

# CS343 - Operating Systems

## Module-5B

### Disk Scheduling



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# Disk Storage Systems Management

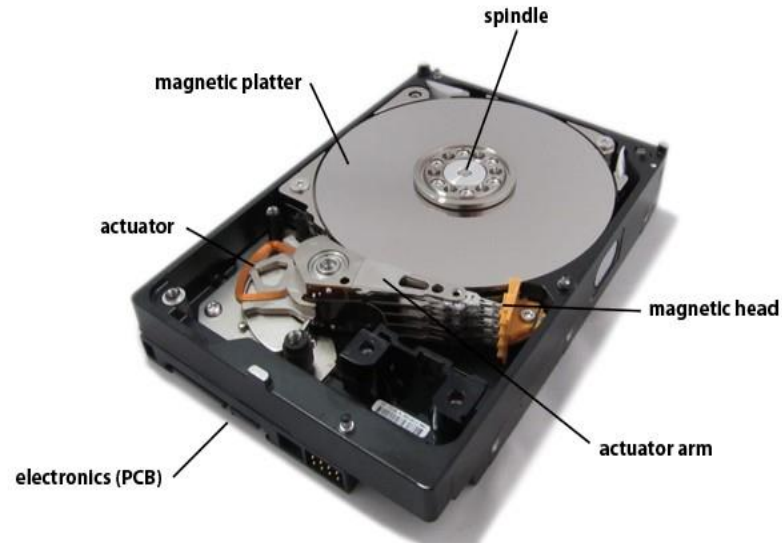
- ❖ Disk Organization & Structure
- ❖ Disk Attachment
- ❖ Disk Scheduling
- ❖ Disk Management
- ❖ Swap-Space Management
- ❖ RAID Structure
- ❖ Stable-Storage Implementation

# Objectives

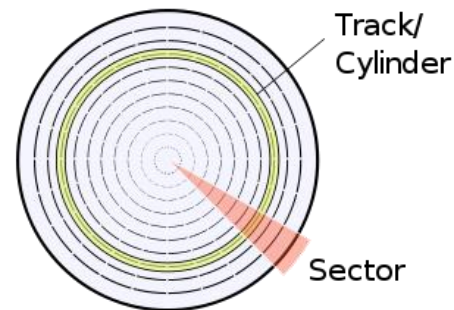
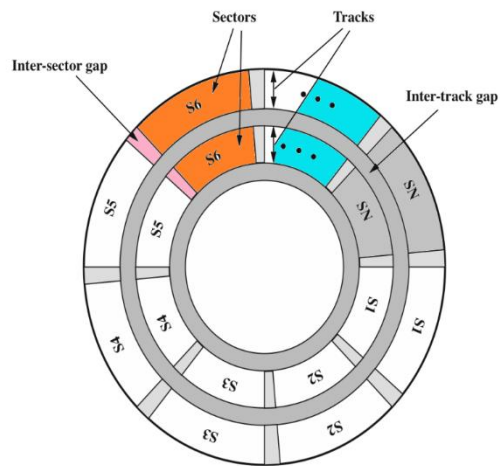
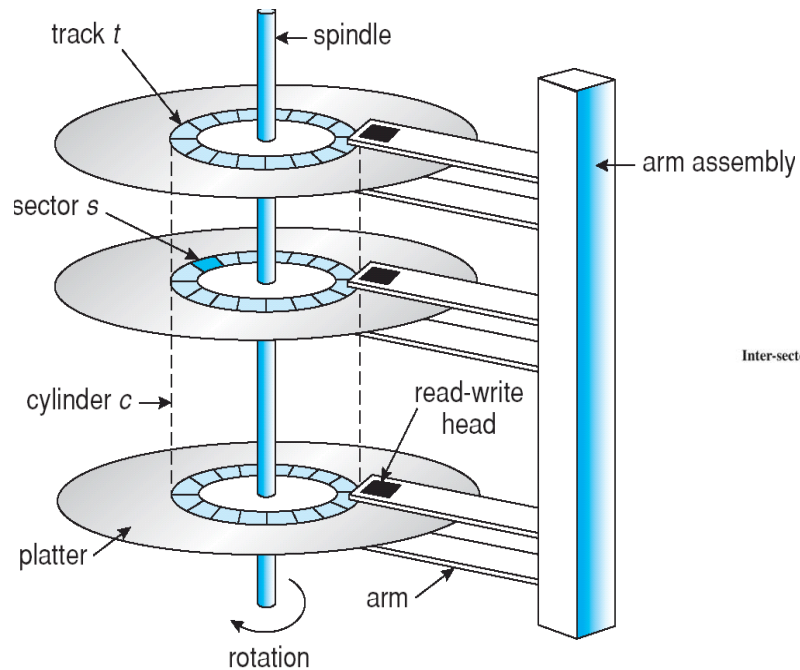
- ❖ To describe the physical structure of secondary storage devices and its effects on the uses of the devices
- ❖ To explain the performance characteristics of mass-storage devices
- ❖ To evaluate disk scheduling algorithms
- ❖ To discuss operating-system services provided for mass storage, including RAID

