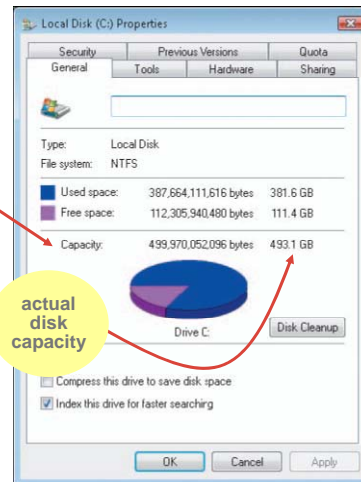


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Magnetic Disks

Sample Hard Disk Characteristics	
Advertised capacity	500 GB
Platters	4
Read/write heads	8
Cylinders	16,383
Bytes per second	512
Sectors per track	63
Sectors per drive	973,773,168
Revolutions per minute	7,200
Transfer rate	300 MB per second
Access time	8.5 ms



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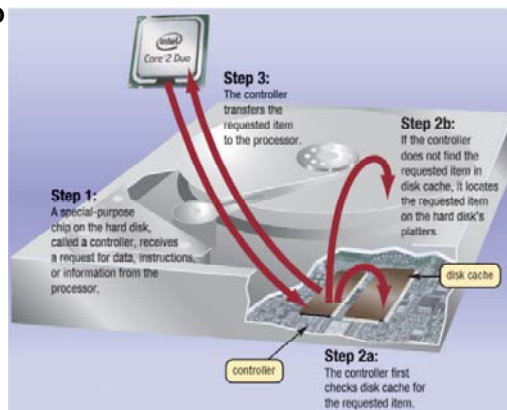
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Magnetic Disks

- Disk cache
 - Portion of memory that processor uses to store frequently accessed items

first request for data—to disk cache

second request for data—to hard disk



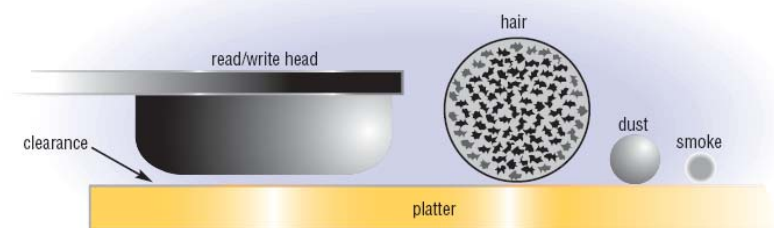
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Magnetic Disks

Head crash!

- ❑ Occurs when read/write head touches platter surface
- ❑ Spinning creates cushion of air that floats read/write head above platter
 - Clearance between head and platter is approximately two-millionths of an inch (2.54 centimeters)
 - A smoke particle, dust particle, or human hair could render drive unusable

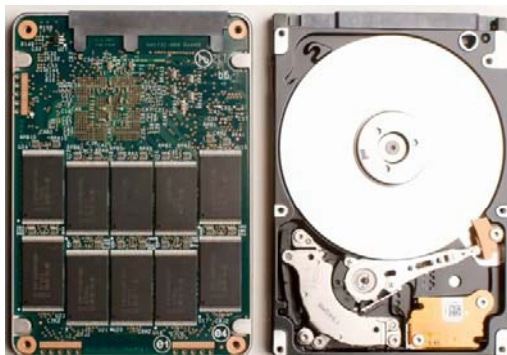


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Solid State Disks - SSD

- ❑ Use electrical current, rather than motors and magnets, to store data they can access data noiselessly and with less power consumption.

