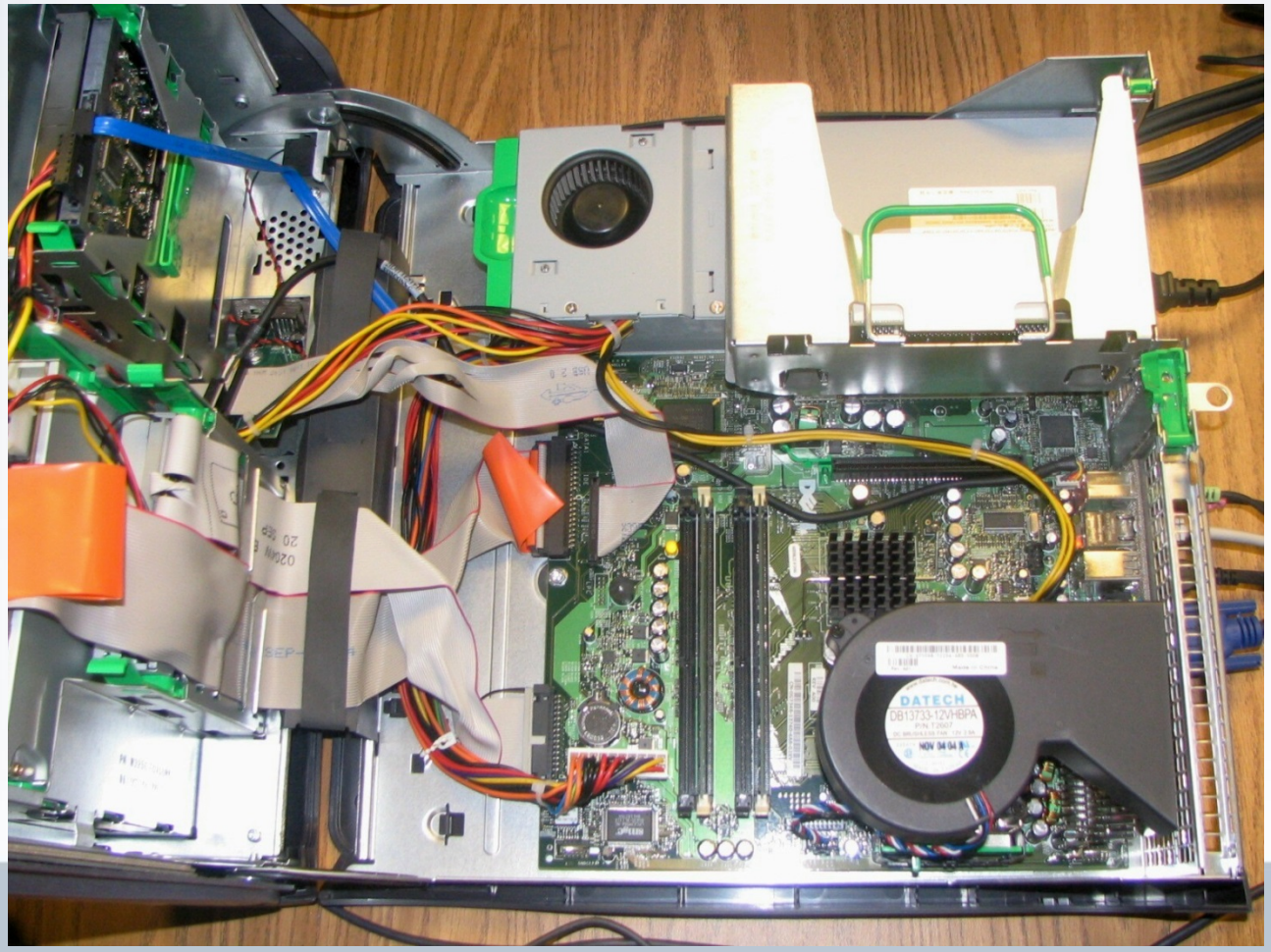
EE 8084
Cyber Security

Hardware Matters

I think we need to be paranoid optimists.

ROBERT J. EATON, CHAIRMAN OF THE BOARD OF MANAGEMENT OF DAIMLERCHRYSLER AG (RETIRED)

What are all those parts inside my computer and what do they do???



Computer Hardware

- Memory Card
- Motherboard
- Sound Card and Video Card
- Power Supply
- NIC Card
- BIOS
- Hard Disk Drive

Memory Card

Remember RAM (Random Access Memory) and ROM (Read-Only Memory)?

- RAM cards will remember what you tell them and can even change to remember new information. But, when the computer is turned off, it forgets everything you did! That's why you always save your work!
- ROM is good at remembering, but cannot change it's mind. It holds the information that was built into it!