# Mass Storage - Hard Disk Drive

- ❖ Systems today need to store many terabytes of data.
- ❖ Primary level of permanent storage is hard disk.
- ❖ Electromechanical
  - ❖ Rotating disks
  - ❖ Arm assembly
- ❖ Electronics
  - ❖ Disk controller
  - ❖ Cache
  - ❖ Interface controller

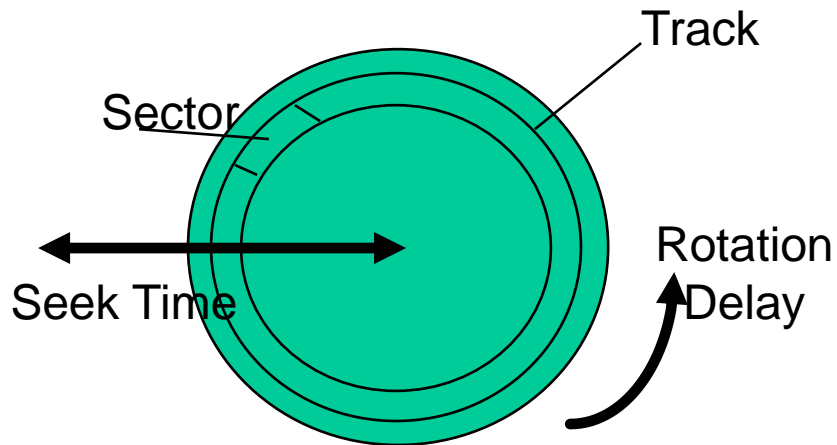


# Hard Disk Drive Organization



# Disk Access Time

- ❖ To read from disk, we must specify:
  - ❖ cylinder #, surface #, sector #, size, memory address
- ❖ Transfer time includes:
  - ❖ Seek time: to get to the track
  - ❖ Rotational Latency: to get to the sector and
  - ❖ Transfer time: get bits off the disk



# Disk Scheduling

- ❖ Access time has two major components
  - ❖ **Seek time** is time to move the heads to the cylinder containing the desired sector
  - ❖ **Rotational latency** is additional time waiting to rotate the desired sector to the disk head.
- ❖ Minimize seek time
- ❖ Disk bandwidth is 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

- ❖ 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
- ❖ Idle disk can immediately work on I/O request, busy disk means work must queue
  - ❖ Optimization algorithms only make sense when a queue exists



