Systems and Networking – Unit 1

B.Sc. in Applied Computer Science and Artificial Intelligence

2021-2022

SAPIENZA
UNIVERSITÀ DI ROMA

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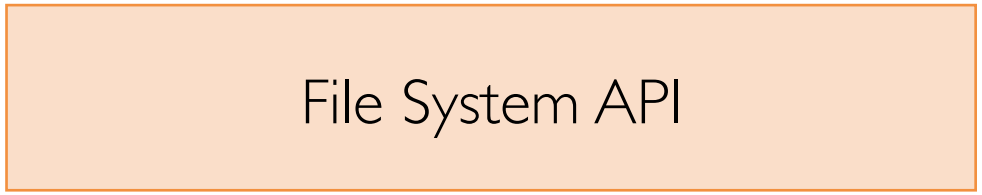
File System's Logical View



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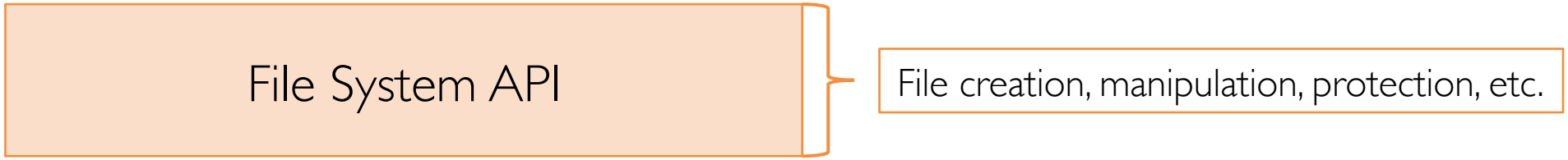

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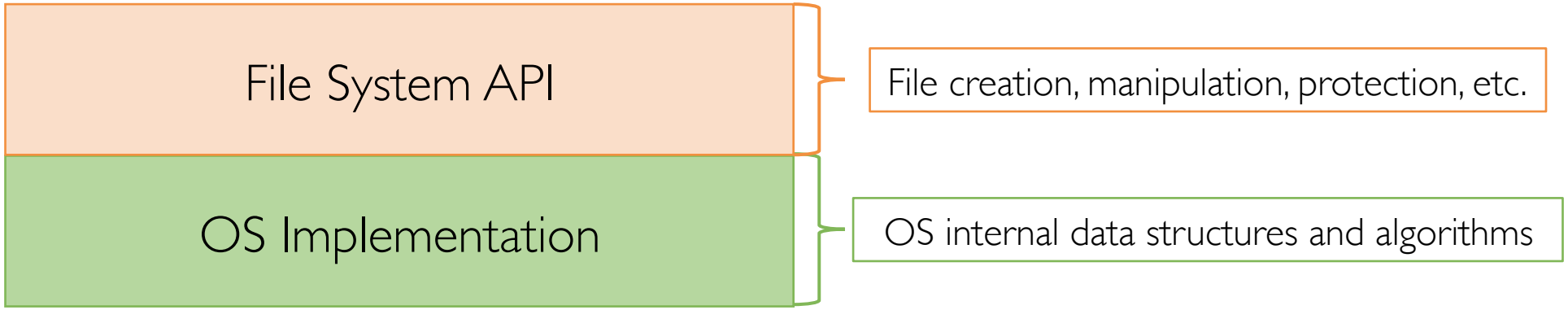

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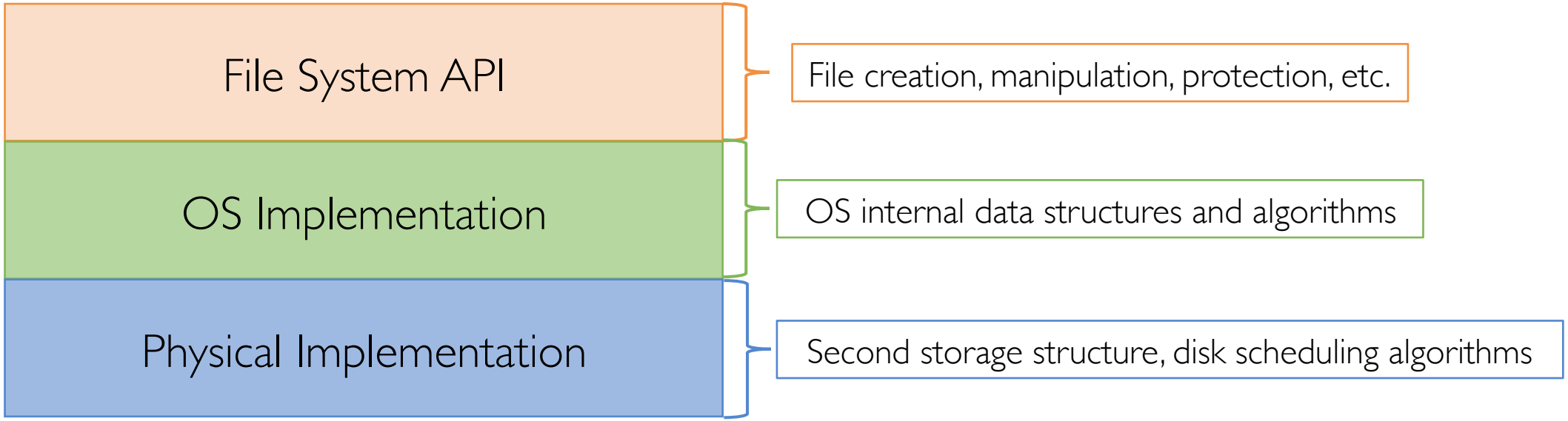

