Module 5:Mass Storage Structures-PART 2

Hard disk, Solid State Disk, Magnetic Tapes

Objectives

- To describe the physical structure of secondary storage devices.
- To explain the performance characteristics of mass-storage devices.

Reference: Chapter 10 – Mass Storage Structure

Text Book: Abraham Silberschatz , Peter B Galvin , Greg Gagne, Operating System Concepts,9/e Wiley India,2015

Magnetic Disks

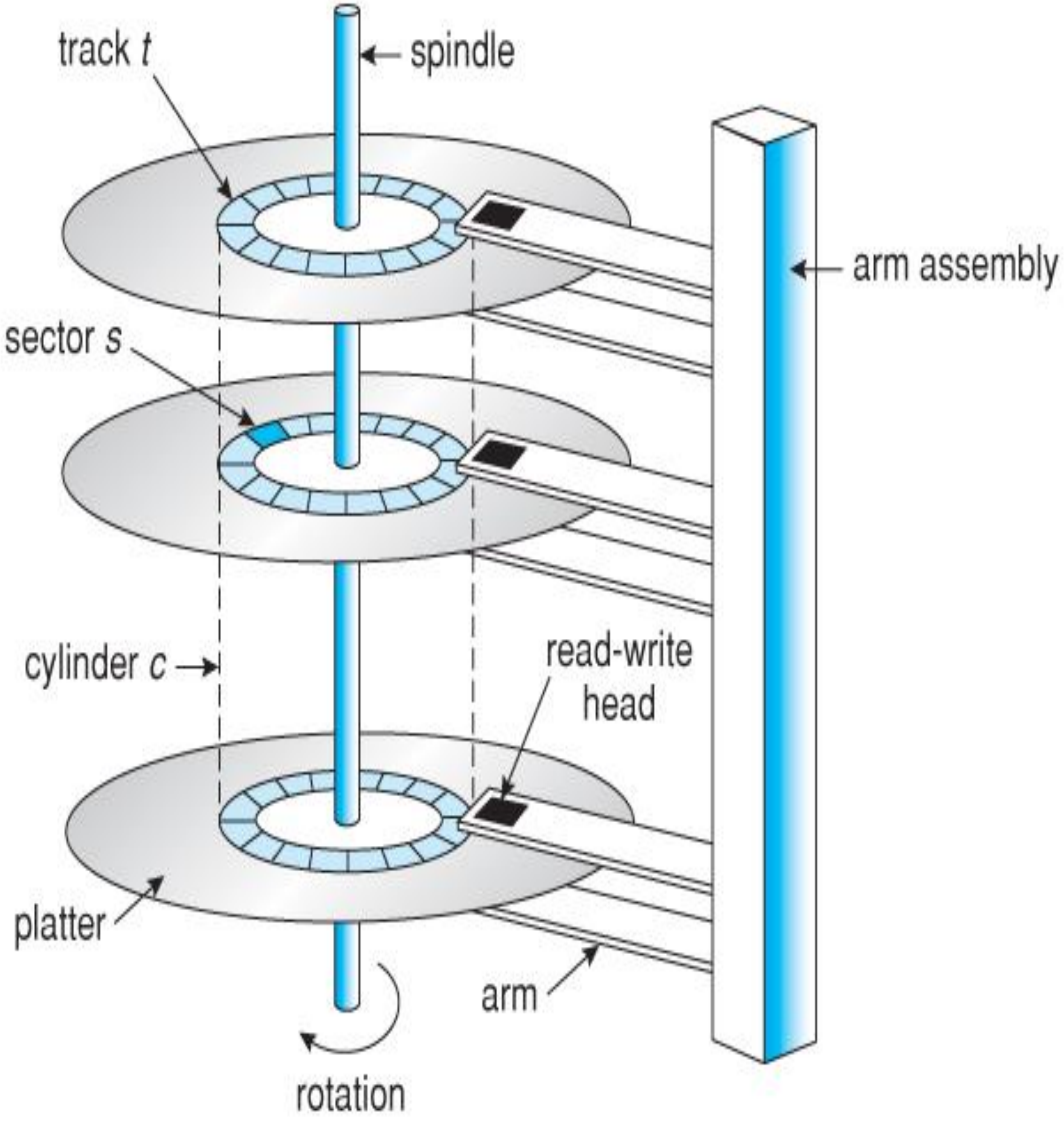
- **What is a disk?**
  - **A secondary storage device that can store large amounts of data**
  - **Eg: Hard disk, Pen drive, DVD,CD etc**
- **Magnetic disks** provide bulk of secondary storage of modern computers.
- Disks can be removable
- Drive attached to computer via **I/O bus**
  - Busses vary, including **EIDE**, **ATA**, **SATA**, **USB**, **Fibre Channel**, **SCSI**, **SAS**, **Firewire**

Magnetic Disks

- A magnetic disk is a storage device that uses a magnetization process to write, rewrite and access data.
- Magnetic disks are flat circular plates of metal or plastic, coated on both sides with iron oxide.
- It is covered with a magnetic coating and stores data in the form of tracks, spots and sectors.
- Hard disks, zip disks and floppy disks are common examples of magnetic disks.

