DATA STORAGE TECHNOLOGIES & NETWORKS

(CS C446, CS F446 & IS C446)

LECTURE 13– STORAGE

Detection of Hard disk failure

- Method to predict hard disk failure
  - Self-Monitoring, Analysis & Reporting Technology System (S.M.A.R.T.)
  - SMART helps user to replace the drive before failure (and data loss) occurs
  - Manufacturer can use SMART data to discover where faults lie and prevent them from recurring in future drive designs
  - 60% of is mechanical failure – may be able to identify if symptoms like increased heat output, increased noise level, problems with reading and writing of data, or an increase in the number of damaged disk sectors is visible

Hard Disks - Addressing

- Access is always in group of 1 or more contiguous sectors
  - Starting sector address must be specified for access
- Addressing:
  - Cylinder, Head, Sector (CHS) addressing
    - OS needs to know the geometry of each disk
  - Logical Block Addressing (LBA)
    - Sequential Numbering of Sector addresses
    - Disk controller translates LBA to CHS
  - Issues in LBA:
    - Bad sectors (before shipping)
      - Address Sliding / Slipping could be used – skip bad sectors for numbering
    - Bad Sectors (during operation)
      - Mapping – maintain a map from logical number to physical CHS address;
      - Remap when you have a bad sector – use reserve sectors

Speed

- Queuing time – waiting for I/O device to be useable
  - Waiting for device – if device is serving another request
  - Waiting for channel – if device shares a channel with other devices (multiplexing)
- Disk rotating at a constant speed (energy saver – disk may stop)

Hard Disks –Access Time

- Read and writing in sector-sized blocks
  - Typically 512 bytes
- Access time
  - Seek time (t_{seek})
    - Required to move the arm and position over required track
    - Disk manufactures usually publishes full stroke seek time, average seek time and track-to-track seek time
    - Average seek time (typically 6 to 9ms)
    - Max. single seek time (upto 20 ms)

Hard Disks –Access Time

- Rotational Latency ($t_{avg\text{-}rotation}$)
  - Head on track, wait time for first bit of the sector to be over/under the head.
  - Time taken by the platter to rotate and position the data under the R/W head.
  - Max. wait time = 1 single rotation i.e. $t_{max\text{-}rotation}$
  - Avg. wait time = ½ of $t_{max\text{-}rotation}$ i.e. $t_{avg\text{-}rotation}$
  - $t_{avg\text{-}rotation}$ = 5.5 ms for 5400 rpm
  - $t_{avg\text{-}rotation}$ = 2.0 ms for 15000 rpm
- Transfer time ($t_{avg\text{-}transfer}$)
  - Time for rotating one sector over/under the head

Hard Disks –Access Time

- Data transfer rate
  - Average amount of data per unit time that the drive can deliver to the HBA (Host Bus Adaptor).
  - In read
    - (1) Data first moves from disk platters to R/W heads
    - (2) Data moves to the drive's internal buffer.
    - (3) Data moves from buffer through the interface to the host HBA
  - In write
    - (1) Data moves from HBA to internal buffer of the disk through the drive's interface
    - (2) Data moves from internal buffer to the R/W head.
    - (3) Data moves from R/W head to disk platters

Hard Disks –Access Time

- Data transfer rate is measured in terms of internal and external transfer rates
- Internal transfer rate
  - Speed at which the data moves from a single track of a platter's surface to internal buffer (cache) of the disk – takes into account seek time
- External transfer rate
  - Rate at which data can be moved through the interface to the HBA
  - It is generally the advertised speed of interface – 133MB/s for ATA

Disk Scheduling

- The operating system is responsible for using hardware efficiently — for the disk drives, this means having a fast access time and disk bandwidth.
- Access time has two major components
  - *Seek time* is the time for the disk are to move the heads to the cylinder containing the desired sector.
  - *Rotational latency* is the additional time waiting for the disk to rotate the desired sector to the disk head.
  - Actual transfer time
- Minimize seek time
- Seek time ≈ seek distance
- Disk bandwidth is the total number of bytes transferred, divided by the total time between the first request for service and the completion of the last transfer.

Disk Scheduling (Cont.)