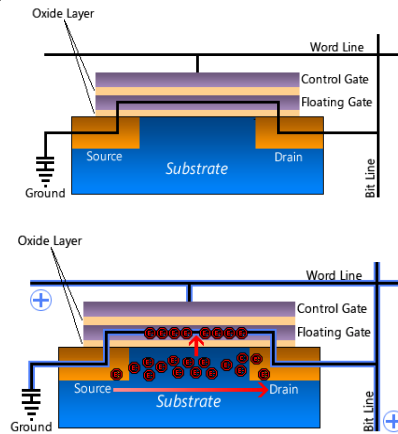
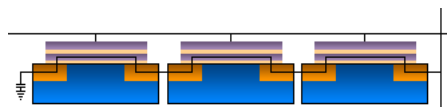


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Solid State Disks- How it Works

- ❑ SSD operate by using Flash Nand Memory - also found in all of your portable devices and flash drive.
- ❑ On a NAND chip each bit (0 or 1, on or off) is stored physically by a specially designed transistor called a floating gate. The floating gate is electrically isolated from all other components by a layer of oxide.

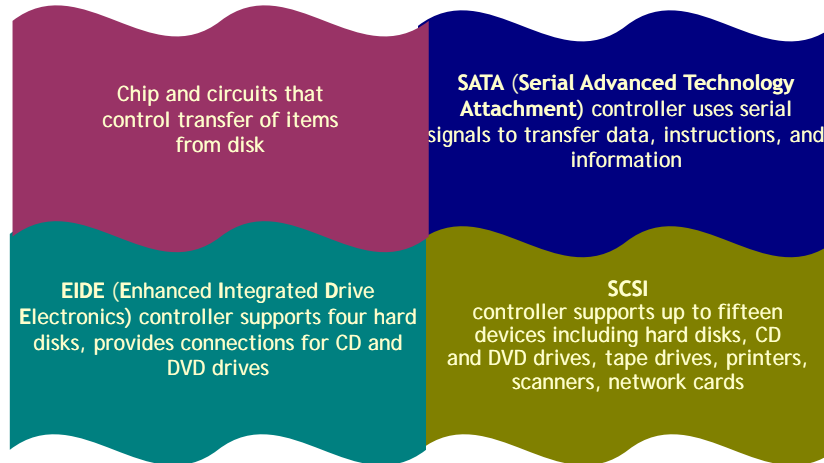


Comparison of SSD with HDD

	SSD	HDD
Industry Standard Dimensions	✓	✓
Industry Standard Interface	✓	✓
Rugged / No Moving Parts	✓	
Ultra Low Power Consumption	✓	
Silent Operation	✓	
Fast Access Time	✓	
Fast Enter/Exit Hibernation	✓	
Fast Sustained Read/Write Speed	✓	✓
Light Weight	✓	
Low Cost per GB		✓
Very High Capacity		✓

Magnetic Disks

□ The disk controller



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Optical Discs

- Flat, round, portable metal discs made of metal, plastic, and lacquer.
- **CD (Compact Disc)**
 - 700 megabytes (MB) capacity
- **DVD (Digital Versatile Disc)**
 - 4.7 gigabytes (GB) for single-layer
 - 8.5 GB for dual-layer
- **Blu-ray Disc**
 - 25 GB for single-layer
 - 50 GB for dual-layer

