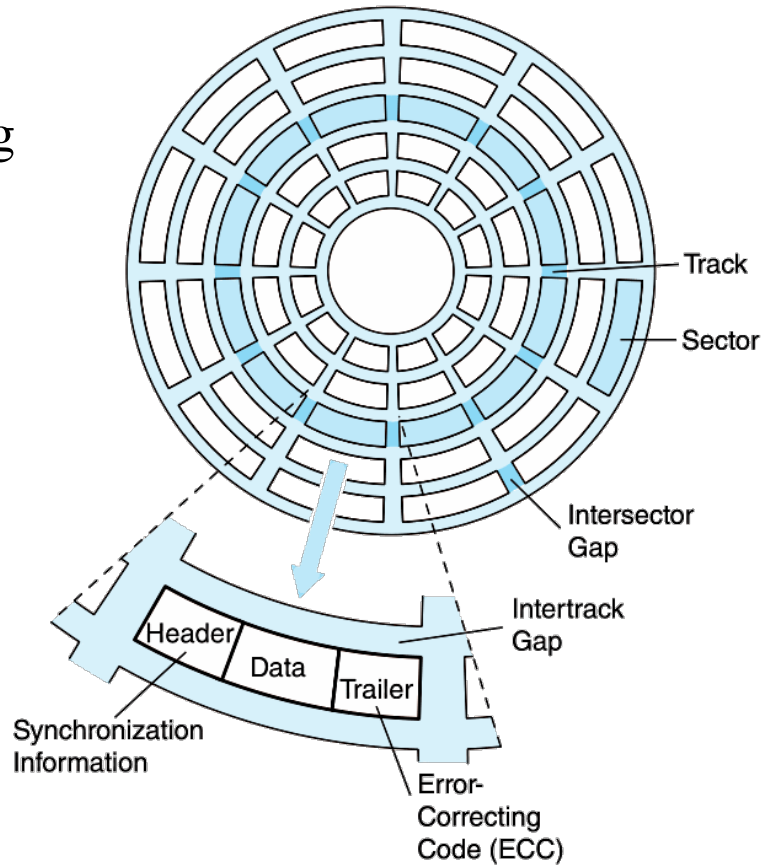


- Processor speeds far outpace the speed of disks
 - Instructions execute in nanoseconds
 - Disks still require milliseconds to access
- Parallel access can hide the slowness of disks
 - Separate blocks are read from different disks at the same time
- The seek and access delays are not reduced
 - The beginning of the data must still be determined
 - Multiple pieces of data are accessed in parallel
 - The multiple pieces are buffered and reassembled
 - The complete file can then be transferred into memory

Disk tracks are numbered from the outside edge, starting with zero.

A sector is the smallest unit of transfer.



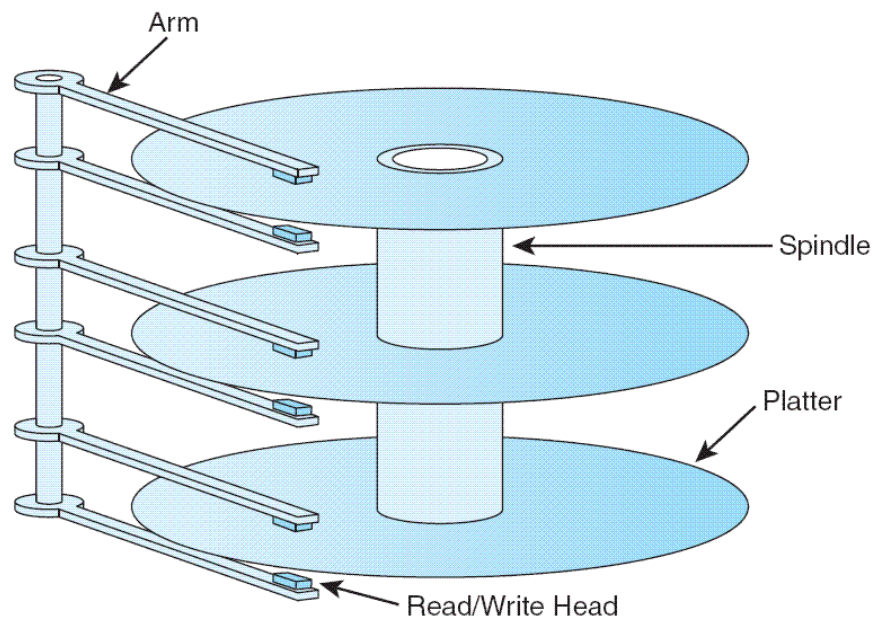
Hard disk platters are mounted on spindles.

Read/write heads are mounted on a comb that swings radially to read the disk.

The rotating disks form a logical cylinder beneath the read/write heads.

Data blocks are addressed by their cylinder, surface, and sector

A disk can perform one read or one write at a time.



Seek time is the time that it takes for a disk arm to move into position over the desired cylinder.

Rotational delay is the time that it takes for the desired sector to move into position beneath the read/write head.