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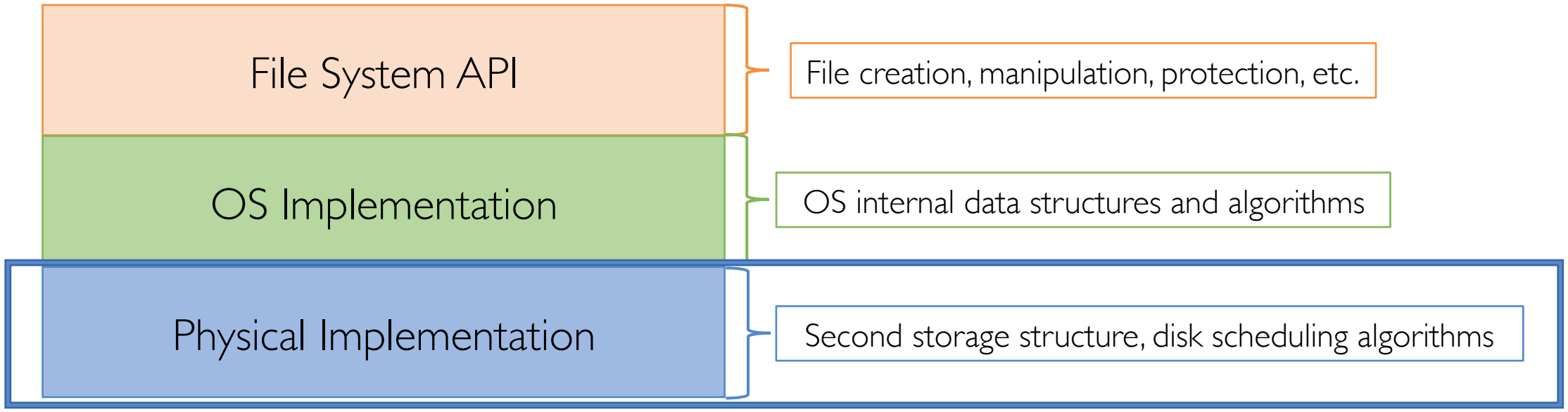

Part V: Storage Management

Overview of Mass-Storage Structure

3 categories of mass-storage devices

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Magnetic Disks

Overview of Mass-Storage Structure

3 categories of mass-storage devices

Magnetic Disks

Solid-State Disks

Overview of Mass-Storage Structure

3 categories of mass-storage devices

Magnetic Disks

Solid-State Disks

Magnetic Tapes

Overview of Mass-Storage Structure

3 categories of mass-storage devices

Magnetic Disks

Solid-State Disks

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Secondary Storage

Overview of Mass-Storage Structure

3 categories of mass-storage devices

Magnetic Disks

Solid-State Disks

Magnetic Tapes

Secondary Storage

Tertiary Storage

Overview of Mass-Storage Structure

3 categories of mass-storage devices

Magnetic Disks

Solid-State Disks

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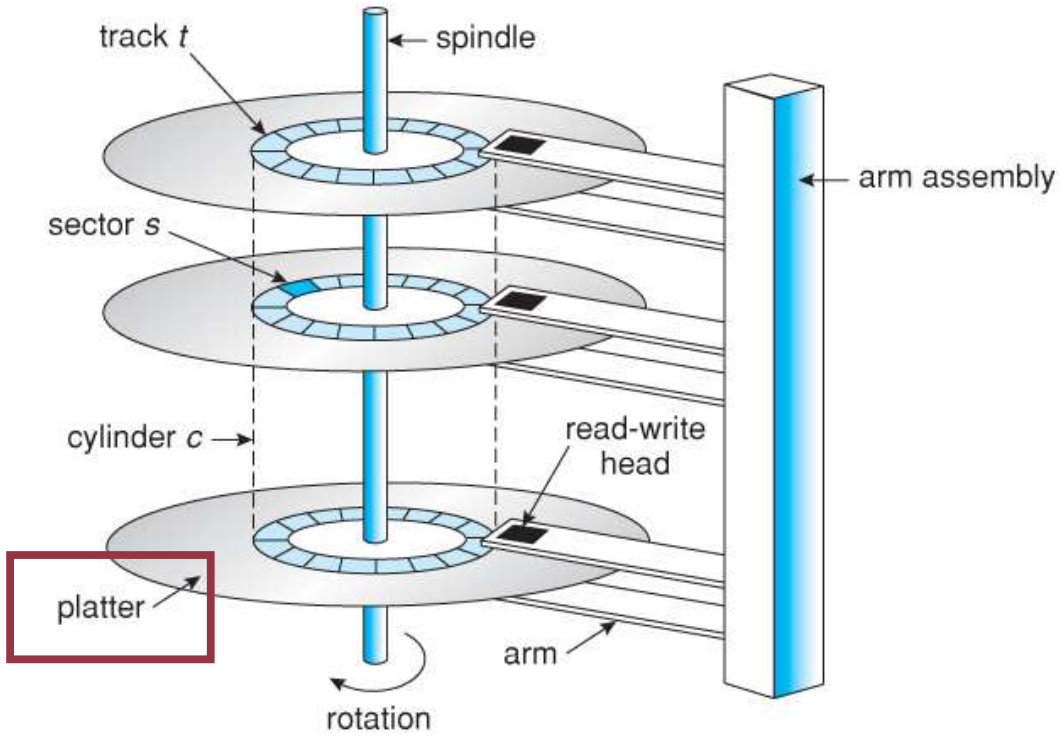
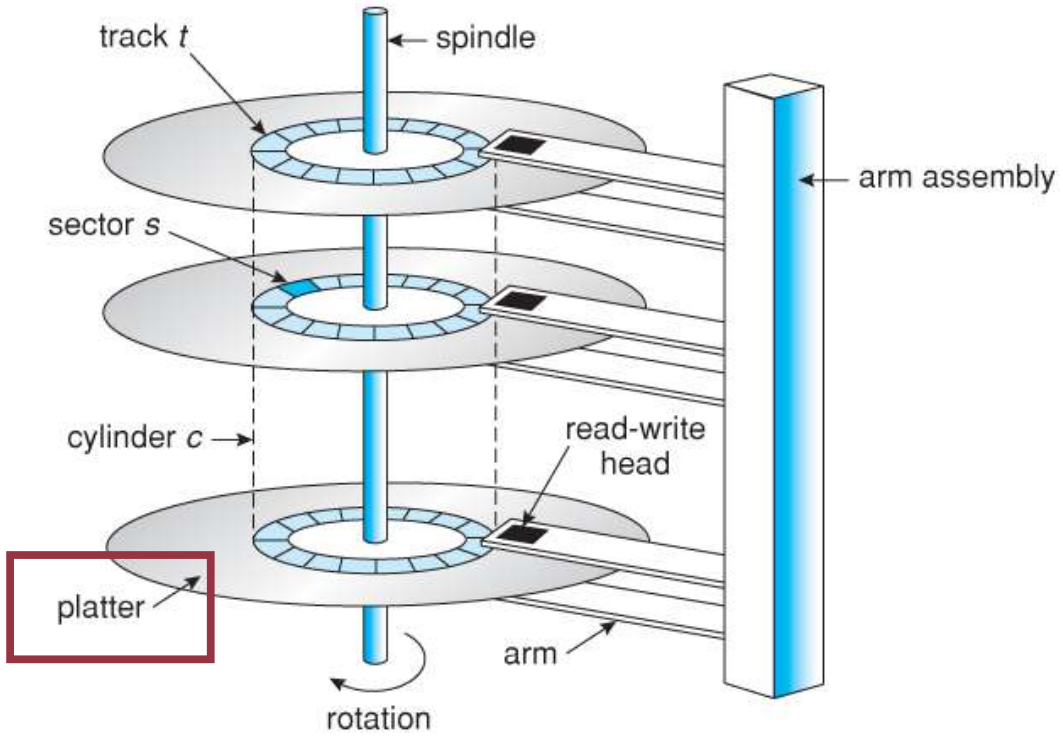
Magnetic Disks: Structure