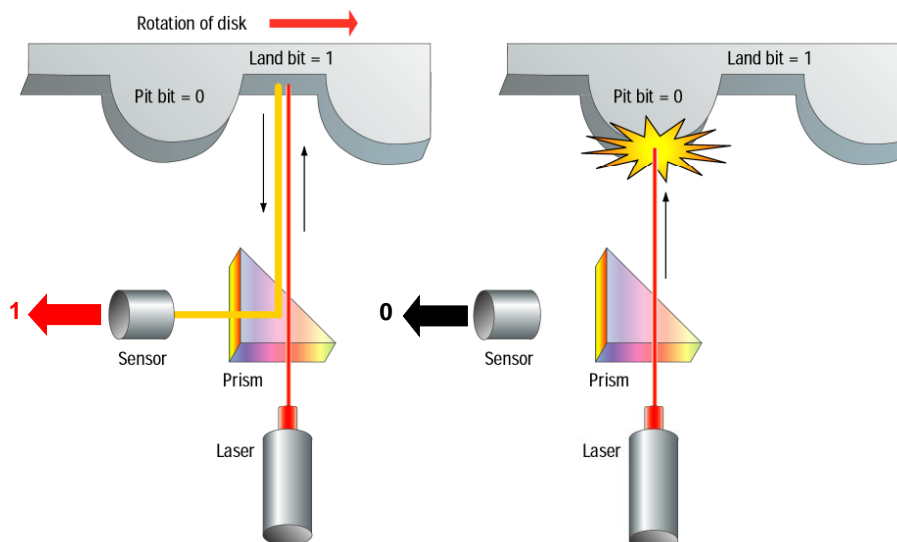


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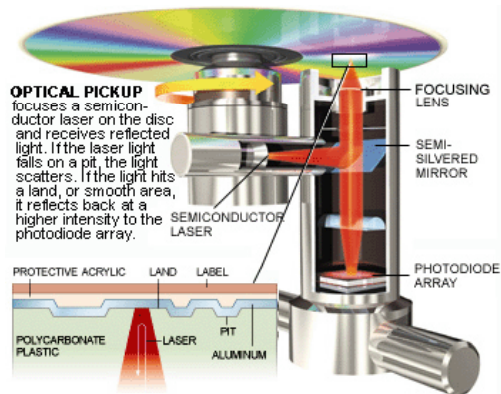
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Optical Discs – How it Works

- An optical disk is a high-capacity storage medium. An optical drive uses reflected light to read data.
- To store data, the disk's metal surface is covered with tiny dents (pits) and flat spots (lands), which cause light to be reflected differently.
- When an optical drive shines light into a pit, the light cannot be reflected back. This represents a bit value of 0 (off). A land reflects light back to its source, representing a bit value of 1 (on).



Optical Discs – How it Works



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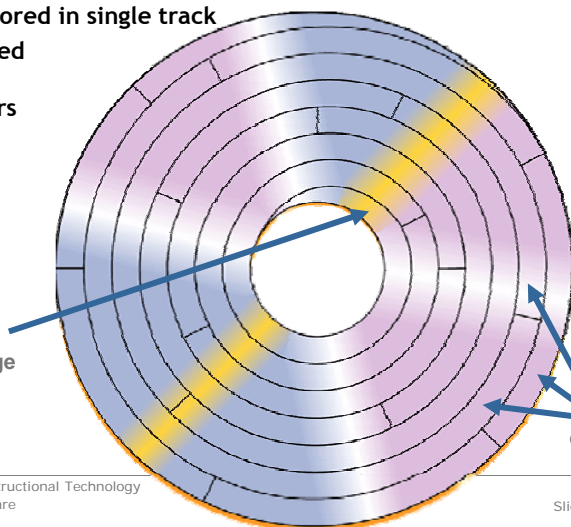


Optical Discs – How it Works

☐ How is data stored on an optical disc?

- Typically stored in single track
- Track divided into evenly sized sectors that store items

single track
spirals to edge
of disc



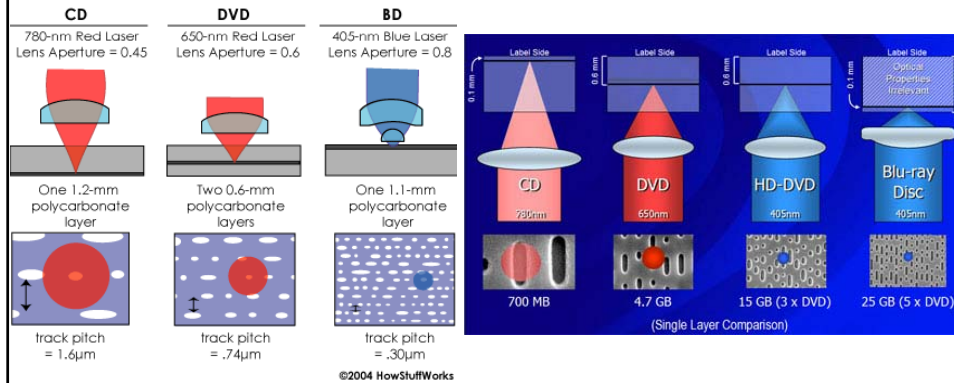
disc sectors

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Optical Discs Comparison

CD vs. DVD vs. Blu-ray Writing



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Optical Discs Comparison

Medium	1X speed			Capacity (GB)	Full Read Time (min)
	Mbit/s	kB/s	KiB/s		
CD	1.229	153.6	150.0	0.734	80
DVD	11.080	1,385.0	1,352.5	4.7	57
Blu-ray Disc	36.000	4,500.0	4,394.5	25.0	93

