Storage

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E-A 001 -- Slide set 8

Types of non-volatile memory

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We need some method for storing files in our computer that persist even when the power is turned off.

- Called non-volatile storage.

Two types of non-volatile storage used today:

- Magnetic disks
- Solid state disks

Magnetic disks

- Composed of metal platters coated with magnetic material.
- Data is stored digitally in the form of tiny magnetized regions on the platter where each region represents a bit.
- This polarity is sensed by integrated controllers built within the hard disk.
- Multiple platters.

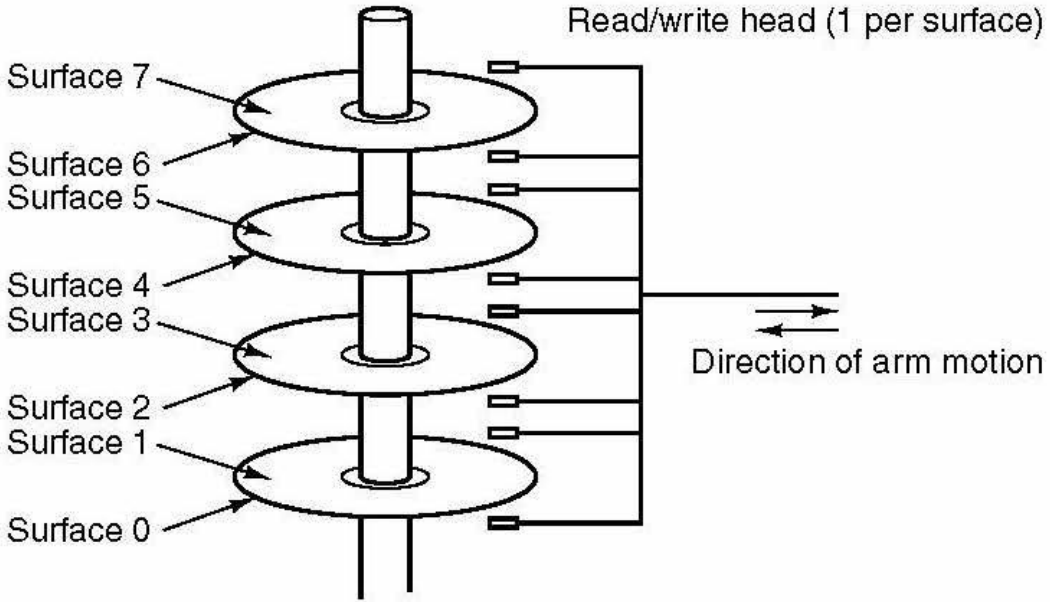

Figure 2-20. A disk with four platters.

Organization of a platter

- A track is a complete circle on a platter.
- A track is broken up into sectors
- Since inner tracks are shorter than outer tracks, the disk is broken up into zones, each with a fixed number of sectors.

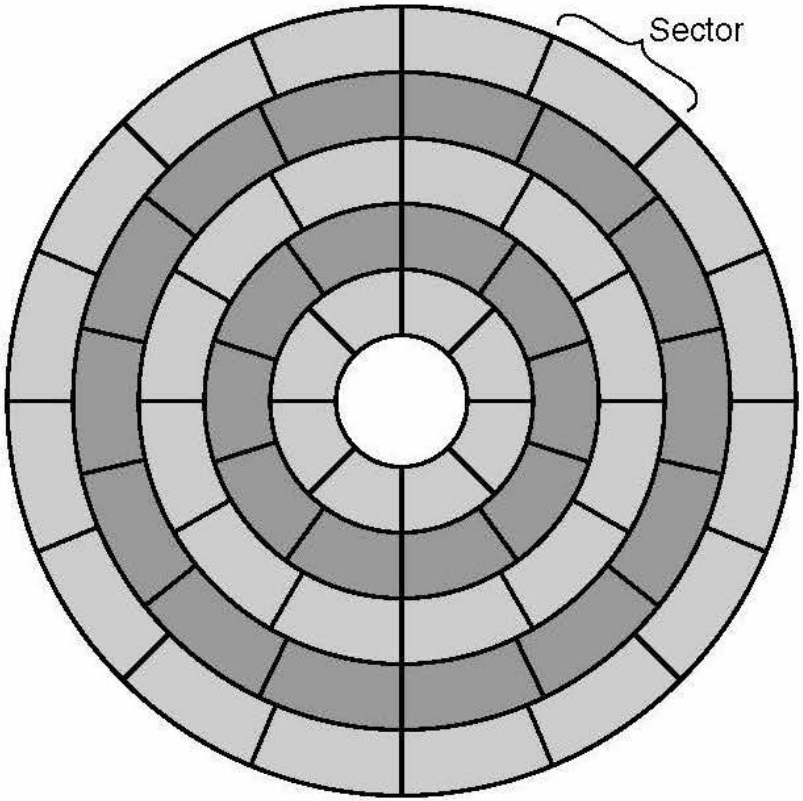

Figure 2-21. A disk with five zones. Each zone has many tracks.