One or more platters covered with magnetic media

Magnetic Disks: Structure



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Hard disk
rigid metal

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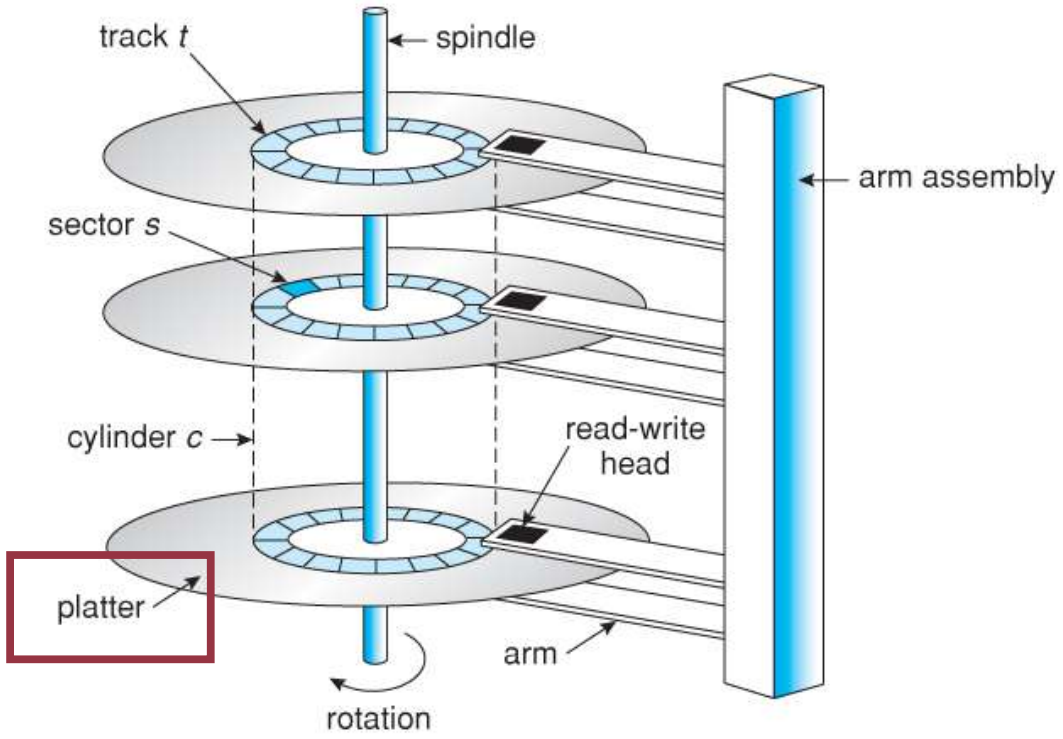

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- Hard disk: rigid metal
- Floppy disk: flexible plastic

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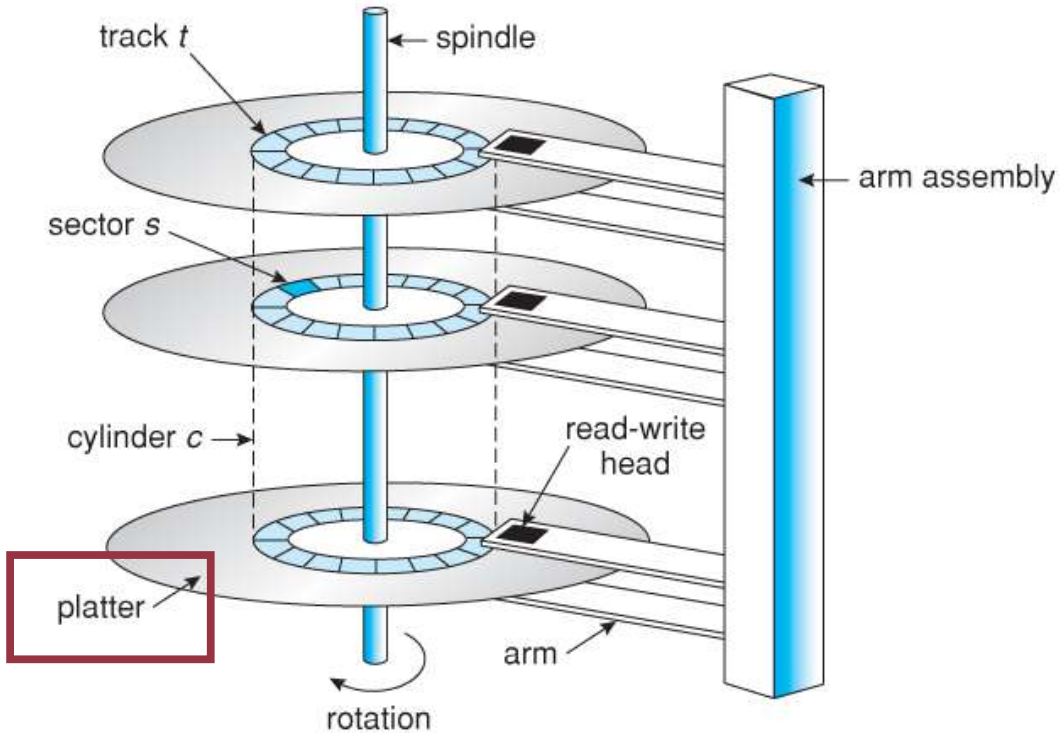