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Storage Interfaces

- SATA – Serial Advanced Technology Attachment
- PATA – Parallel AT Attachment
 - Formerly known as ATA
- ATAPI – AT Attachment with Packet Interface
- IDE - Integrated Drive Electronics
 - Western Digital original standard
- SCSI – Small Computer Systems Interface

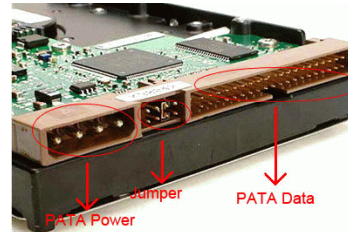
PATA (Parallel AT Attachment)

- Originally called Integrated Drive Electronics (IDE)
 - A Western Digital invention
 - 2nd generation called EIDE (Enhanced IDE)
- The evolution
 - Faster speeds (from 16 MB/s through 133 MB/s)
 - Additional devices
- Now called Parallel ATA (PATA)



PATA (Parallel AT Attachment)

- ❑ PATA Drive Connector and Jumper Settings



- ❑ ATAPI- ATA Packet Interface
Used for Optical disks
to connect to IDE Interface



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SATA (Serial AT Attachment)

- Serial AT Attachment
- SATA Revision 1.0
 - 1.5 gigabits per second
- SATA Revision 2.0
 - 3.0 gigabits per second
- The latest: SATA Revision 3.0
 - 6.0 gigabits per second
 - SATA 6Gb/s, not SATA 6G

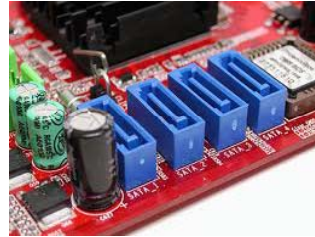
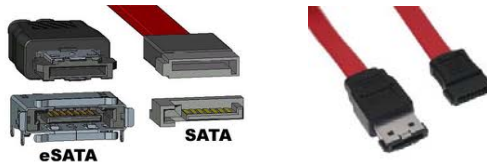


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SATA (Serial AT Attachment)

- ❑ SATA Interface
- ❑ SATA Drive Connector



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RAID

- Redundant Array of Inexpensive Disks
 - They're also independent disks.
- Different RAID levels
 - Some redundant, some not
- RAID 0 – Striping
- RAID 1 - Mirroring
- RAID 5 – Striping with Parity



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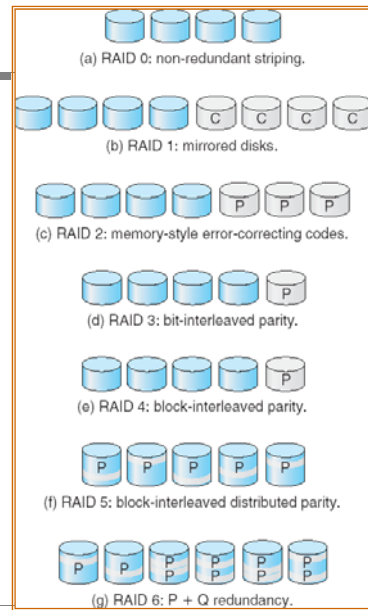
RAID

What is RAID?