Hard Disk Structure

- Hard disks drives are organized as a concentric stack of disks or **‘platters’.**
- Platter resemble the phonograph records found in an old- Fashioned Jukebox. **Multiple platters increase storage without equivalent increase in cost.**
- Platter is made from aluminium, ceramic, or class, coated with a magnetic materials such **as iron oxide**.



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- **Platters** – Each platter has 2 surfaces and two read/write heads for each surface. **Each platter is divided into tracks which in turn are divided into sectors.**
- **Heads**- Each platter is associated with the read/write Head. They are energy converters: I.e., **they transform electric signals into magnetic(write the disk) and vice-versa(read the disk).**
- **Tracks- The data is stored on concentric circles on the surfaces known as tracks.** Corresponding tracks on all platter surfaces make up a cylinder .Numbering starts with 0 at the outermost cylinder. Over 1000 on a hard disk .**Data first written to outer most track .**

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- **Cylinders**- Logical groupings of the same track on each disk surface in a disk unit. OR All the tracks with the same radius are known as a CYLINDER.
- **Sector**- A sector is a continuous linear stream of magnetized bits occupying a curved section of a track. **Sectors are the smallest physical storage units on a disk- Each sector stores 512 bytes of data** .Numbering physical sectors within a track starts with 1. Sector 1 Track 0 Sector 2 Track 0.

- **DISK CAPACITY**- One method of calculating disk capacity is to **multiply the number of cylinders, heads, and sectors** (i.e. CHS) together, and then multiply by the block size of 512 Bytes.

  E.g. 12,495 cylinders * 16 heads * 63 sectors * 512 bytes = approx. 6GB

Performance evaluation

- **Transfer rate** is rate at which data flow between drive and computer
- **Positioning time (random-access time)** consists of 2 parts
  - **Seek time:** The seek time is the time for the disk arm to move the heads to the cylinder containing the desired sector.
  - **Rotational latency :**The rotational latency is the additional time for the disk to rotate the desired Sector to the disk head.
  - **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

Hard disk

- Platters range from .85” to 14” (historically)
  - Commonly 3.5”, 2.5”, and 1.8”
- Range from 30GB to 3TB per drive
- Performance
  - Transfer Rate – theoretical – 6 Gb/sec
  - Effective Transfer Rate – real – 1Gb/sec
  - Seek time from 3ms to 12ms – 9ms common for desktop drives
  - Average seek time measured or calculated based on 1/3 of tracks
  - Latency based on spindle speed
    - 1 / (RPM / 60) = 60 / RPM
  - Average latency = ½ latency

Solid State Disk

- Nonvolatile memory used like a hard drive
  - Many technology variations
- Can be more reliable than HDDs
- More expensive per MB
- Maybe have shorter life span
- Less capacity
- But much faster
- Busses can be too slow -> connect directly to PCI for example
- No moving parts, so no seek time or rotational latency

Magnetic Tape

- Was early secondary-storage medium
  - Evolved from open spools to cartridges
- Relatively permanent and holds large quantities of data
- Access time slow
- Random access ~1000 times slower than disk
- Mainly used for backup, storage of infrequently-used data, transfer medium between systems
- Once data under head, transfer rates comparable to disk
  - 140MB/sec and greater
- 200GB to 1.5TB typical storage

Difference between Magnetic Tape & Magnetic Disk

- Magnetic Tapes and Magnetic Disks are the types of magnetic memory. Both are called non-volatile storage and used to store data.
- **Magnetic tape** contains thin plastic ribbon is used for storing data. It is a sequential access memory. So the data read/write speed is slower. It is mainly used for data backups.
- **Magnetic Disk** contains circular disk made of metal or plastic. Both sides of the disk are usually used for storing data. The disk is coated with magnetic oxide. The disk is divided into multiple concentric circles known as tracks and tracks are divided into sectors in which data are stored.