One or more platters covered with magnetic media

Hard disk
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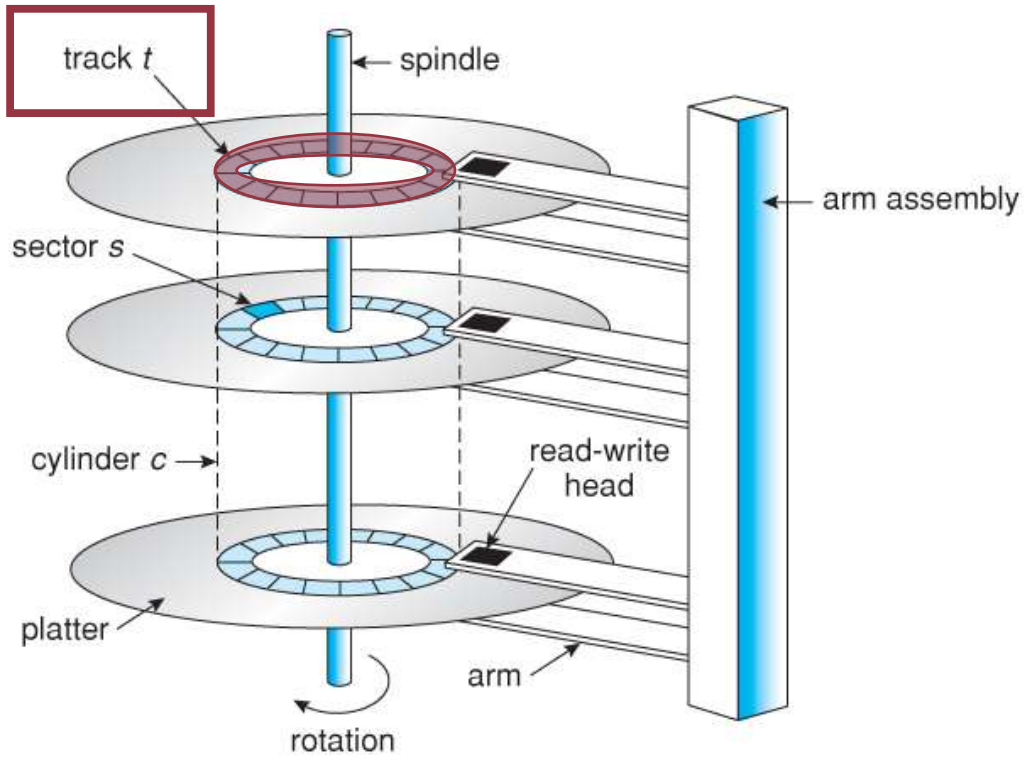
Floppy disk
flexible plastic

Each platter has 2 working surfaces

Magnetic Disks: Tracks and Cylinders



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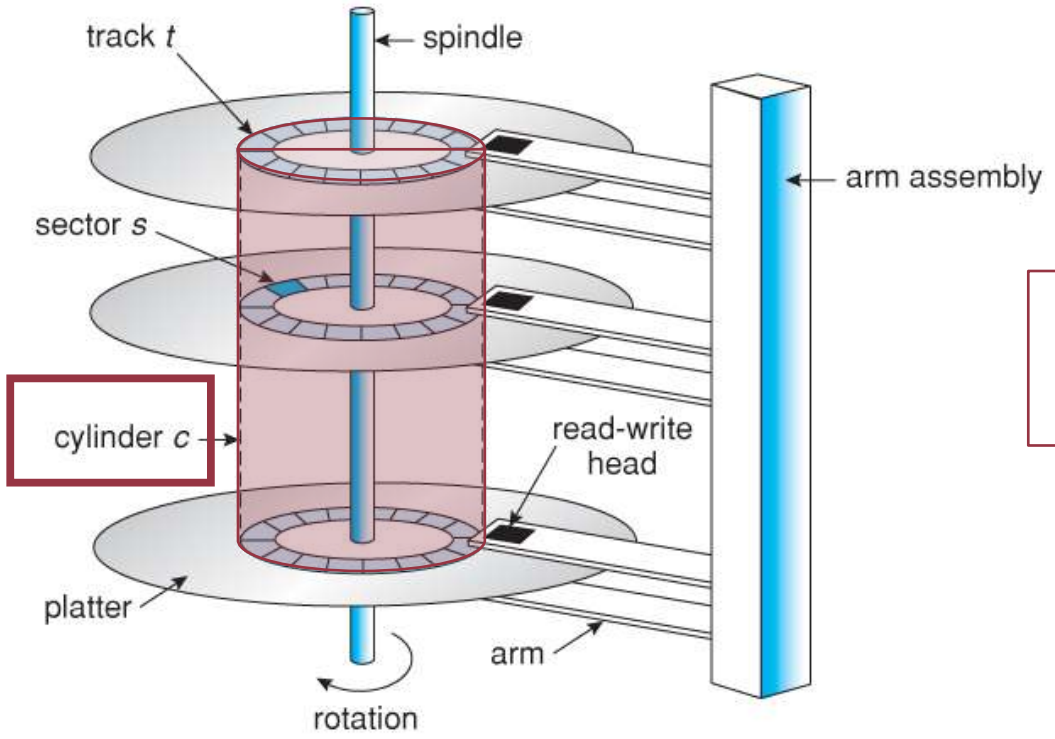