- Redundant Array of Independent Disks
- Connects multiple smaller disks into a single unit that acts as a single large hard disk

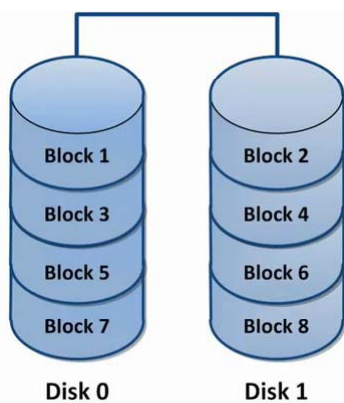
- Read <http://en.wikipedia.org/wiki/RAID>

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RAID 0 - Striping

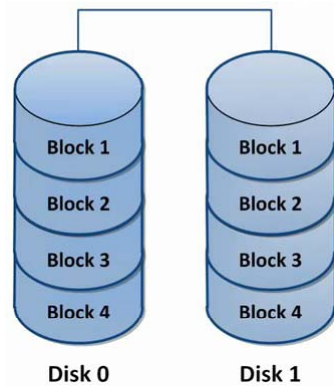


- Files are split between physical drives
- High performance
 - Data written quickly
- Poor redundancy
 - A drive failure breaks the array

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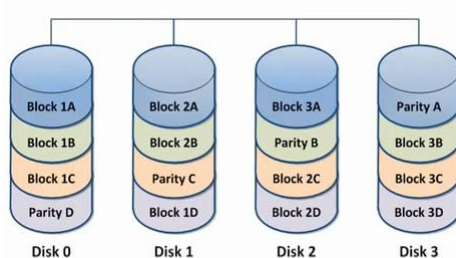
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RAID 1 - Mirroring



- Files are duplicated between physical drives
- High disk utilization
 - Every file is duplicated
 - Required disk space is doubled
- High redundancy
 - Drive failure does not affect data availability

RAID 5 – Striping with Parity



- Files are striped
 - Along with a parity block
- Efficient use of disk space
 - Files aren't duplicated, but space is still used for parity
- High redundancy
 - Data is available after drive failure
 - Parity calculation may affect performance

RAID

- Software-based RAID
 - A feature of the operating system
 - Doesn't require any special hardware
 - Usually lower-performance than hardware-based
- Hardware-based RAID
 - A feature of the hard drive controller
 - Configured outside of the OS
 - Usually invisible to the operating system
 - High performance, designed for speeds



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Removable Storage

□ External Hard Disk Drive



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Tape

- Magnetically coated plastic ribbon capable of storing large amounts of data at low cost
- Primarily used for backup



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Tape

- **Sequential access**
 - Reads and writes data consecutively, like music tape
 - Unlike direct access – used on hard disks, CDs, and DVDs – which can locate particular item immediately



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Miniature Mobile Storage Media

- Miniature mobile storage media
 - Storage for small mobile devices



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Miniature Mobile Storage Media

- Common types of flash memory cards?

CompactFlash



Secure Digital



xD Picture Card



Memory Stick



Memory Stick PRO Duo



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Miniature Mobile Storage Media

☐ USB Flash Drive

- Plugs in a USB port on a computer or mobile device
- Storage capacities up to 256 GB
- Made the floppy disk obsolete

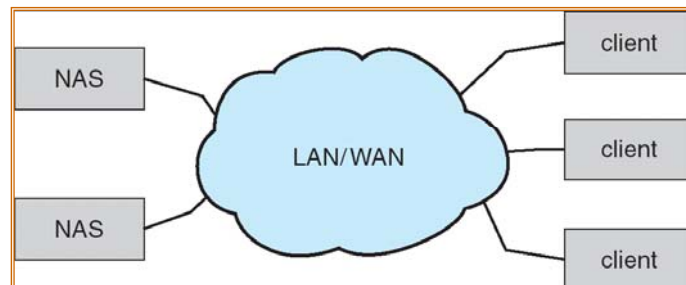


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Network-Attached Storage

- ☐ Network-attached storage (**NAS**) is storage made available over a network rather than over a local connection (such as a bus)
- ☐ NFS and CIFS are common protocols
- ☐ Implemented via remote procedure calls (RPCs) between host and storage
- ☐ New iSCSI protocol uses IP network to carry the SCSI protocol