Module 5:Disk arm scheduling algorithms

FCFS,SSTF,SCAN,C-SCAN,LOOK,C-LOOK

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
  - 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.
- The main purpose of disk scheduling algorithm is **to select a disk request from the queue of IO request and decide the schedule when this request will be processed.**

Performance evaluation

- **Transfer rate** is rate at which data flow between drive and computer
- **Access time = Seek time + Rotational latency**
- **Seek time: The seek time is the time for the disk arm to move the heads to the cylinder containing the desired sector.**
- **Rotational latency: The rotational latency is the additional time for the disk to rotate the desired Sector to the disk head.**
- **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.**

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- There are many sources of disk I/O request
  - OS
  - System processes
  - Users processes
- I/O request includes input or output mode, disk address, memory address, number of sectors to transfer.
- OS maintains queue of requests, per disk or device.
- Several algorithms exist to schedule the servicing of disk I/O requests.

Disk arm scheduling algorithms

- FCFS(First Come First Serve)
- SSTF(Shortest Seek Time First)
- SCAN or Elevator
- C-SCAN
- LOOK
- C-LOOK

Note:

Here all scheduling algorithms are illustrated with a request queue :98, 183, 37, 122, 14, 124, 65, 67 and assumes that there are 200 cylinders numbered 0 to 199.Head pointer is at 53.

FCFS ALGORITHM

- FIRST COME FIRST SERVE.
- This algorithm entertains requests in the order they arrive in the disk queue.
- It is the simplest disk scheduling algorithm.

ADVANTAGES

- It is simple,easy to understand and implement.
- it does not cause starvation to any request.

DISADVANTAGES

- It results in increased total seek time.
- it is inefficient

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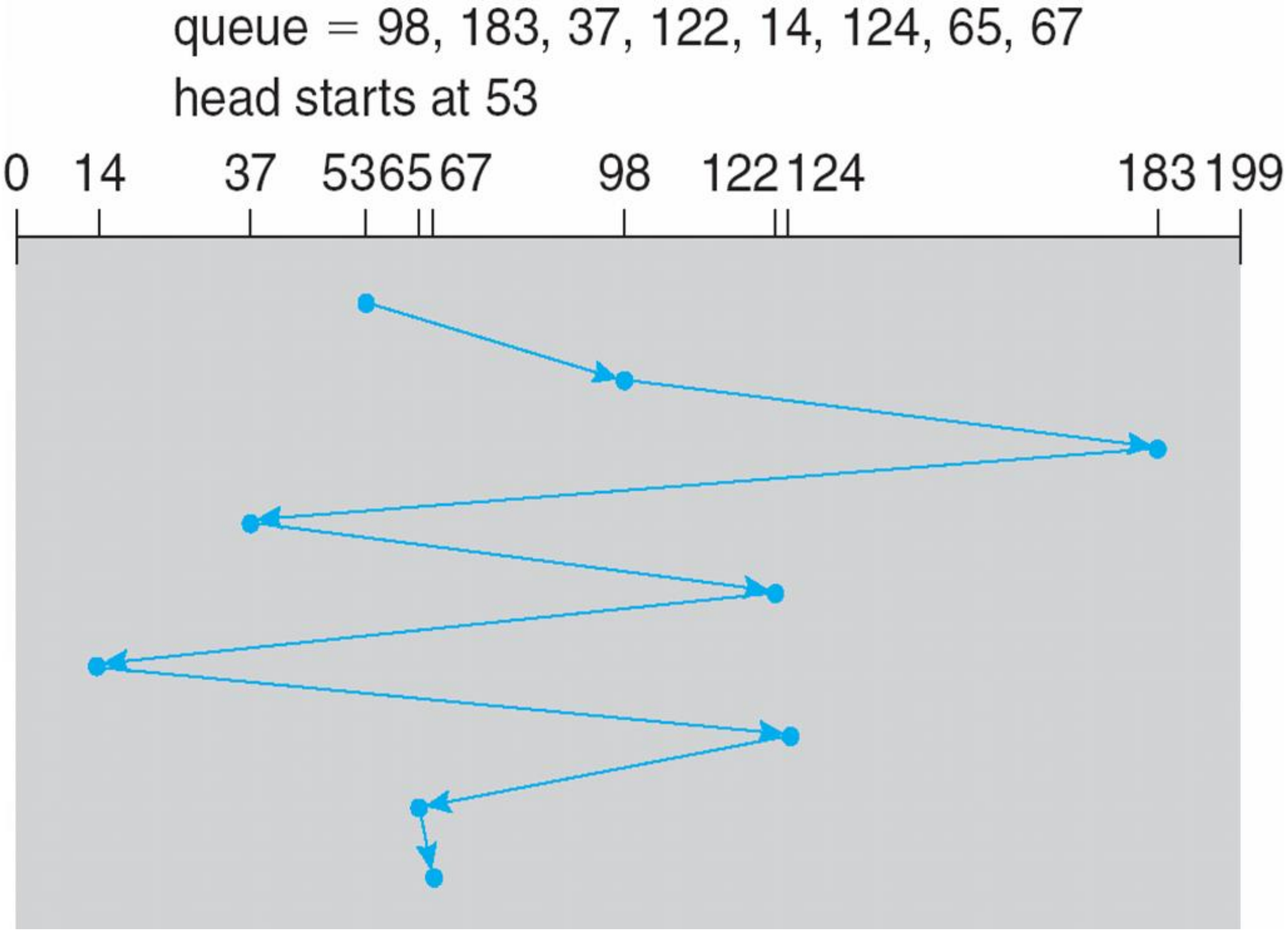