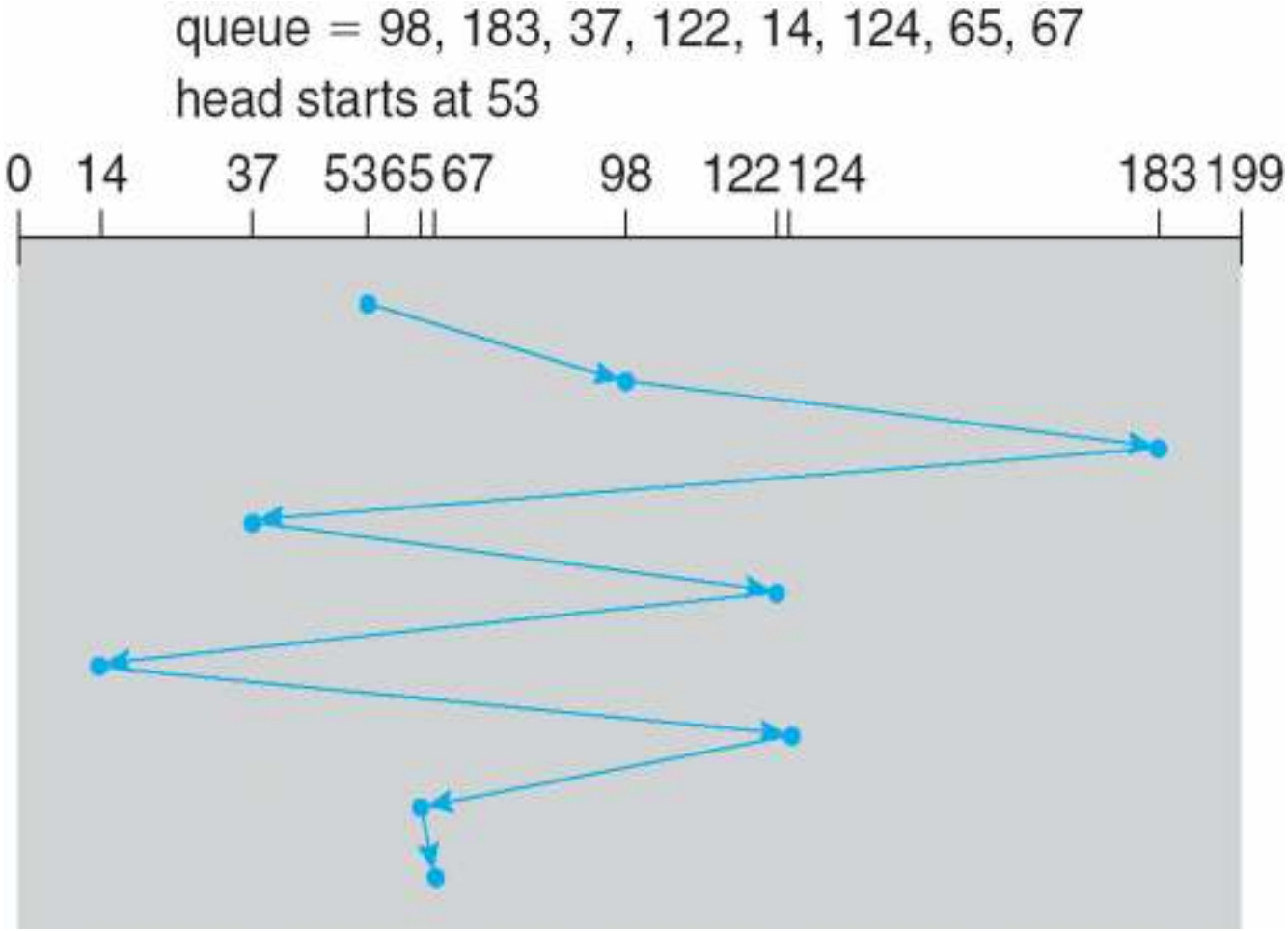
- Several algorithms exist to schedule the servicing of disk I/O requests.
- We illustrate them with a request queue (0-199).

98, 183, 37, 122, 14, 124, 65, 67

Head pointer 53

FCFS

Illustration shows total head movement of 640 cylinders.



Disk Scheduling Policies

- Priority
  - Goal is not to optimize disk use but to meet other objectives
  - Short batch jobs may have higher priority
  - Provide good interactive response time

Disk Scheduling Policies

- Last-in, first-out
  - Good for transaction processing systems
    - The device is given to the most recent user so there should be little arm movement
  - Possibility of starvation since a job may never regain the head of the line