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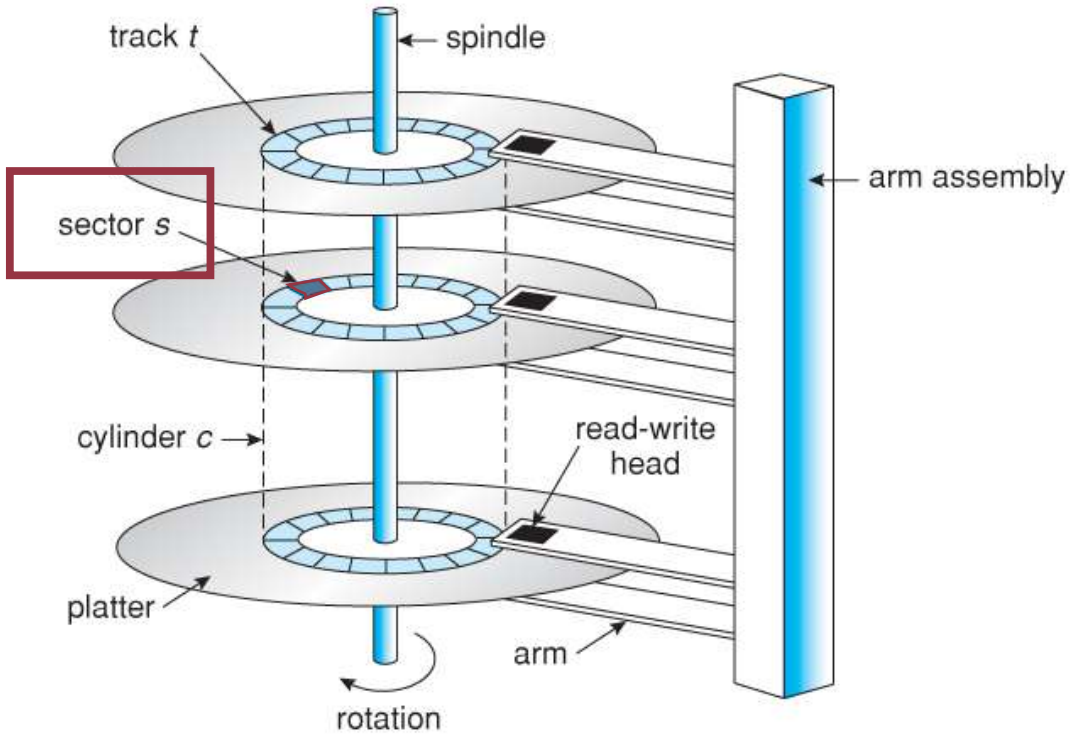
The set of all tracks that are the same distance from the edge of the platter is called a cylinder

Magnetic Disks: Sectors



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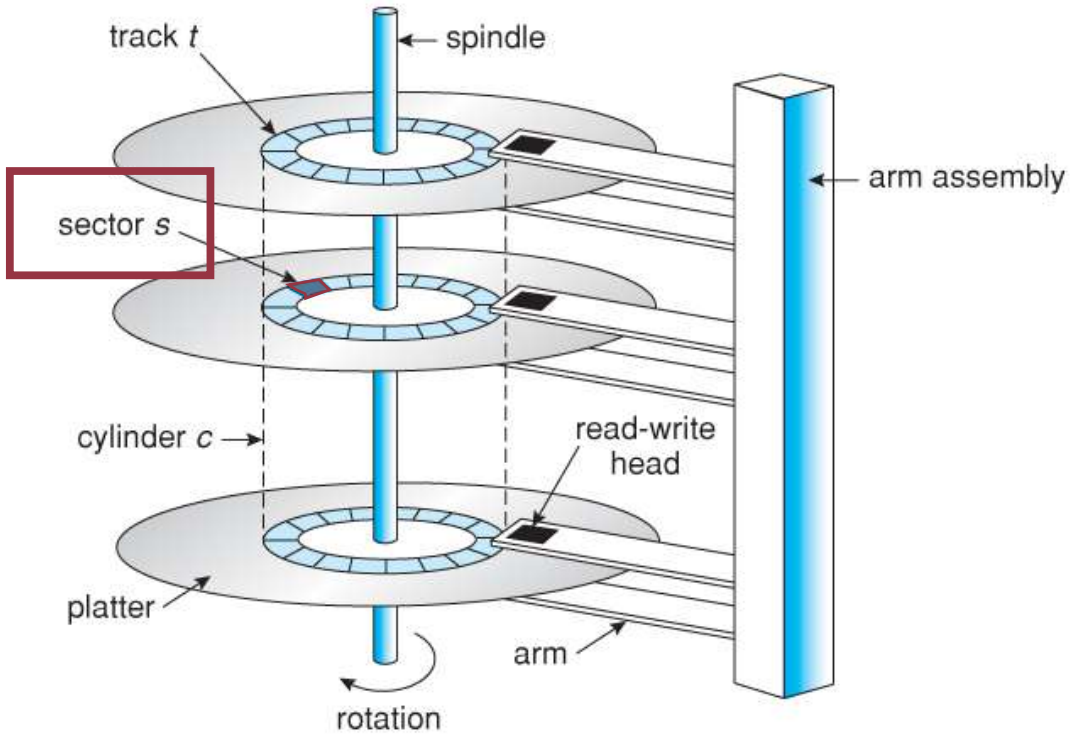

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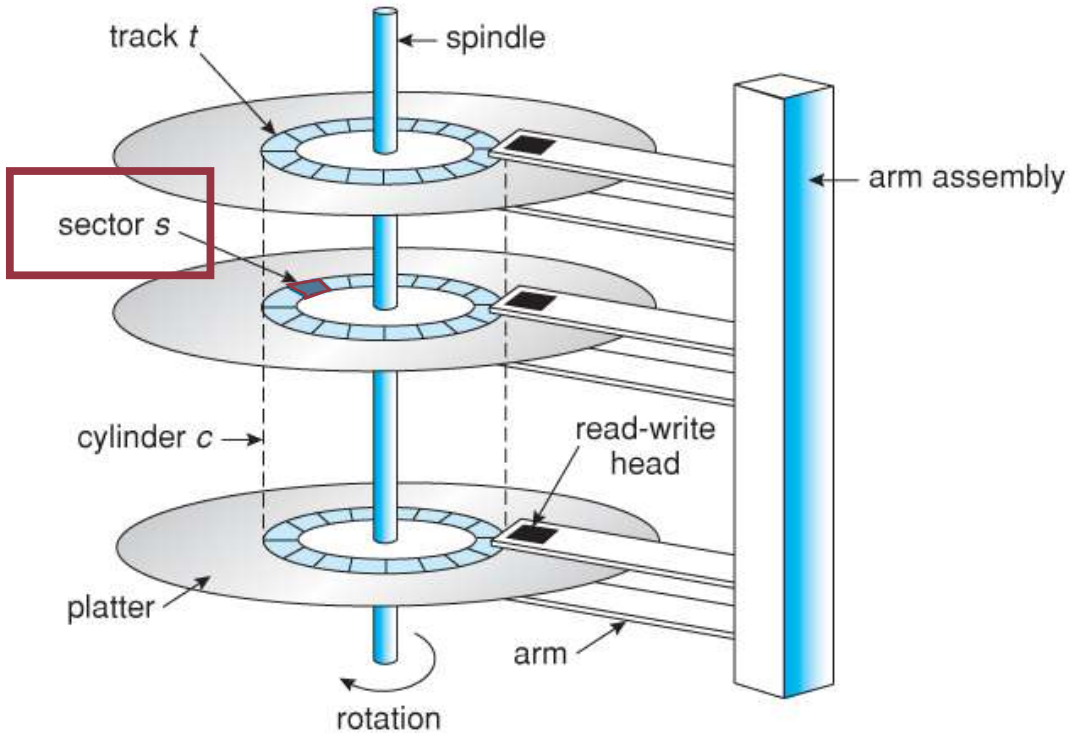