# Disk Scheduling

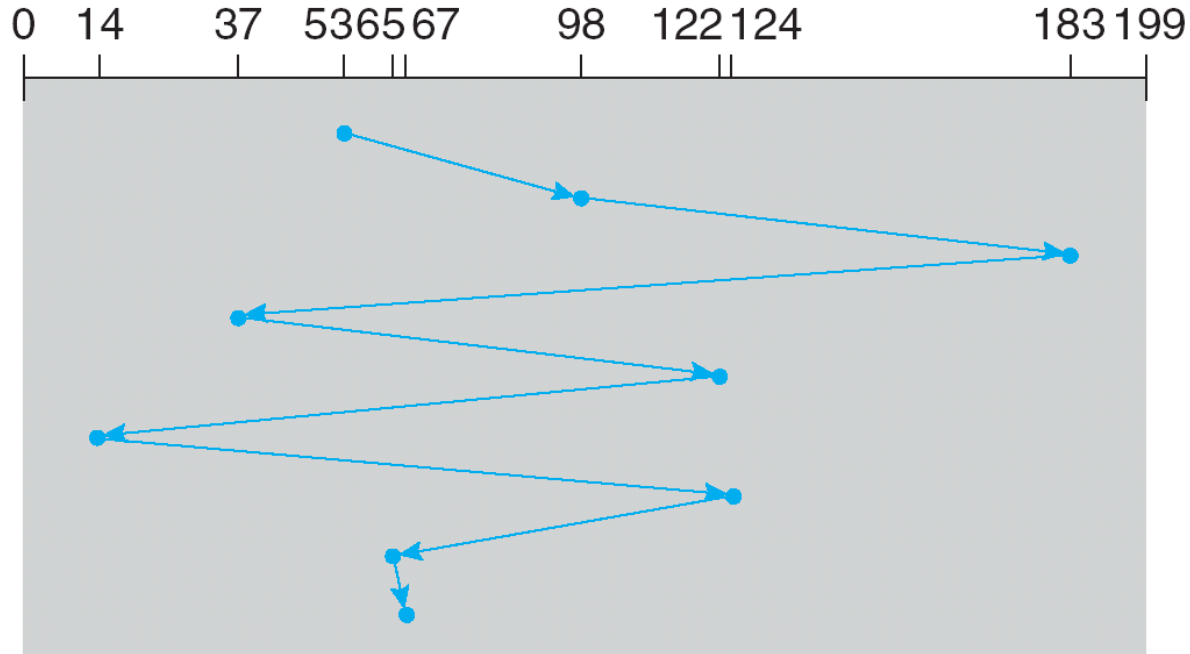
- ❖ Drive controllers have small buffers to manage a queue of I/O requests.
- ❖ Several algorithms exist to schedule the servicing of disk I/O requests
- ❖ Disk Scheduling - The order in which disk cylinder request are serviced so as to optimize average seek time.
  - ❖ **FCFS**
  - ❖ **SSTF**
  - ❖ **SCAN**
  - ❖ **C-SCAN**
  - ❖ **C-LOOK**
- ❖ **Example:** 98, 183, 37, 122, 14, 124, 65, 67    (0-199 cylinders, Head pointer @ 53)