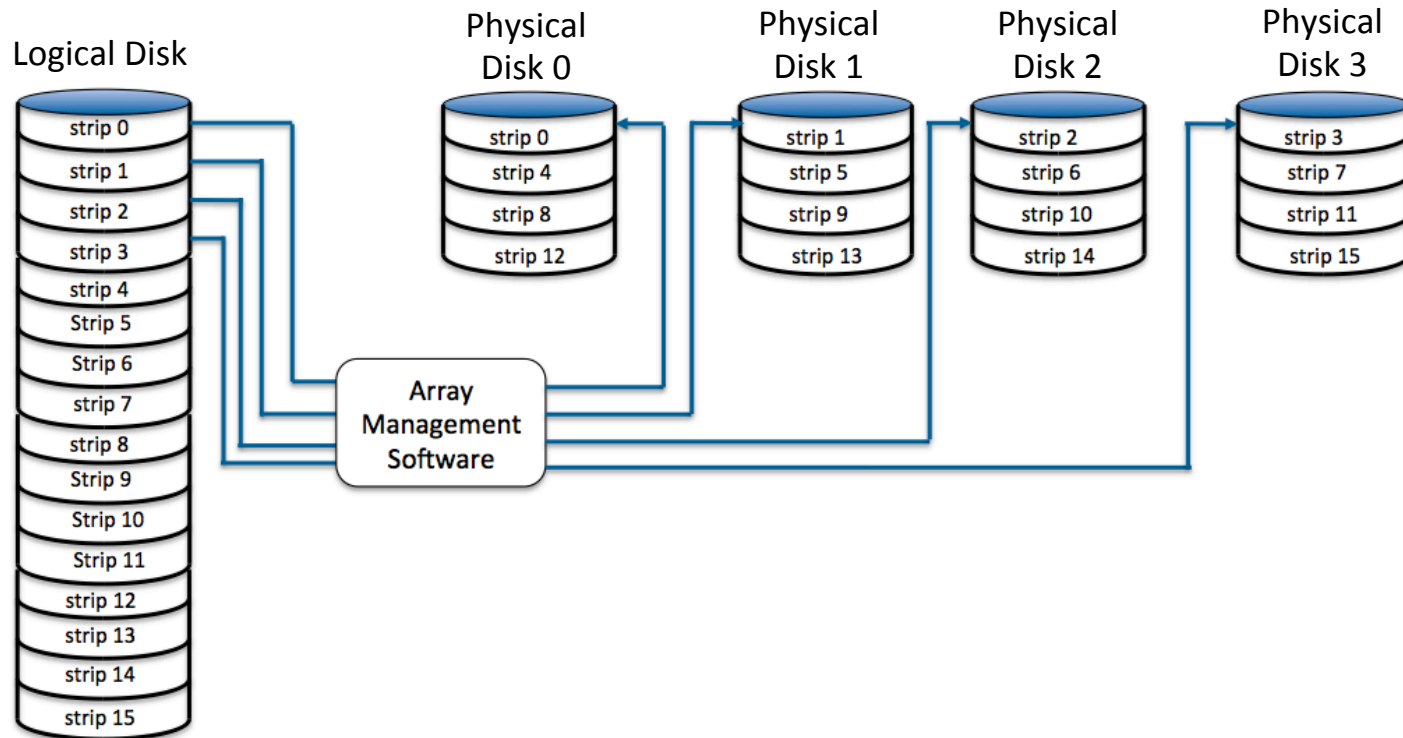
Seek time + rotational delay = *access time*.

The data transfer time is also a factor that must be considered.



- RAID is an acronym:
 - Redundant array of inexpensive disks
 - Most disks are now inexpensive
 - So “inexpensive” was replaced by “independent”
- Different level numbers do not imply ranking
 - They only distinguish one category from another
 - Originally, levels 0 through 5 were identified
- Not all levels duplicate data
- Not all levels provide redundancy

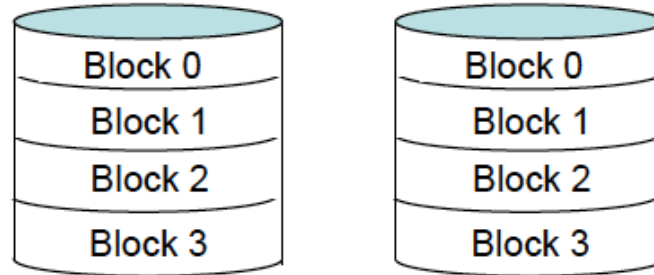
- Data Striping can improve performance
 - Files are split into smaller pieces (blocks)
 - The pieces are stored on different disks
 - For reads, all disks access their portions of the data
- Multiple categories or levels have been defined
 - Files are split into separate parts
 - The separate parts are on different disks
 - Multiple disks can be accessed at the same time
- Using multiple disks can yield greater reliability
 - Duplicate copies of data can be stored
 - Error correcting information can be included
 - Contents of failing disks can be reconstructed



RAID 0 provides no redundancy (low reliability)

Speeds access to large amounts of logically contiguous data

Supports multiple transactions that map to separate strips or blocks



Redundancy provided by duplicating each data disk

- Each data disk has a mirror image or shadow disk

If a disk fails, its mirror image is used

- copied to replacement disk

Disk spindles are not synchronized

Reads obtain data from first available copy

Writes must update both mirror images

Main disadvantage is the cost of fully duplicating the data