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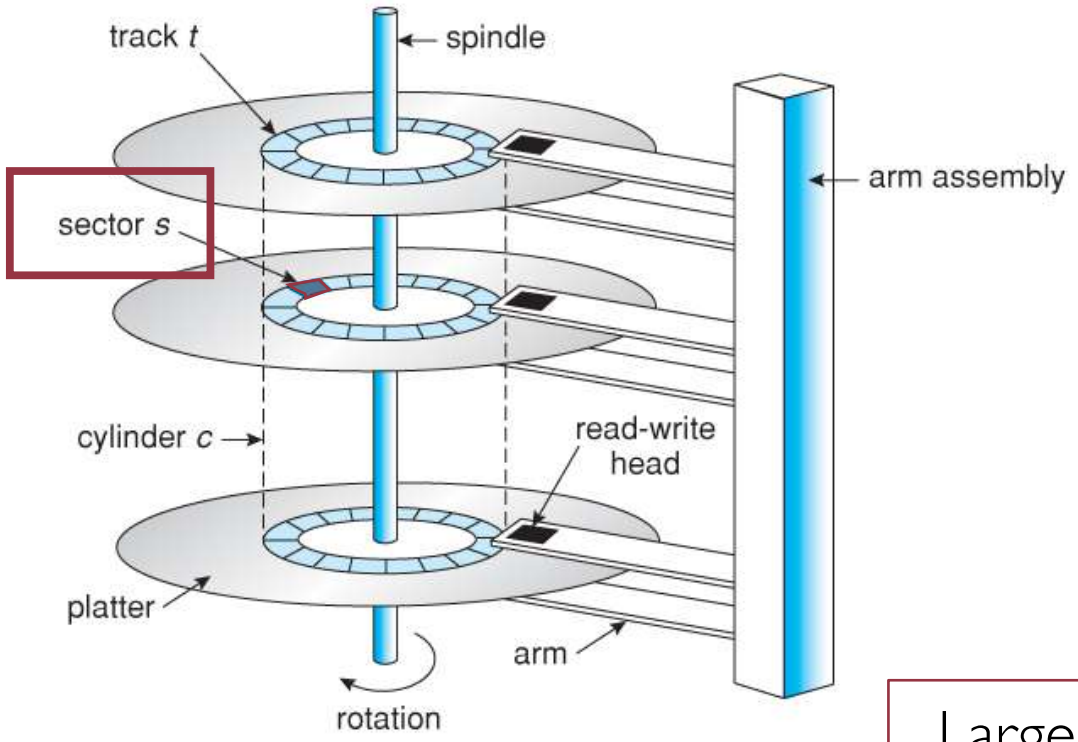

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Larger sector sizes reduce the space wasted by headers and trailers, but increase internal fragmentation

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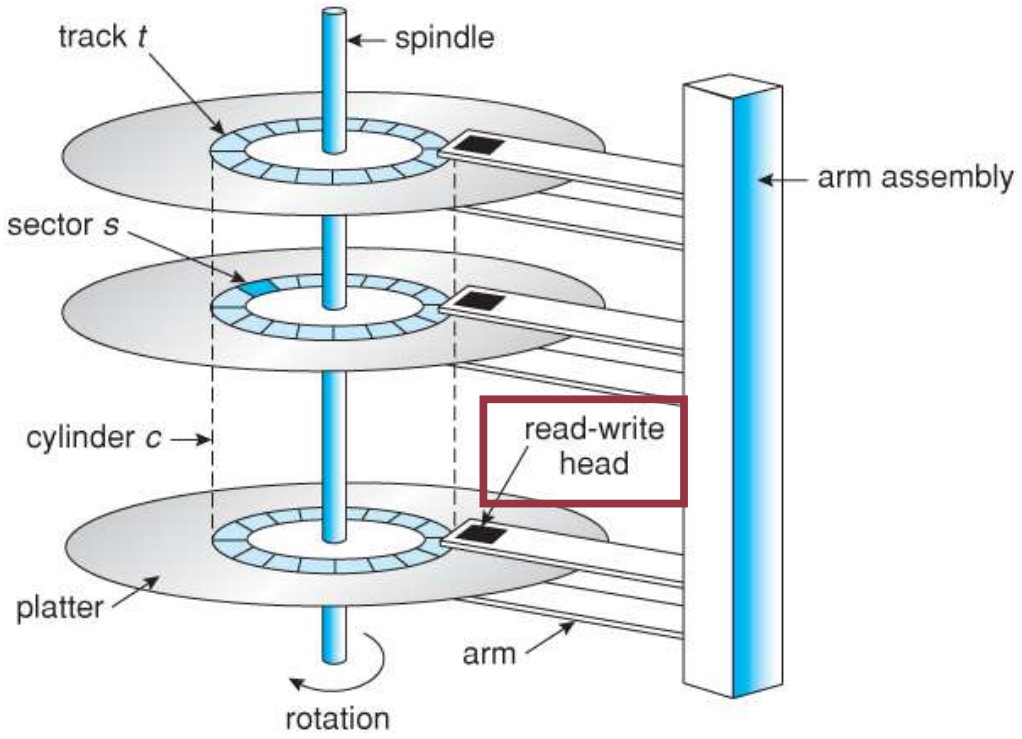
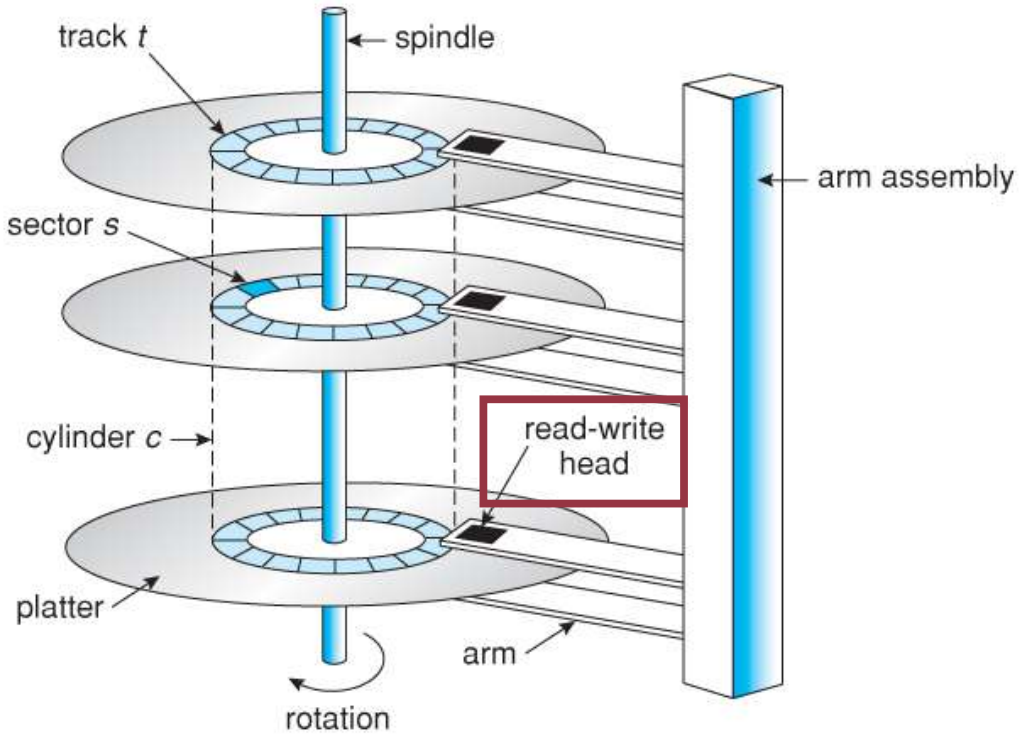