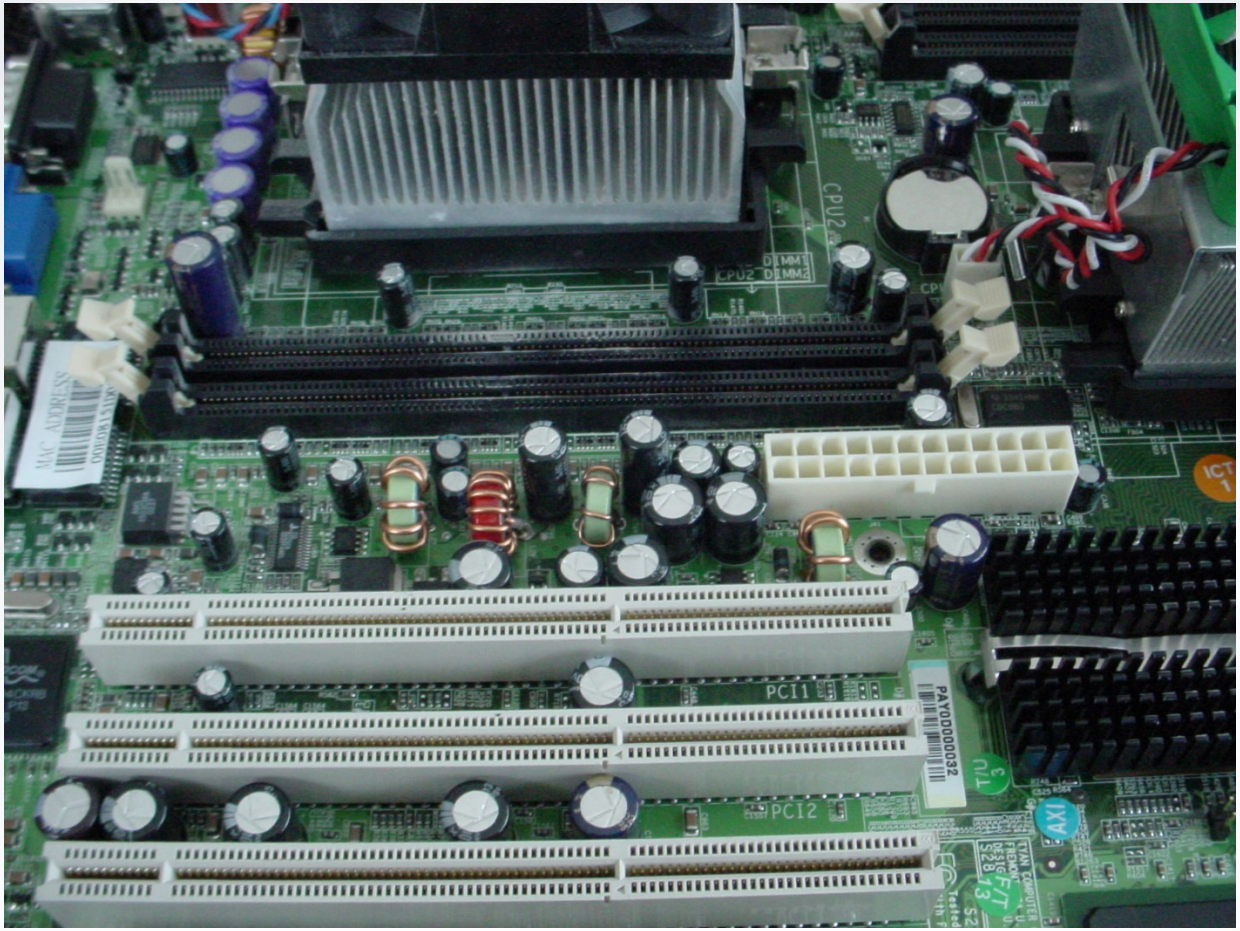
Random Access Memory (RAM)

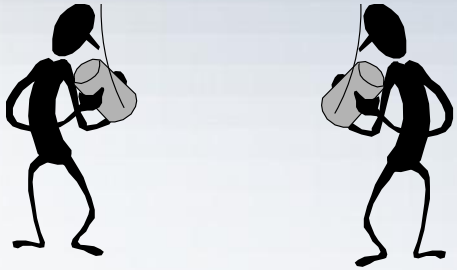
When a computer processes information, it uses software programs. Each program requires a certain amount of electronic memory, or RAM (Random Access Memory) to run correctly.

Read-Only Memory (ROM)

A second kind of computer memory is ROM, which stands for Read-Only Memory. This memory is **permanent**. The information there was put there when the computer was made. The computer needs the information in it's ROM memory in order to function.

The Motherboard





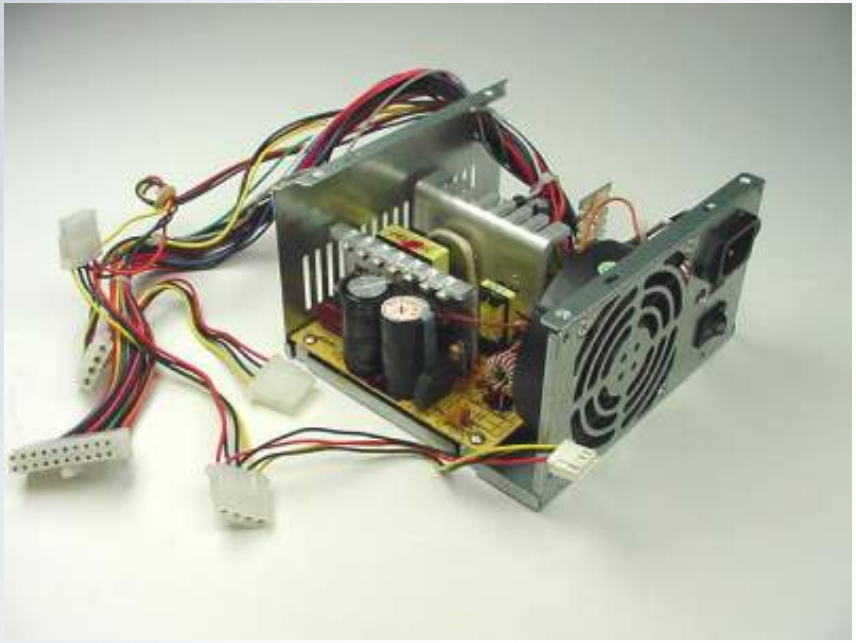
- Your computer couldn’t work without the **motherboard**. It ties everything together!
- It allows every part of your computer to receive power and communicate with each other.
- Everything that runs the computer or enhances it’s performance is either part of the **motherboard** or plugs into one of it’s expansion slots or ports.