queue = 98, 183, 37, 122, 14, 124, 65, 67

head starts at 53

Total head movements=|(53-98)| + |(98-183)| +(183-37)+|(37-122)| +(122-14)+ |(14-124)| +(124-65)+ |(65-67)| =640

SSTF

- Shortest Seek Time First selects the request with the minimum seek time from the current head position

- SSTF scheduling is a form of SJF scheduling; may cause starvation of some requests.

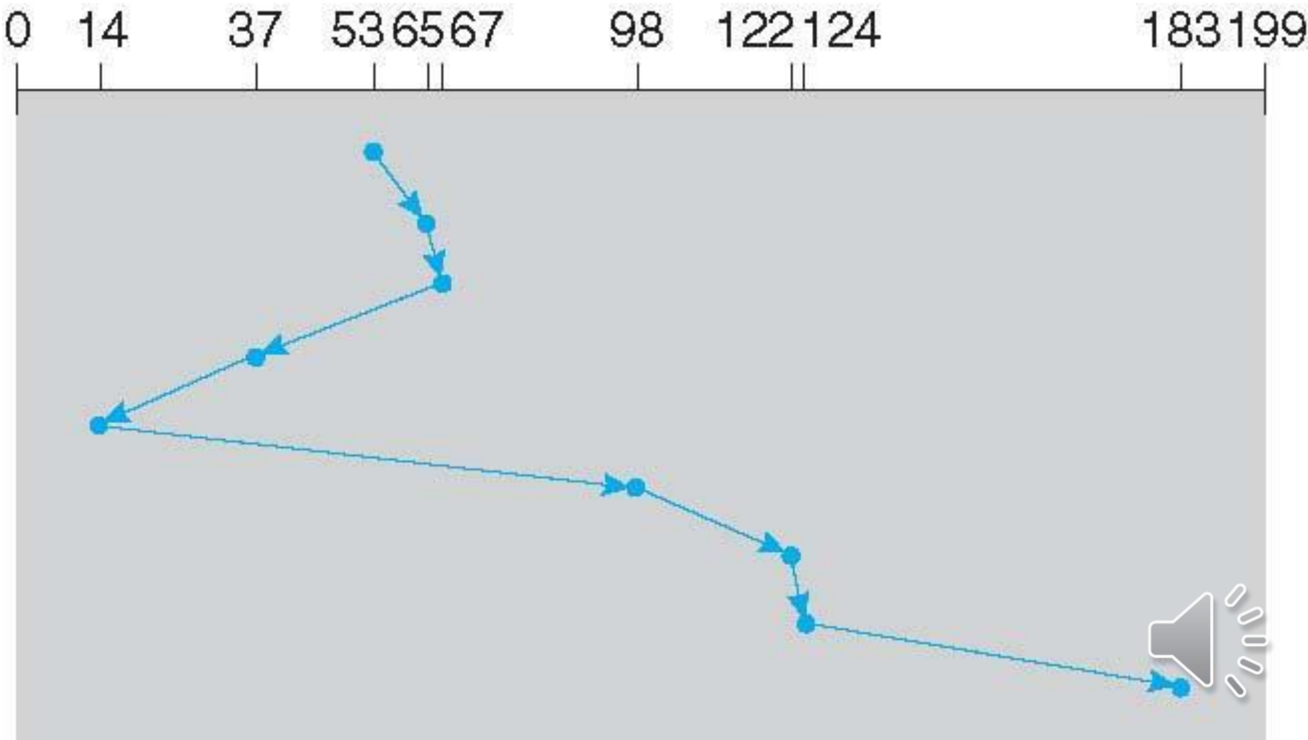
- Illustration shows total head movement of 236 cylinders.