# Disk Scheduling Algorithm: FCFS

Total head movements = 640

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

head starts at 53

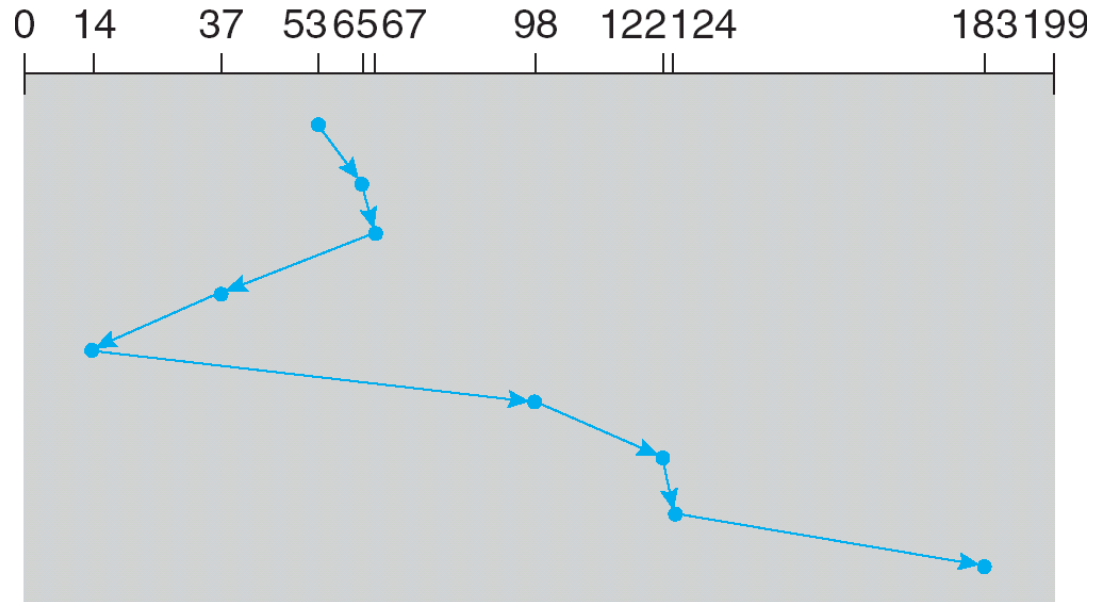


# Disk Scheduling Algorithm: SSTF

- ❖ Selects request with minimum seek time from current head position,
- ❖ SSTF scheduling is a form of SJF scheduling; may cause starvation of some requests

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

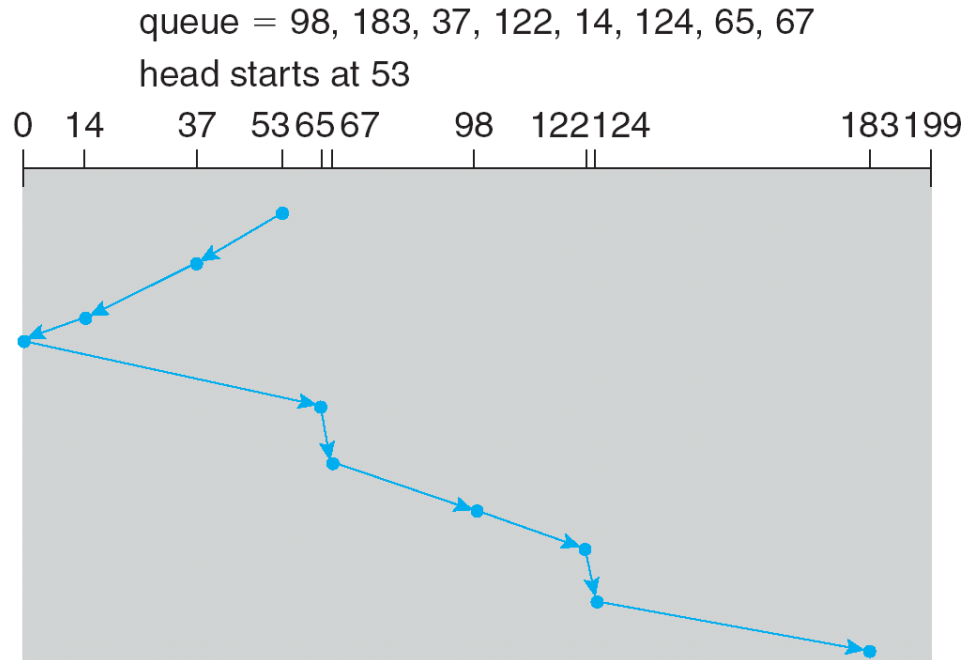
Total head movement  
of 236 cylinders



# Disk Scheduling Algorithm: SCAN

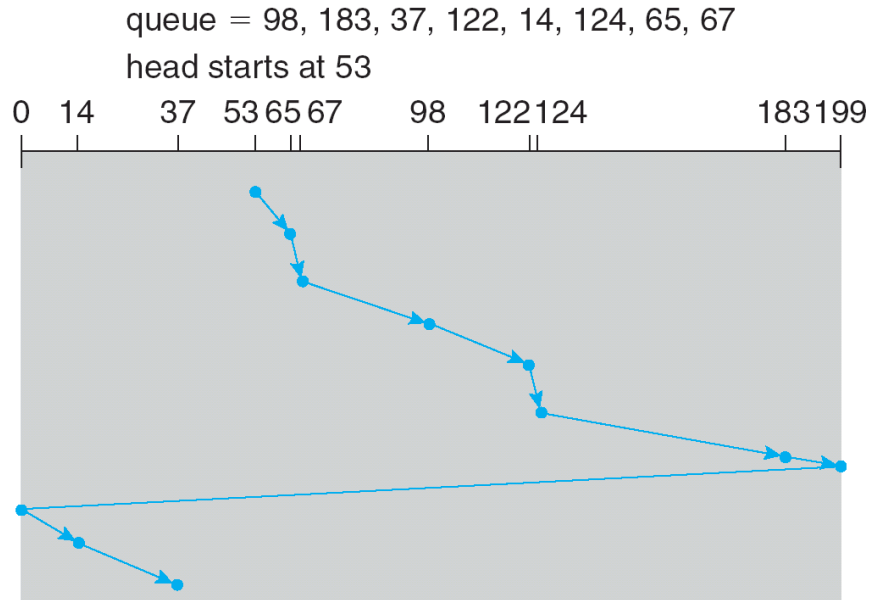
- ❖ The disk arm moves toward one end servicing requests
- ❖ Head movement is reversed when it reach the end and servicing continues. [ Also known as elevator algorithm]