Sound and Video Cards

Sound and Video Cards are Output Devices. They contain special circuits that allow your computer to play sounds and display graphics on your monitor.

Power Supply

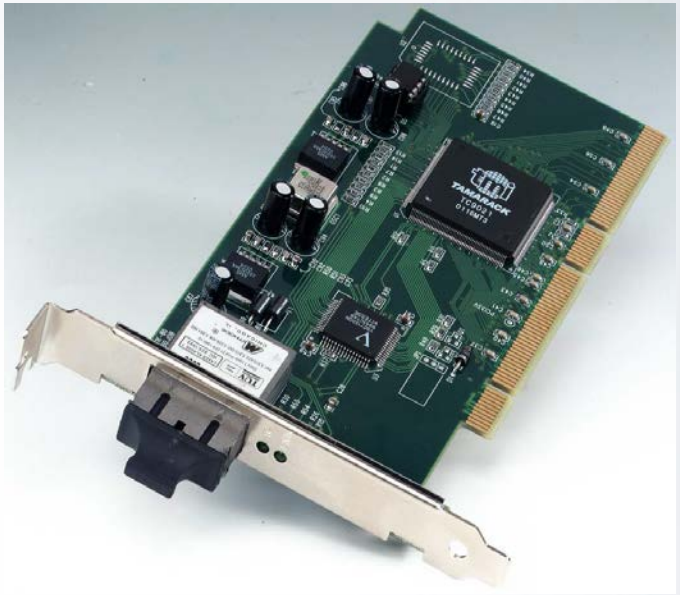
- If there is any one component that is absolutely vital to the operation of a computer, it is the power supply!
- Without it, a computer is just a box full of plastic and metal.
- The power supply converts the alternating current (AC) line from your home or school to the direct current (DC) needed by the computer.



- You can see the power supply from the back of your computer because of the power cord and the cooling fan.
- Computers put out a LOT of heat and need the fan to keep them from overheating.

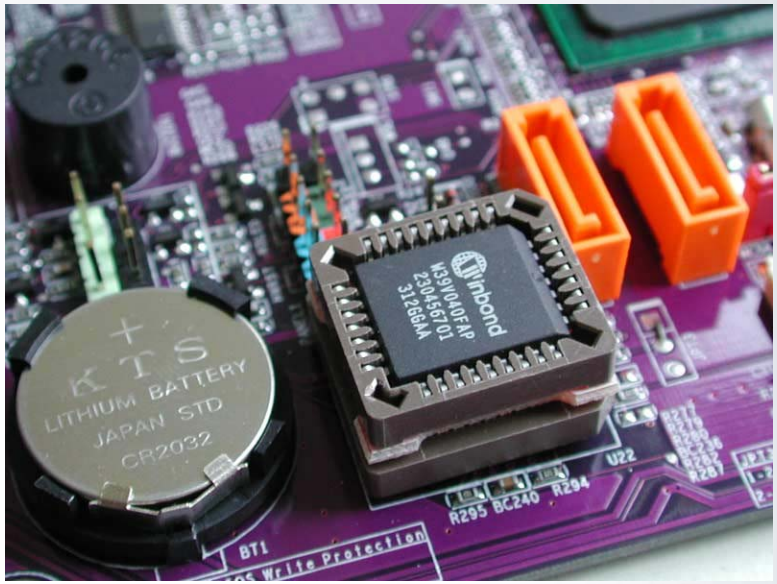
Network Interface Card

- A NIC card (Network Interface Card) allows your computer to talk to other computers!
- A cable (CAT 6 or CAT 6e) is plugged into the NIC card and your computer can then be attached to a network and be on the internet!



BIOS CHIP

- A BIOS chip (Basic Input Output System) is a very important computer component.
- In simple terms, the BIOS chip wakes up the computer when you turn it on and reminds it what parts it has and what they do!