Performance of magnetic disks

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Total access time = Seek time + Rotational latency + Transfer time
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- Seek time is the time to move the head to the desired track.
  - An average seek time is used for calculations.
- Rotational latency is the time to wait for the desired sector.
  - Varies between 0 seconds and time for one rotation.
  - Average is ½ X Time for one rotation.
- Transfer time is the time to read the sectors, and transfer their contents to main memory via the system bus.
  - Calculated using average transfer rate.

Solid state disks (SSDs)

Solid state disks are a method of building non-volatile storage.

- They are built out of flash memory, a type of semiconductor storage.
- SSDs are commonly used in desktops, laptops, and servers, as well as smartphone and tablets.
- Flash memory is also used in:
  - SD cards
  - USB drives

Technology used:

- Not built using logic (gates)
- Not built using DRAM (capacitances)
- Instead, flash memory is a type of Electrically Erasable Programmable Read-Only Memory (EEPROM), which stores bits using a floating gate.

How does flash memory work?

- It contains a floating gate sandwiched between an insulator.
- When a high voltage (12V) is applied, electrons leak across the insulator into the floating gate.
- When the high voltage is removed, the electrons remain trapped in the floating gate indefinitely.
- Negative charge increases voltage needed to turn on transistor below.
- By checking if a low voltage turns on the transistor at the test tap, we can detect stored 0 or 1.
- Reading is faster than writing.

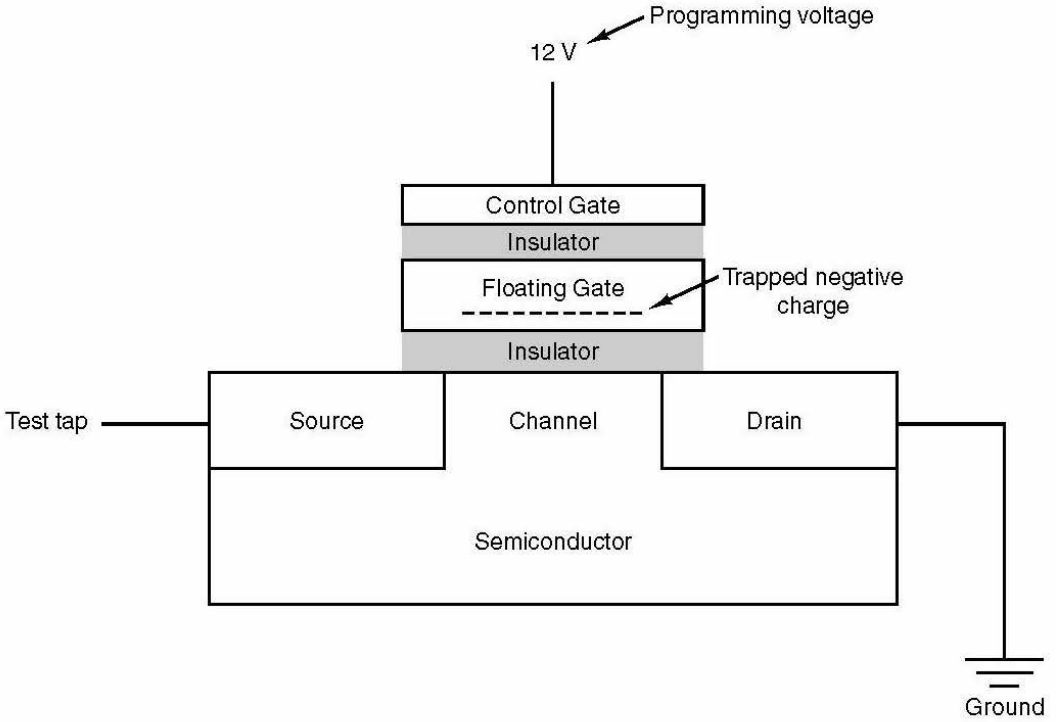

Figure 2-24. A flash memory cell.

Comparing magnetic disks to SSDs

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Advantages of Magnetic disks:

- Cheaper, but difference is narrowing.
- Writes to flash memory can wear out the flash. Maximum of a few hundred thousand writes per sector. But that is long enough for most SSDs to last several years. So no longer a drawback since magnetic disks also have a mean time to failure (MTTF) of a few years.

Advantages of SSDs:

- Much faster:
  - Way lower response time (No seek time). Can be 100X lower.
  - Higher sustained transfer rate. 2-3X faster.
- Consume less power (no need to constantly spin disk)
- More robust during movement ⇒ Used in smartphones and tablets.
- Lower failure rate.