Total head movement  
of 208 cylinders



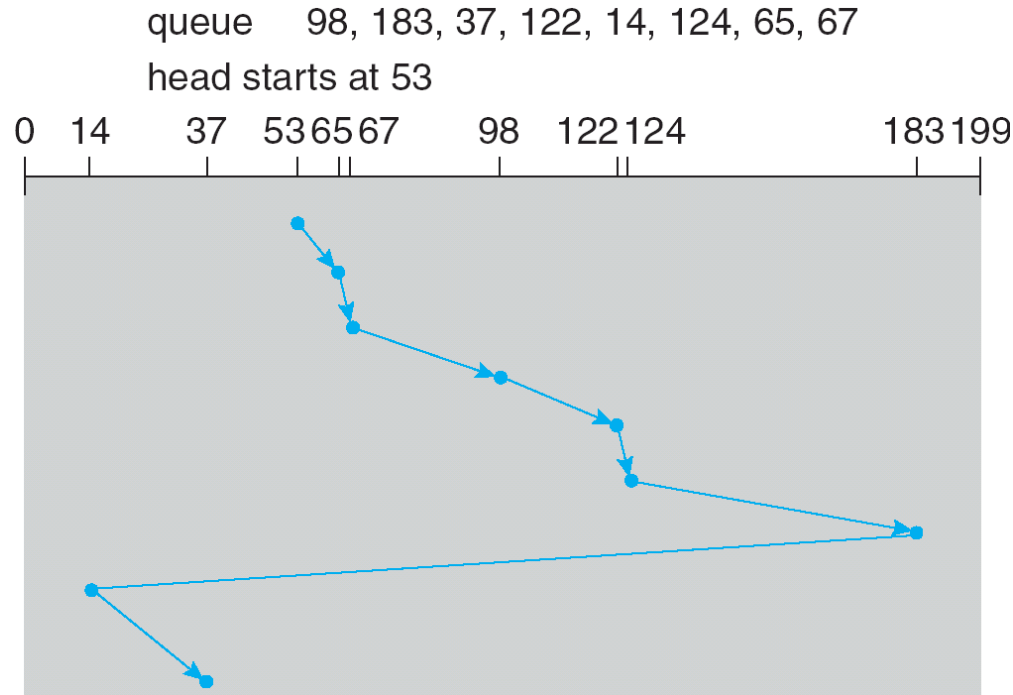
# Disk Scheduling Algorithm : C-SCAN

- ❖ The head moves from one end of the disk to the other and service the requests as it goes.
- ❖ When it reaches the other end it immediately returns to beginning of the disk, No servicing on the return trip.



# Disk Scheduling Algorithm : C-LOOK

- ❖ Version of C-SCAN
- ❖ Arm only goes as far as last request in each direction, then reverses direction immediately,

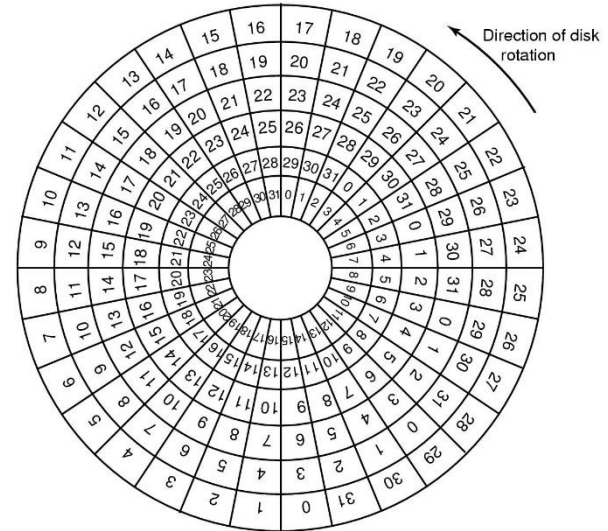


# Selecting a Disk-Scheduling Algorithm

- ❖ SSTF is common and has a natural appeal
- ❖ 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
- ❖ 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