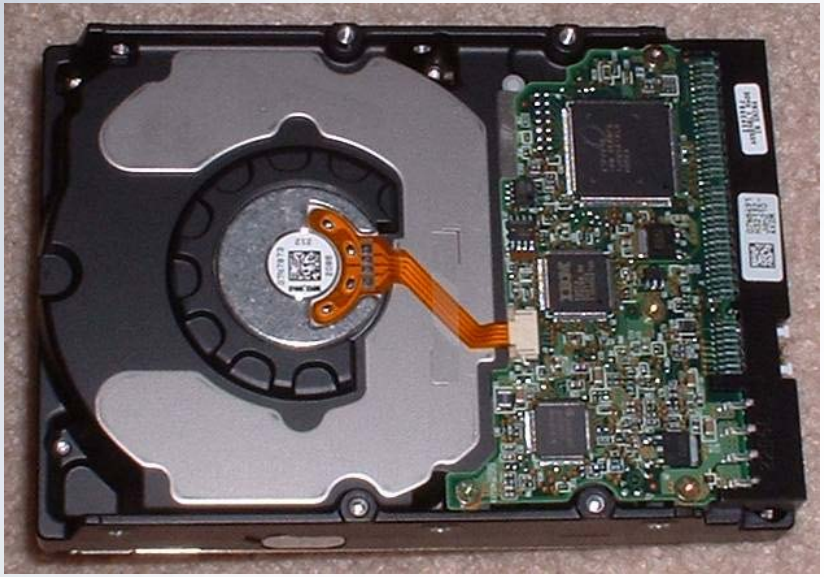
Hard Disk Drive

- The Hard Disk Drive is a magnetic storage device. All the computer programs and files you create and save are located there.
- This is **permanent storage** (at least until you uninstall software or delete a file). The hard drive is normally signified by the drive letter “C”.
- Today’s hard drives can store a HUGE amount of information. A new computer might have a hard drive that will hold 4 Terabytes!

Hard Disk Drive Components

- Electromechanical
  - Rotating disks
  - Arm assembly
- Electronics
  - Disk controller
  - Cache
  - Interface controller

- Inside the Hard Disk Drive case you'll find circular disks that are made of steel.
- On the disks, there are many tracks, or cylinders.
- An electronic reading device called the **head** passes back and forth over the cylinders, reading information from the disk or writing to it.



Hard Disk Drives use Magnetic Recording Techniques. The magnetic medium can be easily erased and rewritten and will “remember” the magnetic flux patterns stored on it for many years!

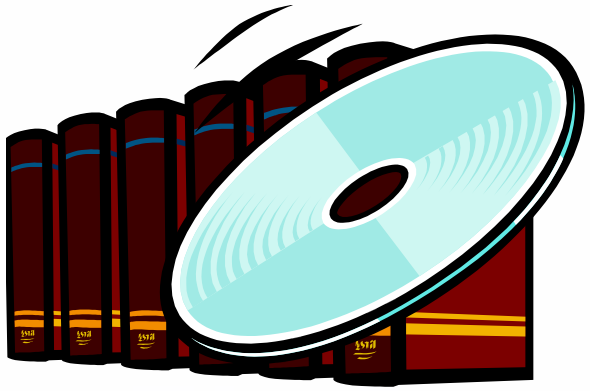
Inside a Hard Disk

It is a sealed aluminum box with controller electronics attached to one side.

The electronics

- control the read/write mechanism and the motor that spins the platters
- assemble the magnetic domains on the drive into bytes (reading) and turn bytes into magnetic domains (writing)
- are all contained on a small board that detaches from the rest of the drive

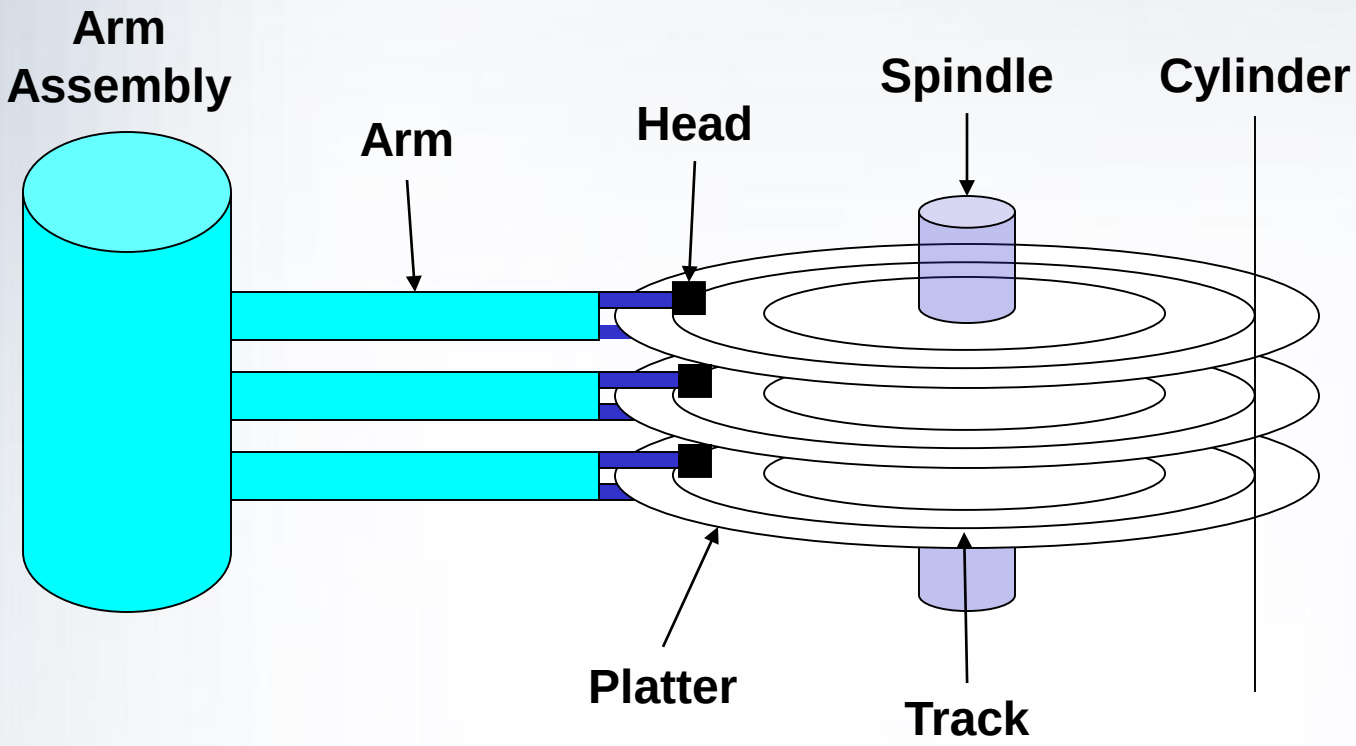
Hard Disk Drives can spin at 7200 or more rpm's (Revolutions Per Minute). That means in one minute, the hard drive spins around more than 7200 times!