SSTF

- **Total head movements=12+2+30+23+84+24+2+59= 236.**

		98	183	37	122	14	124	65	67
head initially at	53	45	130	-16	69	-39	71	**12**	14
head at 65	65	33	118	-28	57	-51	59		**2**
head at 67	67	31	116	**-30**	55	-53	57		
head at 37	37	61	146		85	**-23**	87		
head at 14	14	**84**	169		108		110		
head at 98	98		85		**24**		26		
head at 122	122		61				**2**		
head at 124	124		**59**						
head at 183	183								

queue = 98, 183, 37, 122, 14, 124, 65, 67
head starts at 53



SCAN

- The disk arm starts at one end of the disk, and moves toward the other end, servicing requests until it gets to the other end of the disk, where the head movement is reversed and servicing continues.
- **SCAN algorithm** Sometimes called the **elevator algorithm**
- Illustration shows total head movement of 208 cylinders
- But note that if requests are uniformly dense, largest density at other end of disk and those wait the longest

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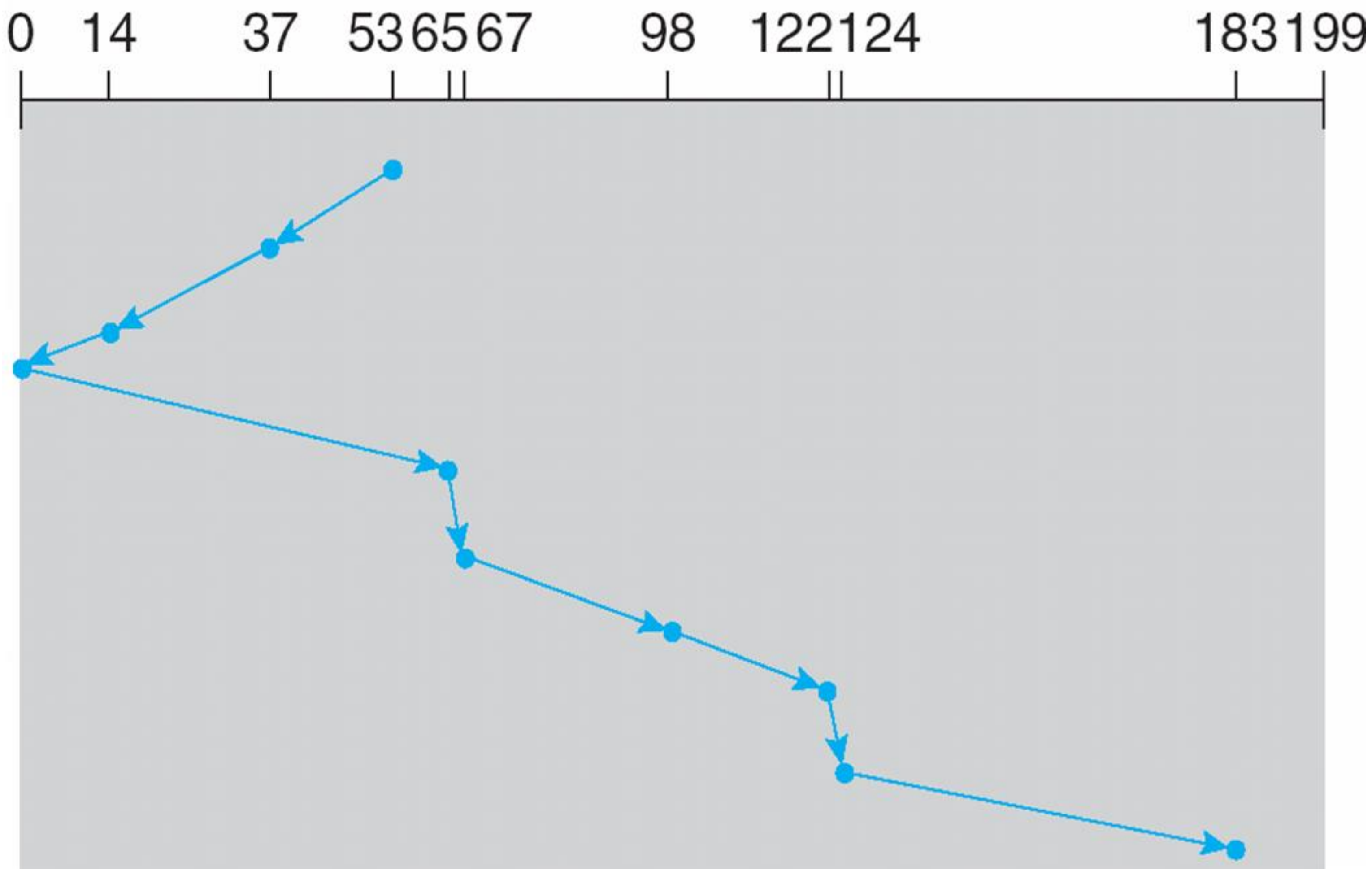
queue = 98, 183, 37, 122, 14, 124, 65, 67

head starts at 53



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TOTAL HEAD MOVEMENTS

= (53-37)+(37-14)+(14-0)+(65-0)+(67-65)+(98-67)+(122-98)+(124-122)+(183-124)