Data on hard drive is read by read-write heads

Magnetic Disks: Heads



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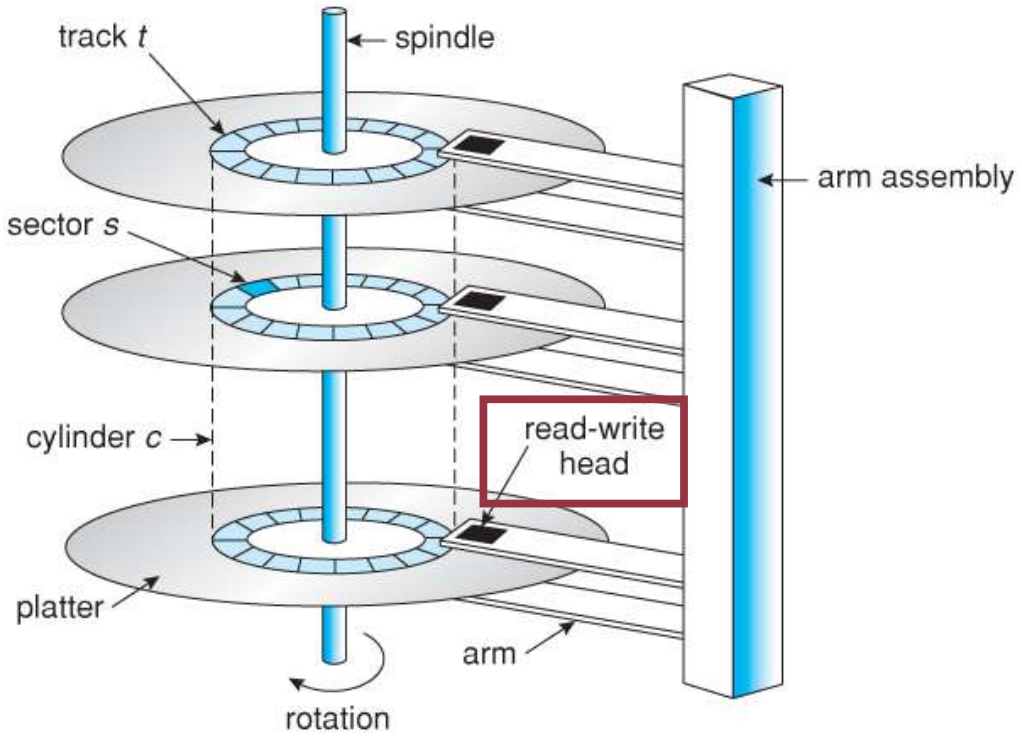

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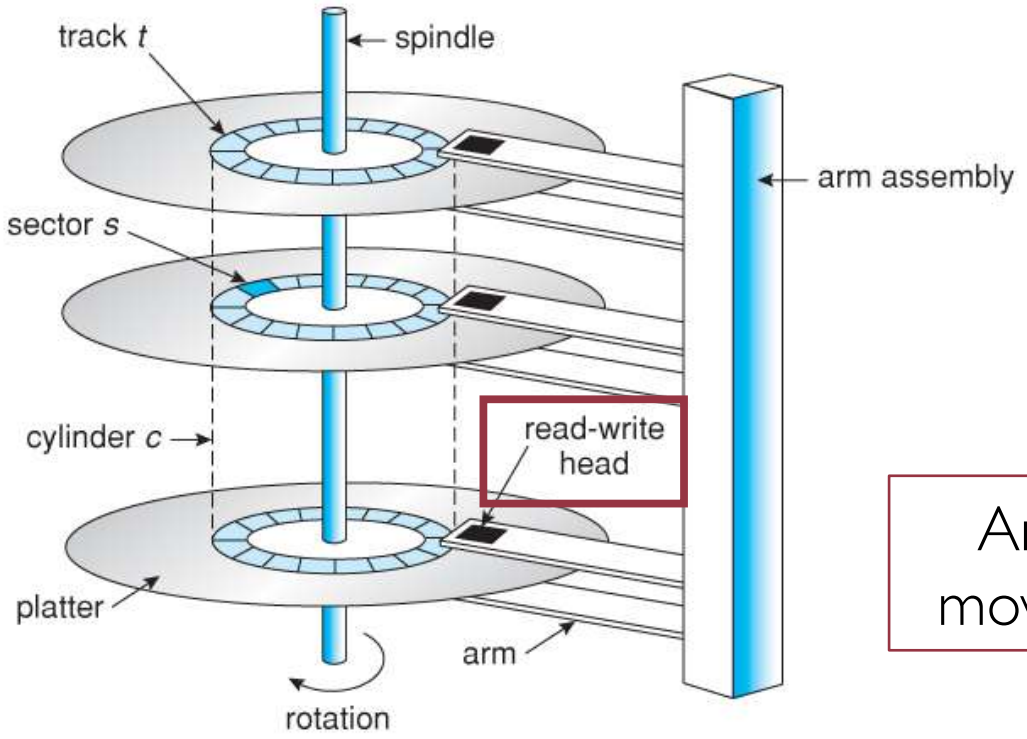