Multiple Platters

- In order to increase the amount of information the drive can store, most hard disks have **multiple platters**. This drive has three platters and six read/write heads.

HDD Organization



HDD Organization

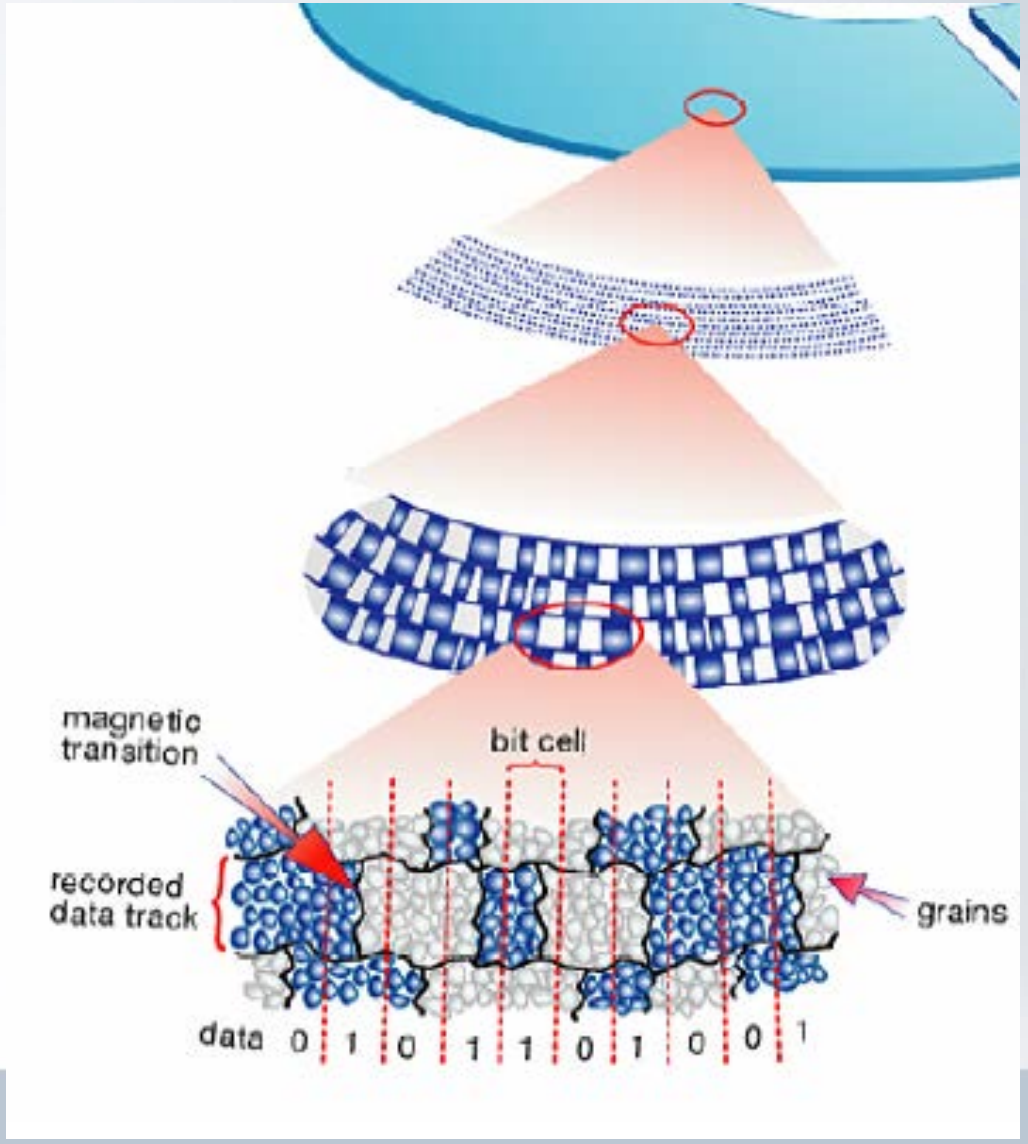
- Typical configurations seen in disks today
  - Platter diameters: 3.7”, 3.3”, 2.6”
  - RPMs: 5400, 7200, 10000, 15000
    - 0.5-1% variation in the RPM during operation
  - Number of platters: 1-5
  - Mobile disks can be as small as 0.75”
- Power proportional to:
  - Tradeoff in the drive-design
- Read/write head
  - Reading – Faraday’s Law
  - Writing – Magnetic Induction
- Data-channel
  - Encoding/decoding of data to/from magnetic phase changes