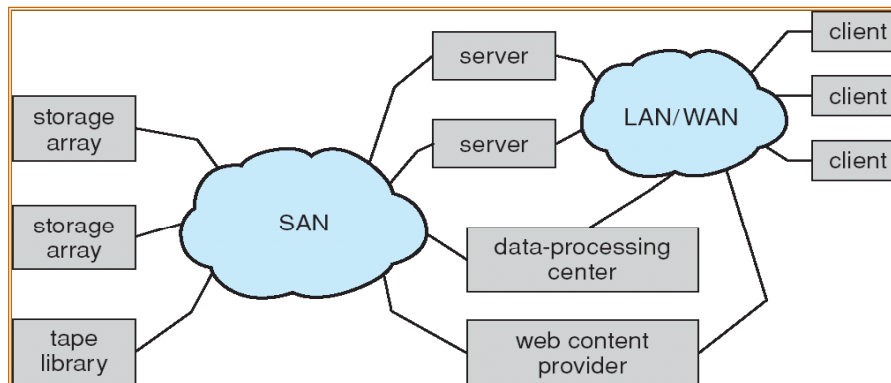


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Storage Area Network

- ❑ Common in large storage environments (and becoming more common)
- ❑ Multiple hosts attached to multiple storage arrays - flexible

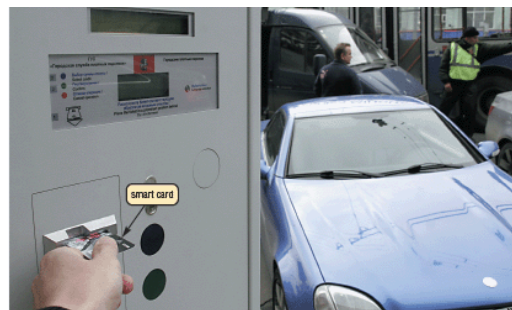


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Miniature Mobile Storage Media

- ❑ **The smart card**
 - Stores data on microprocessor embedded in small card
 - Input, process, output, and storage capabilities



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Online Storage

- ❑ A new form of storage - **online storage**
 - Service on Web that provides storage for minimal monthly fee
 - Files can be accessed from any computer with Web access
 - Large files can be downloaded instantaneously
 - Others can be authorized to access your data

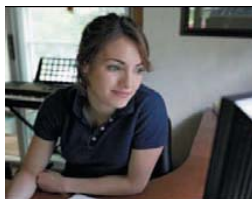


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Putting It All Together

- ❑ Recommended storage devices for home users



- 250 GB hard disk
- Online storage
- CD or DVD drive
- Card reader/writer
- USB flash drive

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Putting It All Together

- ❑ Recommended storage devices for small office/home office (SOHO) users



- 500 GB hard disk
- Online storage
- CD or DVD drive
- External hard drive for backup
- USB flash drive

Putting It All Together

- ❑ Recommended storage devices for mobile users



- 200 GB hard disk
- Online storage
- CD or DVD drive
- Card reader/writer
- Portable hard disk for backup
- USB flash drive

Putting It All Together

☐ Recommended storage devices for power users



- 1.5 TB hard disk
- Online storage
- CD or DVD drive
- Portable hard disk for backup
- USB flash drive

Putting It All Together

☐ Recommended storage devices for large business users



- Desktop computer
 - 500 GB hard disk
 - CD or DVD drive
 - Smart card reader
 - Tape drive
 - USB flash drive
- Server or Mainframe
 - Network storage server
 - 40 TB hard disk system
 - CD-ROM or DVD-ROM server
 - Microfilm or microfiche

Youtube Videos

- ☐ <http://www.youtube.com/watch?v=ZDITqacAkFQ>
- ☐ http://www.youtube.com/watch?v=G2EfxglM_mQ
- ☐ <http://www.youtube.com/watch?v=SipFUeFdQOE>
- ☐ <http://www.youtube.com/watch?v=wtC8RhYHAAI>
- ☐ <http://www.youtube.com/watch?v=5zgCPEDGeXE>