=16+23+14+65+2+31+24+2+59

=236

C-SCAN

- Provides a more uniform wait time than SCAN
- The head moves from one end of the disk to the other, servicing requests as it goes
  - When it reaches the other end, however, it immediately returns to the beginning of the disk, without servicing any requests on the return trip
- Treats the cylinders as a circular list that wraps around from the last cylinder to the first one
- Total number of cylinders?

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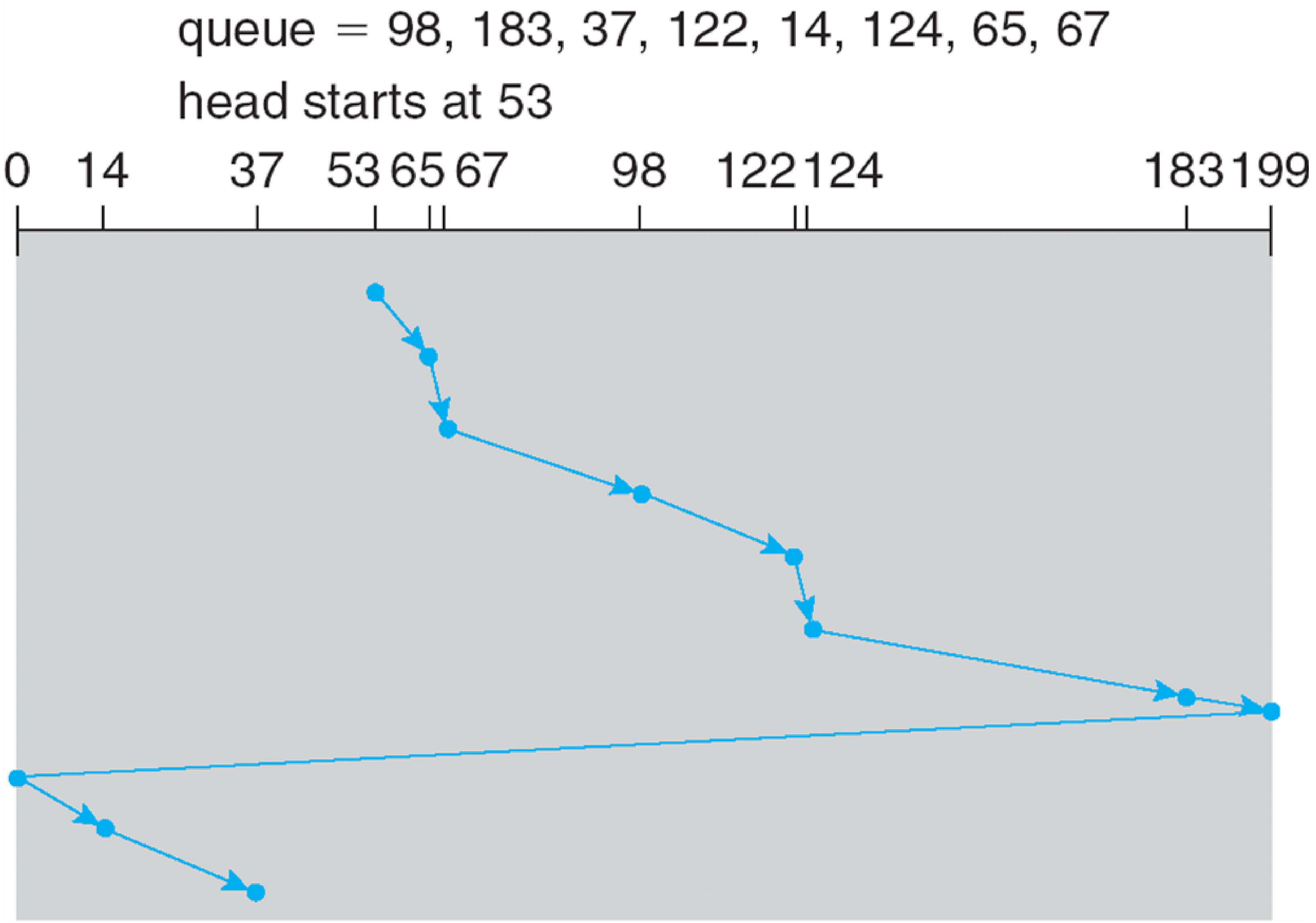