Disk Medium Materials

- Aluminum with a deposit of magnetic material
- Some disks also use glass platters
  - Eg. Newer IBM/Hitachi products
  - Better surface uniformity and stiffness but harder to deposit magnetic material
- Anti-Ferromagnetically Coupled media
  - Uses two magnetic layers of opposite polarity to reinforce the orientation.
  - Can provide higher densities but at higher manufacturing complexity

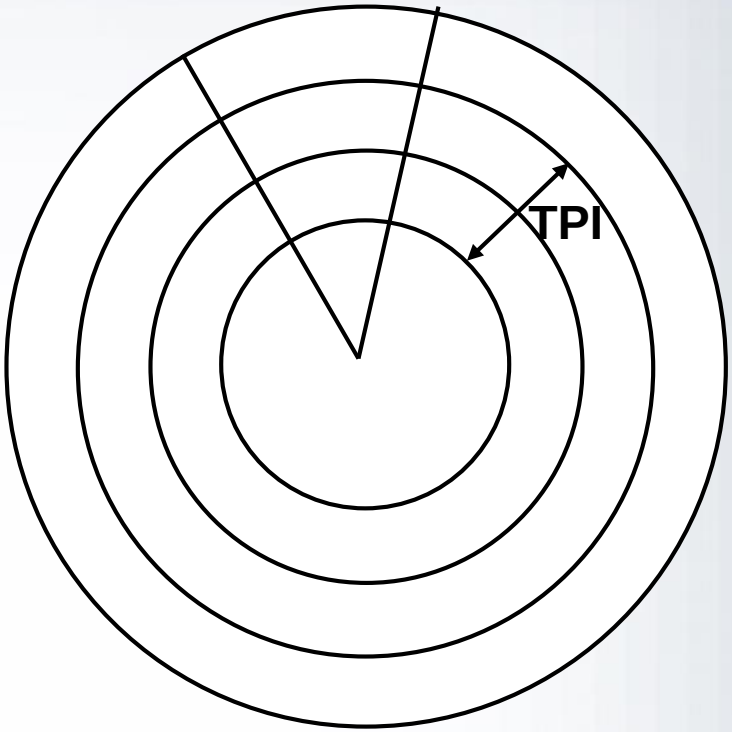
A Magnetic ‘Bit’

- Bit-cell composed of magnetic grains
  - 50-100 grains/bit
- ‘0’
  - Region of grains of uniform magnetic polarity
- ‘1’
  - Boundary between regions of opposite magnetization



Storage Density

- Determines both capacity and performance
- Density Metrics
  - Linear density (Bits/inch or BPI)
  - Track density (Tracks/inch or TPI)
  - Areal Density = BPIxTPI



Tracks and Sectors

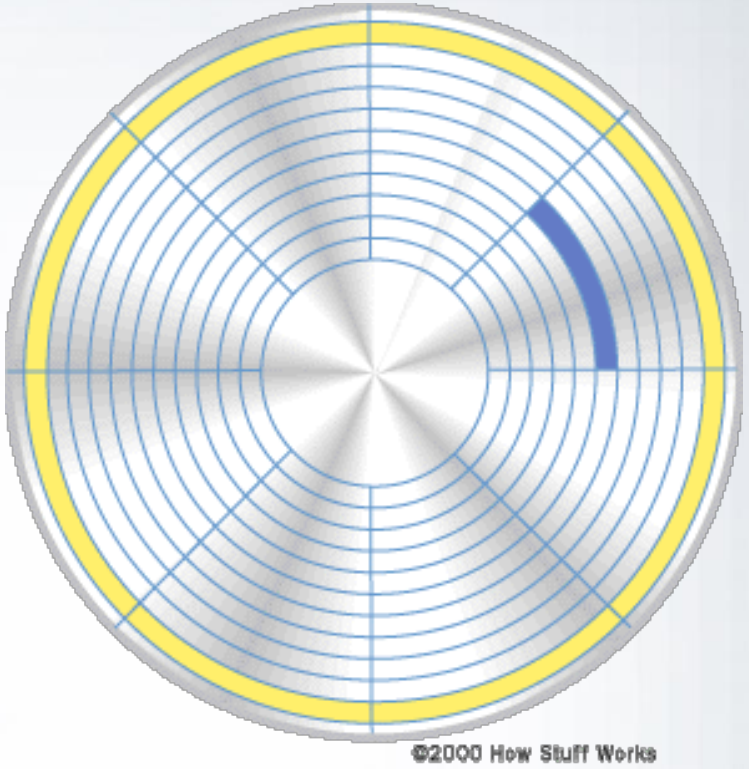
- Bits are grouped into sectors
- Typical sector-size = 512 bytes of data
- Sector also has overhead information
  - Error Correcting Codes (ECC)
  - Servo fields to properly position the head

Data in Hard Disk

- A modern desktop machine will have a hard disk with a capacity between 20 gigabytes to 4 terabytes. Data is stored on the disk in the form of **files**.
- A file is simply a named collection of bytes. The bytes might be the ASCII codes for the characters of a text file, the instructions from a software application for the computer to execute, the records of a data base, or the pixel colors for a GIF image.
- No matter what it contains, however, a file is simply a string of bytes. When a program running on the computer requests a file, the hard disk retrieves its bytes and sends them to the CPU one at a time.

Storing the Data

- Data is stored on the surface of a platter in **sectors** and **tracks**. Tracks are concentric circles, and sectors are pie-shaped wedges on a track.
- A typical track is shown in yellow; a typical sector is shown in blue. A sector contains a fixed number of bytes -- for example, 256 or 512.
- Either at the drive or the operating system level, sectors are often grouped together into **clusters**.



