Storage

Storage is slower with a higher capacity than main memory.
Performance of storage is based on two characteristics:
- throughput → which is improving
- latency → which is improving very slowly

Magnetic Disks
Magnetic disks = Hard drives and floppy disks
Data bits are on both surfaces of the disks.

Access Time for Magnetic Disks
Seek time - time to move head assembly to the correct cylinder
Rotational latency - time to move to disk to the correct sector
Data Read - time required to read the entire sector
Controller time - time to check data (check sum, etc)
I/O Bus time - time to load data on the bus and send to processor

Only one disk access can be performed at a time, so there is an additional
Queuing delay - time to wait for availability of the disk

Trends for Magnetic Disks
Capacity is improving
Seek Time has slowly improved
Rotation Speed has improved
Controller and Bus Speed have improved

Optical Disks
Optical disks (such as CDs and DVDs) are similar to magnetic disks.
Since they are portable, they need to be standardized, which slows improvement.

Magnetic Tape
Magnetic tape is used for secondary (backup) storage.
They have a large capacity, but must be read sequentially.

Using RAM for Storage
RAM is benefitting from Moore's Law.
SSD = Solid State Disk
SSD can be a DRAM and Battery, it is fast, but expensive.
Flash Memory uses transistors and is low power.

Hybrid Magnetic Flash
A combination of magnetic disk and flash drive. The flash drive is used as a cache for the disk.

Connecting IO Devices

IO devices are connected to the system with a bus.

- The buses must be standardized to connect to a number of IO devices, so improvement to the bus are slow.