queue = 98, 183, 37, 122, 14, 124, 65, 67

head starts at 53

TOTAL HEAD MOVEMENTS

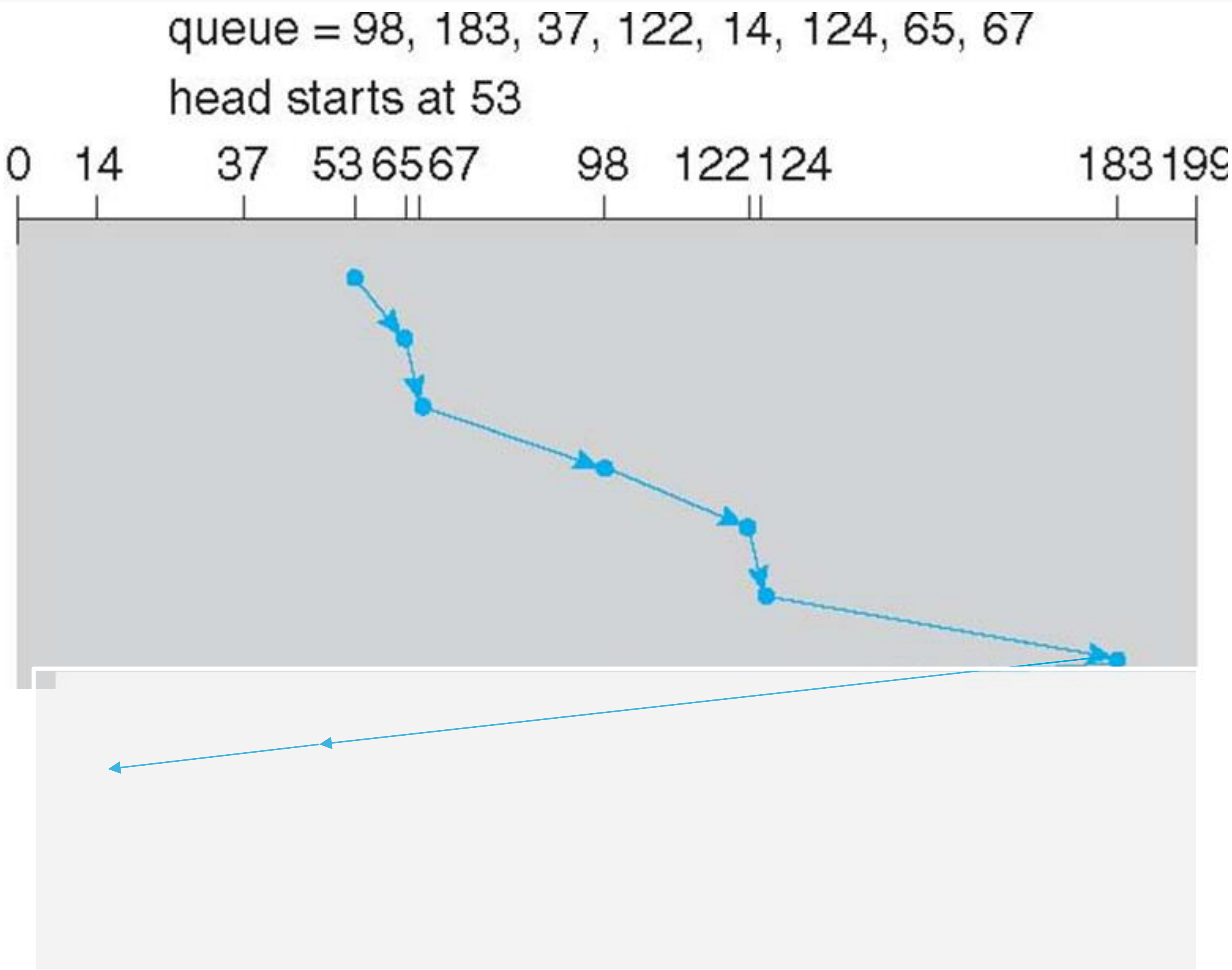
= (65-53)+(67-65)+(98-67)+(122-98)+(124-122)+(183-124)+(199-183)+(199-0)+(14-0)+(37-14)

=382

LOOK

- LOOK algorithm is an improved version of the SCAN algorithm.
- LOOK algorithm scans all the cylinders of the disk starting from the first request at one end to the last request at the other end.

LOOK


queue = 98, 183, 37, 122, 14, 124, 65, 67
head starts at 53
0
14
37
53
65
67
98
122
124
183
199

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 going all the way to the end of the disk
- Total number of cylinders?