# Cylinder Skew

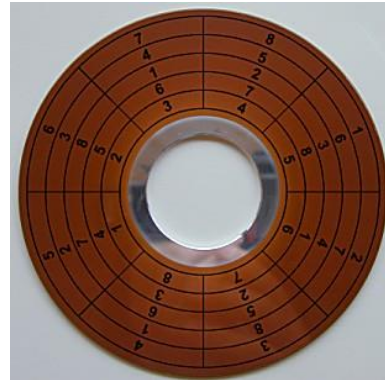
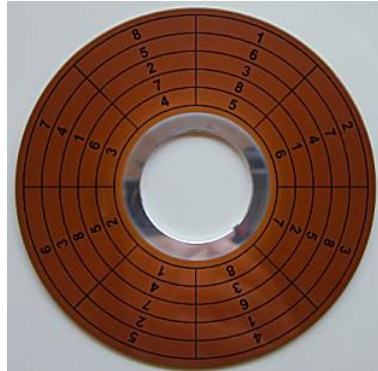
- ❖ Why cylinder skew?
- ❖ Offsetting the start sector of adjacent tracks to minimize the likely wait time (rotational latency) when switching tracks
- ❖ How much skew?
- ❖ Example, if 10000 rpm disk drive rotates in 6 ms.
  - ❖ Track has 300 sectors
  - ❖ New sector every  $20\ \mu\text{s}$
  - ❖ If track seek time  $800\ \mu\text{s}$ 
    - ❖ 40 sectors pass on seek
- ❖ Cylinder skew: 40 sectors





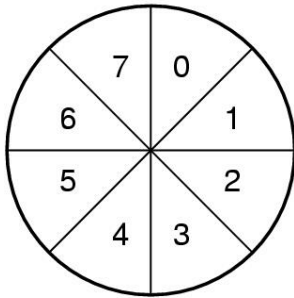
# Head Skew

- ❖ Occurs when we change heads within a cylinder, but different platter surfaces.
- ❖ Here there is no physical movement of arm assembly.
- ❖ But it still takes time for the switch from reading one head to reading another.
- ❖ Head skew is the offsetting done on the start sector of tracks of adjacent platters (heads) of same cylinder.



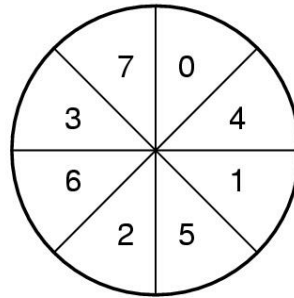
# Sector Interleaving

- ❖ To ensure that sector # $n+1$  didn't rotate past the head while sector # $n$  was being processed.



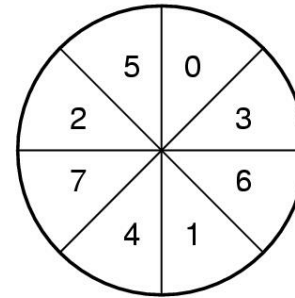
(a)

No interleaving



(b)

Single interleaving



(c)

Double interleaving

# Swap-Space Management

- ❖ Swap-space — Virtual memory uses disk space as an extension of main memory
- ❖ Swap-space can be carved out of the normal file system, or, more commonly, it can be in a separate disk partition (raw)
- ❖ Swap-space management in various OS.
  - ❖ Allocates swap space when process starts; holds text segment (the program) and data segment
  - ❖ Uses **swap maps** to track swap-space use
  - ❖ Some allocate swap space only when a dirty page is forced out of physical memory, not when the virtual memory page is first created.

*Thank you*

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