Formatting the HDD

- The process of **low-level formatting** a drive establishes the tracks and sectors on the platter. The starting and ending points of each sector are written onto the platter. This process prepares the drive to hold blocks of bytes.
- **High-level formatting** then writes the file-storage structures, like the file-allocation table, into the sectors. This process prepares the drive to hold files.

Tracks, Cylinders, and Sectors

- The tracks are numbered, starting from zero, starting at the outside of the platter and increasing as you go in. A modern hard disk has tens of thousands of tracks on each **platter**.

- Data is accessed by moving the heads from the inner to the outer part of the disk, driven by the head actuator. This organization of data allows for easy access to any part of the disk, which is why disks are called *random access* storage devices.

Tracks, Cylinders, and Sectors

- Each track can hold many thousands of bytes of data. It would be wasteful to make a track the smallest unit of storage on the disk, since this would mean that small files would waste a large amount of space. Therefore, each track is broken into smaller units called **sectors**.

- Each sector holds 512 bytes of user data, plus as many as a few dozen additional bytes used for internal drive control, and for error detection and correction. Today's hard disks can have *thousands* of sectors in a single track, and make use of zoned recording to allow more sectors on the larger outer tracks of the disk.

Maintaining Your Hard Drive

To maintain your hard drive, you should know how to

- remove unnecessary files and clutter
- check the integrity of your hard drive
- defrag your hard drive

Removing Unnecessary Files

Every time you run a program, install, uninstall, or go on the web, junk files get left behind. It is good to remove these junk files. In the System Tools of your computer is a utility called **Disk Cleanup**.

- Disk Cleanup will search your hard drive and remove the files you no longer need.
- There are other programs that can also perform a more thorough cleanup of your drive.

Check the integrity of your hard drive

- The Windows Operating System includes a utility called **Scan Disk**. Scan Disk is located in the System Tools folder with the Disk Cleanup utility.
- Scan Disk will check the hard drive for errors in the file system and attempt to fix anything it finds. It can also check for defects on the platters themselves.
- Scan Disk should be run before defragging.

Defragging A Hard Drive

- As you use your computer, some files can become **fragmented**, meaning that part of a file may be stored in one location, and the rest of it in another. In order for your computer to read the file, it will need to go to both locations, resulting in slowed performance.
- It makes sense that if the computer only had to look in one location to get an entire file, it would perform faster. **Defragging** a hard drive will accomplish this.

