Carrying out disk accesses in the order they are received will not always produce optimal performance.

Seek time is the reason for differences in performance.

For a single disk there will be a number of I/O requests.

If requests are selected randomly, we will expect poor performance.

Can use priority scheme.

Can reduce average access time by sending requests to disk controller in certain order.
First-in, first-out (FIFO)

- process request sequentially
- "fair" to all processes
- approaches random scheduling in performance if there are many processes

Request order:  55  58  39  18  90  160  150  38  184

Total distance head moves:  498
SSTF: shortest seek (service) time first
- select the disk I/O request that requires the least movement of the disk arm from its current position
- guarantees minimum average seek time, but can lead to starvation

Request order:  55 58 39 18 90 160 150 38 184
Actual order:   90 58 55 39 38 18 150 160 184

Total distance head moves: 248
SCAN Scheduling

SCAN: “elevator algorithm”
- arm moves in one direction only, satisfying all outstanding requests until it reaches the last track in that direction
- then direction is reversed

Request order: 55 58 39 18 90 160 150 38 184
Actual order: 150 160 184 90 58 55 39 38 18

Total distance head moves: 250
C-SCAN Scheduling

C-SCAN:
- restricts scanning to one direction only
- when the last track has been visited in one direction, the arm is returned to the opposite end of the disk and the scan begins again
- more uniform waiting times
- "fairer" than SCAN

Request order: 55 58 39 18 90 160 150 38 184
Actual order: 150 160 184 18 38 39 55 58 90

Total distance head moves: 312
Other Variations

N-step-SCAN
- Segments the disk request queue into subqueues of length N
- Subqueues are processed one at a time, using SCAN
- New requests added to other queue when queue is processed

FSCAN
- Two queues
- One queue is empty for new requests
## Comparison

<table>
<thead>
<tr>
<th></th>
<th>(a) FIFO</th>
<th></th>
<th>(b) SSTF</th>
<th></th>
<th>(c) SCAN</th>
<th></th>
<th>(d) C-SCAN</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(starting at track 100)</td>
<td>(starting at track 100)</td>
<td>(starting at track 100, in the direction of increasing track number)</td>
<td>(starting at track 100, in the direction of increasing track number)</td>
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<tr>
<td>Next track accessed</td>
<td>Number of tracks traversed</td>
<td>Next track accessed</td>
<td>Number of tracks traversed</td>
<td>Next track accessed</td>
<td>Number of tracks traversed</td>
<td>Next track accessed</td>
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<td>Average seek length</td>
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<td>27.5</td>
<td>Average seek length</td>
<td>27.8</td>
<td>Average seek length</td>
<td>35.8</td>
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</tr>
</tbody>
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Operating systems are the best place to manage the scheduling of disk accesses.

Problem: high-level interfaces like ATA and SCSI provide the OS with logical block addresses, not physical disk addresses.
FIGURE 6.19 Example showing OS versus disk schedule accesses, labeled host-ordered versus drive-ordered. The former takes three revolutions to complete the four reads, while the latter completes them in just three-fourths of a revolution (from Anderson [2003]). Copyright © 2009 Elsevier, Inc. All rights reserved.