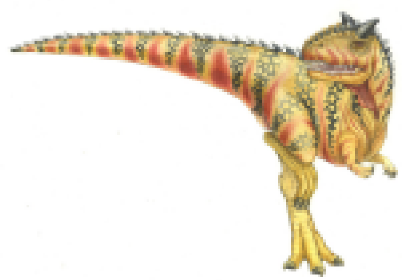
Chapter 10: Mass-StorageSystems



Chapter 10: Mass-StorageSystems

- Overview of Mass Storage Structure

Objectives

- Disk Structure
- Disk Attachment
- Disk Scheduling

- To describe the physical structure of secondary storagedevicesand its effects on the uses of the devices
- To explain the performance characteristics of mass-storagedevices
- To evaluate disk scheduling algorithms

Moving-headDiskMechanism

Hard Disk Performance

- **Access Latency** = **Average access time** = average seektime+average latency
  - For fastest disk 3ms + 2ms = 5ms
    - For slow disk 9ms + 5.56ms = 14.56ms
- Average I/O time = average access time + (amount to transfer / transfer rate) + controller overhead
- For example to transfer a 4KB block on a 7200 RPMdiskwitha5ms average seek time, 1Gb/sec transfer rate with a .1mscontroller overhead =
  - 5ms + 4.17ms + 0.1ms + transfer time =
  - Transfer time = 4KB / 1Gb/s * 8Gb / GB * 1GB/ 1024^2KB=32 / (1024^2) = 0.031 ms
  - Average I/O time for 4KB block = 9.27ms + .031ms =9.301ms

Disk Structure

- Disk drives are addressed as large 1-dimensional arraysof **logicalblocks**, where the logical block is the smallest unit of transfer
  - Low-level formatting creates **logical blocks** on physical media
- The 1-dimensional array of logical blocks is mapped intothesectorsofthe disk sequentially
  - Sector 0 is the first sector of the first track on the outermost cylinder
  - Mapping proceeds in order through that track, thentherest of thetracks in that cylinder, and then through the rest of thecylindersfrom outermost to innermost
  - Logical to physical address should be easy 4 Except for bad

    sectors

    4 Non-constant # of sectors per track via constant angular velocity

Disk Scheduling

- The operating system is responsible for using hardwareefficiently — for the disk drives, this means having a fast access time and large disk bandwidth
- Access time has two components:

  Seek time and Rotational latency

- Seek time: Time for the disk harm to move the heads tothecylinder containing the desired sector.

- Rotational latency : additional time for the disk to rotatethedesired sector to the disk head.
- Minimize seek time
- Disk **bandwidth** is the total number of bytes transferred, divided by the total time between the first request for serviceand the completion of the last transfer

Disk Scheduling(Cont.)

- There are many sources of disk I/O request
  - System processes
  - OS
  - Users processes
- I/O request includes input or output mode, disk address, memoryaddress, number of sectors to transfer
- OS maintains queue of requests, per disk or device
- Idle disk can immediately work on I/O request, busy diskmeanswork must queue
  - Optimization algorithms only make sense when a queueexists

Disk Scheduling(Cont.)

- Note that drive controllers have small buffers and can manageaqueue of I/O requests (of varying "depth")
- Several algorithms exist to schedule the servicing of diskI/Orequests
- The analysis is true for one or many platters
- Suppose a disk is having 200 cylinders numberedfrom0to199. The disk is currently servicing at cylinder 53andpreviousrequest was at cylinder 60. The Queue of pendingrequestinFIFO order is -

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

Calculate the total distance the read/write headwill travel.

FCFS

Illustration shows total head movement of 640 cylinders:

640=(98-53)+(183-98)+(183-37)+(122-37)+(122-14)+(124-14)+(124-65)+(67-65)

SSTF

- Shortest Seek Time First selects the request with the minimumseektimefrom the current head position:SSTF scheduling is a formof SJFscheduling;may cause starvation of some requests

- Illustration shows total head movement of 236 cylinders

236=(65-53)+(67-65)+(67-37)+(37-14)+(98-14)+(122-98)+(124-122)+(183-124)

SCAN

- The disk arm starts at one end of the disk, and moves towardtheotherend, servicing requests until it gets to the other end of thedisk, wherethe head movement is reversed and servicing continues.

- **SCAN algorithm** Sometimes called the **elevator algorithm** ■ Illustration

shows total head movement of 236 cylinders

- But note that if requests are uniformly dense, largest densityat otherend of disk and those wait the longest

SCAN(Cont.)

236= (53-37)+(37-14)+(14-0)+(65-0)+(67-65)+(98-67)+(122-98)+(124-122)+(18

3-124)