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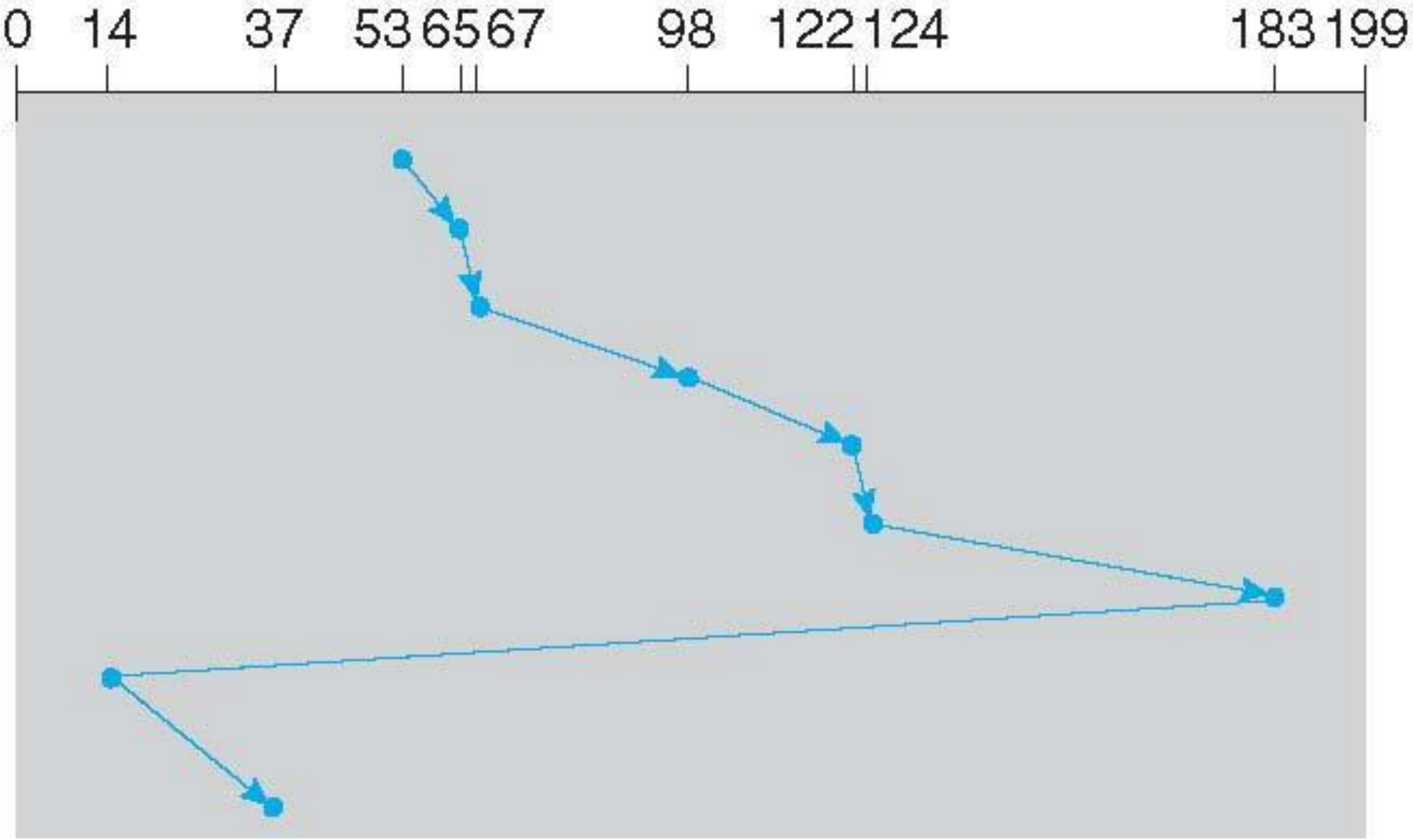
queue = 98, 183, 37, 122, 14, 124, 65, 67

head starts at 53



Selecting a disk arm scheduling algorithm

- SSTF is common and has a natural appeal because it increases performance over FCFS.
- SCAN and C-SCAN perform better for systems that place a heavy load on the disk
  - Less starvation
- Performance depends on the number and types of requests
- Requests for disk service can be influenced by the file-allocation method
  - And metadata layout
- The disk-scheduling algorithm should be written as a separate module of the operating system, allowing it to be replaced with a different algorithm if necessary
- Either SSTF or LOOK is a reasonable choice for the default algorithm
- What about rotational latency?
  - Difficult for OS to calculate
- How does disk-based queueing effect OS queue ordering efforts?

thank You!