Malware - recap

Malware

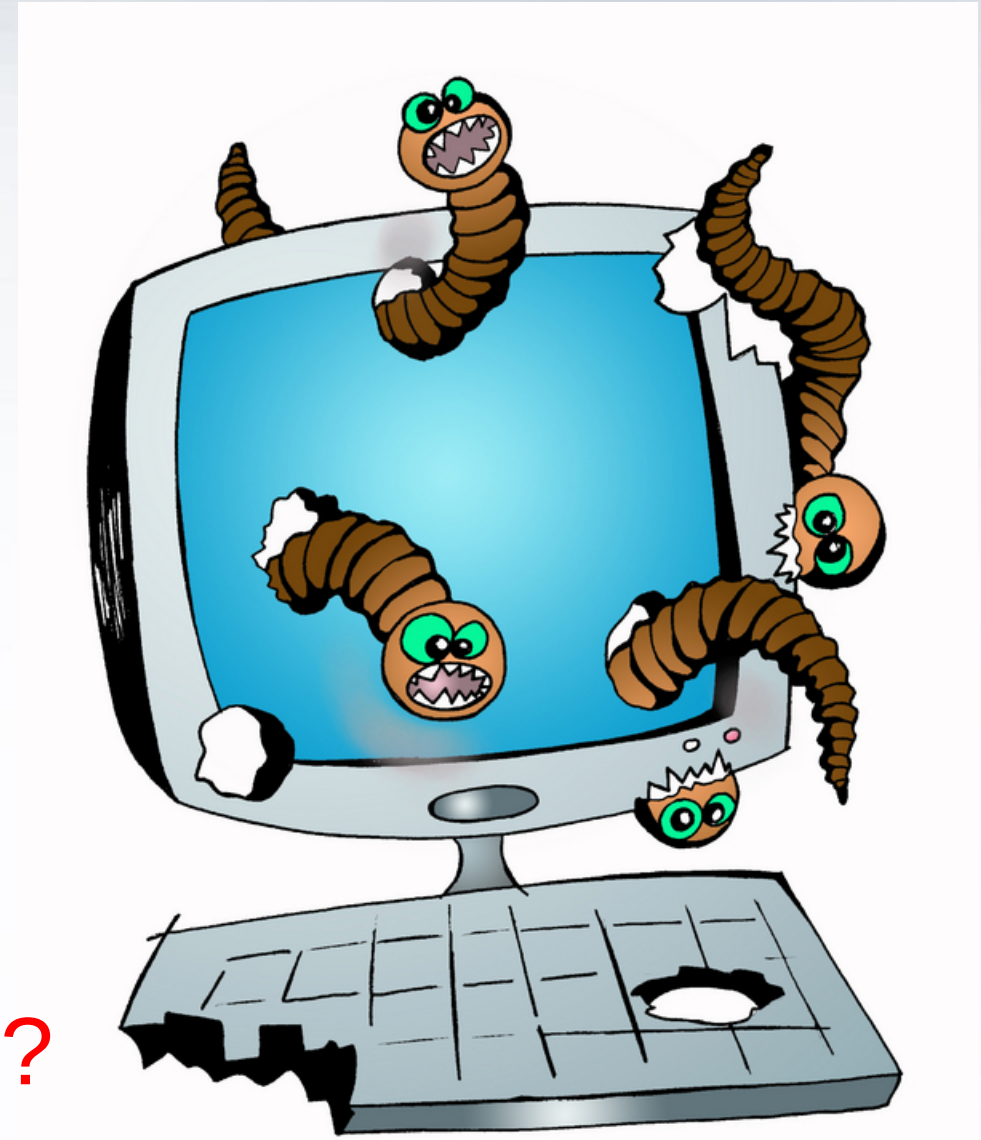
- A general name for evil software

Vulnerability-Specific versus Universal Malware

- Vulnerabilities are security flaws in specific programs.
- Vulnerability-specific malware requires a specific vulnerability to be effective.

Universal malware does not require a specific vulnerability to be effective.

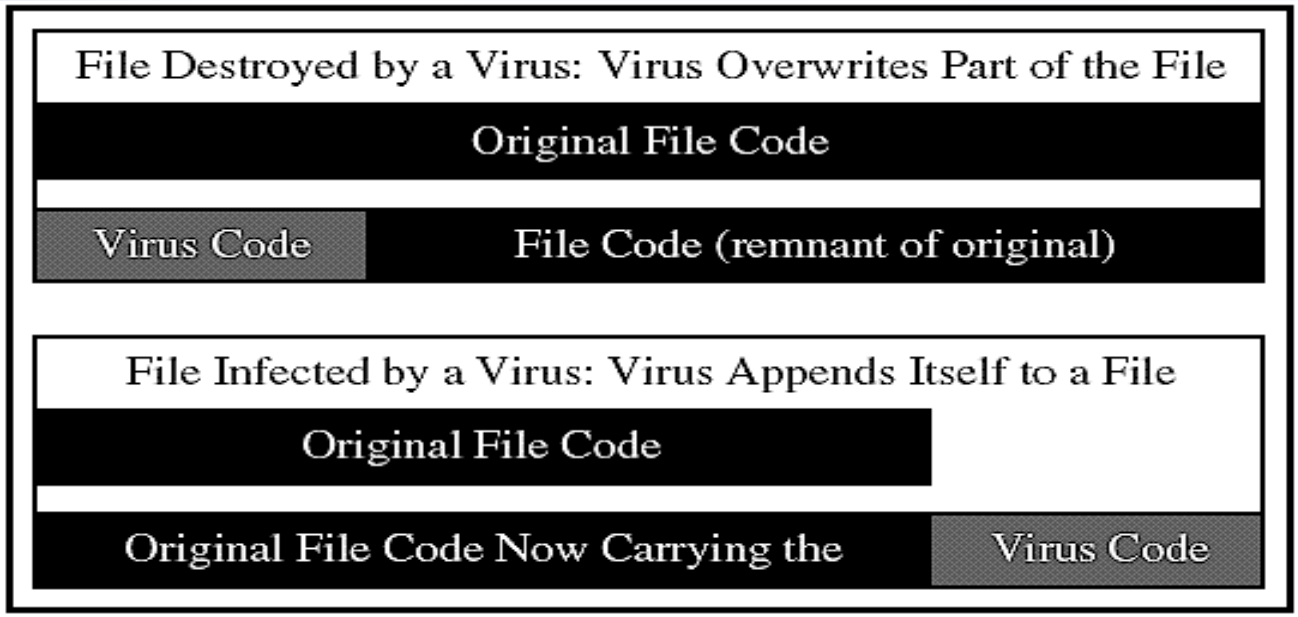
Malwares



Where are they stored?

Malware: Viruses, Worms, Trojans,logic bombs

Virus File-Destruction and Infection Techniques



Overview of how files are created, deleted, and restored

When a file is created three things occur:

1. An entry is made into the **File Allocation Table** (FAT) to indicate where the actual data is stored in the Data Area.
2. A **Directory entry** is made to indicate file name, size, the link to the FAT and other info.
3. The data is written to the **Data Area**.

File Deletion

When a file is deleted only two things occur:

1. The **FAT** entry for the file is zeroed out and the space on the hard drive becomes available for use by a new file.
2. The first character of the **Directory entry** file name is changed to a special character.

- Nothing is done to the **Data Area**.

File Restoration

When a file is restored only two things are done:

1. The **FAT entry** for the file is linked again to the location in the data area where the file is stored.
2. The first character of the **Directory entry** file name is changed to a legal character.

- Nothing is done to the **Data Area**.

Before Getting Rid of Your Old Computer

- Before you purchase a new PC, donate your old computer to a charity, local group or school, it is important to make sure your computer's hard drive is completely free of data
- Physically smash the hard drive is not good enough
- Formatting a disk does not erase the data on the disk, only the address tables: not 100% secure
- You need disk wiping (or disk scrubbing) or overwriting with random bits

Summary

- Memory Card
- Motherboard
- Sound Card and Video Card
- Power Supply
- NIC Card
- BIOS
- **Hard Disk Drive – why it is not safe to simply discard it without proper handling!**