(OR) Total Head Movements=(53-0) +(183-0) =236

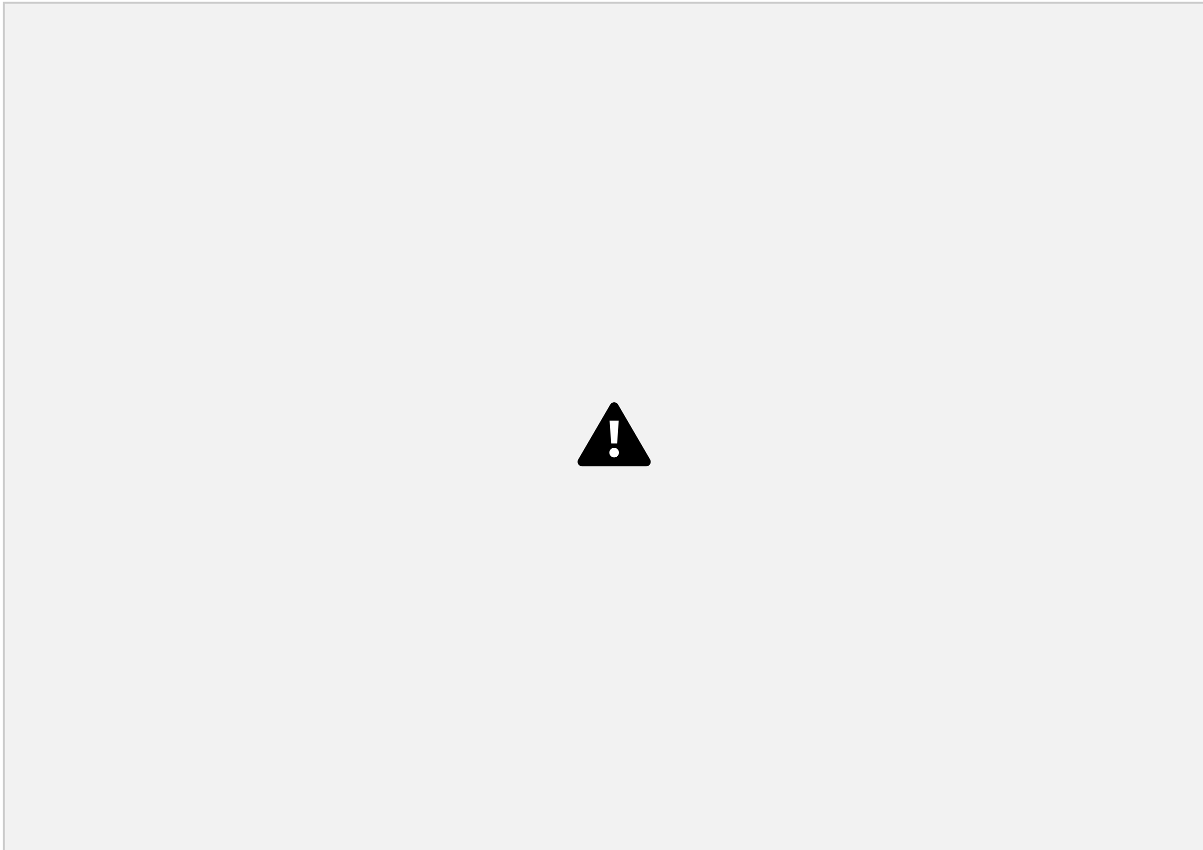
C-SCAN

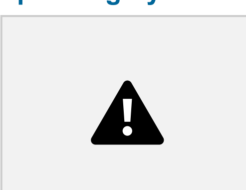
- Provides a more uniform wait time than SCAN
- The head moves from one end of the disk to the other(increasingorderof cylinder number), servicing requests as it goes
  - When it reaches the other end, however, it immediatelyreturnstothe beginning of the disk, without servicing any requestsonthereturn trip
- Treats the cylinders as a circular list that wraps aroundfromthelastcylinder to the first one
- Total number of cylinders?

C-SCAN(Cont.)

Total Head Movements=(199-53) +

(199-0)+(37-0) =382





C-LOOK

- LOOK a version of SCAN, C-LOOK a version of C-SCAN

- Arm only goes as far as the last request in each direction, then reverses direction immediately, without first goingall the way to the end of the disk
- Total number of cylinders?

C-Look

C-LOOK(Cont.)

Head Movements=(183-53) + (183-14)+(37-14) =322

Selecting a Disk-SchedulingAlgorithm

- SSTF is common and has a natural appeal
- SCAN and C-SCAN perform better for systems that place a heavy loadon the disk
  - Less starvation
- Performance depends on the number and types of requests ■ Requests for disk service can be influenced by the file-allocationmethod
- The disk-scheduling algorithm should be written as a separate moduleof the operating system, allowing it to be replaced with a different algorithmif necessary
- Either SSTF or LOOK is a reasonable choice for the default algorithm

PROTECTION:

- **GOALS OF PROTECTION**
- Protection is a mechanism for **controlling the access** of programs,processes, or users to the resources defined by a computer system.Protection ensures that only processes that have gainedproper authorization from the operating system can operate onthefiles, memorysegments, CPU, and other resources of a system.
- Protection is required to prevent mischievous, intentional violationofanaccess restriction by a user.

- **PRINCIPLES OF PROTECTION**
- A key, time-tested guiding principle for protection is the‘principleofleastprivilege’. It dictates that programs, users, and even systemsbegivenjustenough privileges to perform their tasks. An operating systemprovidesmechanisms to enable privileges when they are neededandtodisablethemwhen they are not needed.

PROTECTION:

- **DOMAIN OF PROTECTION**
- A computer system is a collection of processes and objects. O*bjects*areboth **hardware objects** (such as the CPU, memory segments, printers,disks, and tape drives) and **software objects** (such as files, programs,andsemaphores). Each object (resource) has a unique namethat differentiatesit from all other objects in the system.
- The operations that are possible may depend on the object. For example,aCPU can only be executed on. Memory segments can

bereadandwritten,whereas a CD-ROM or DVD-ROM can only be read. Tapedrivescanberead, written, and rewound. Data files can be created, opened, read,written,closed, and deleted; program files can be read, written, executed, anddeleted.

- A process should be allowed to access only those resources
- a) for which it has authorization
- b) currently requires to complete process