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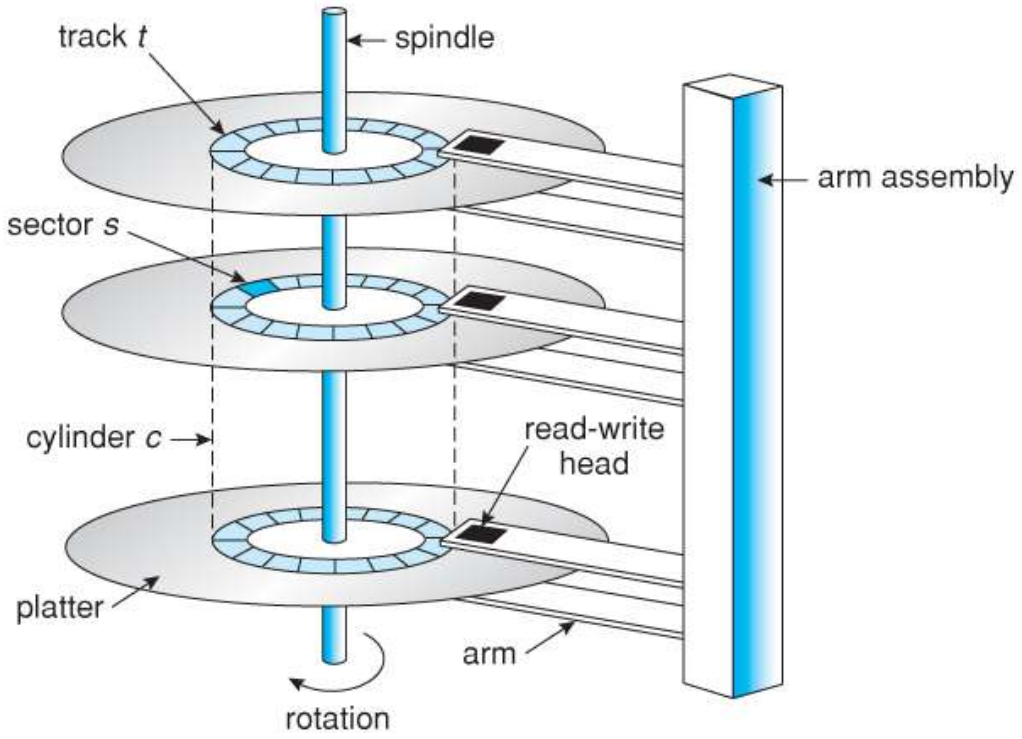
Arms are controlled by a common arm assembly moving simultaneously from one cylinder to another

Magnetic Disks: Storage Capacity



H = number of heads (working surfaces)

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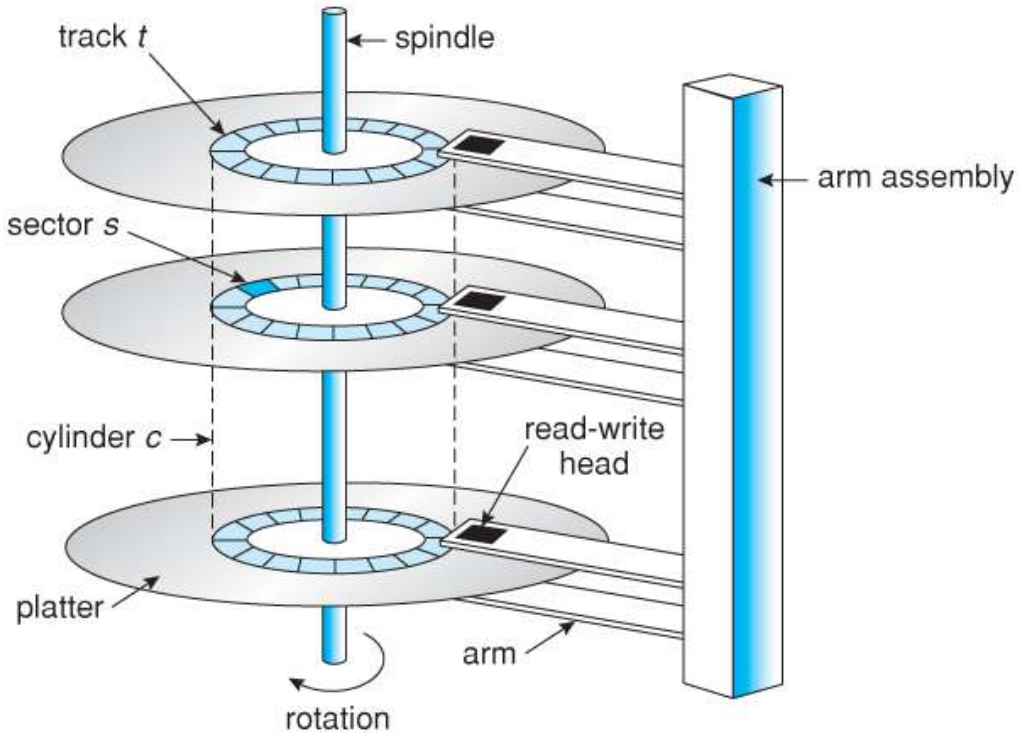

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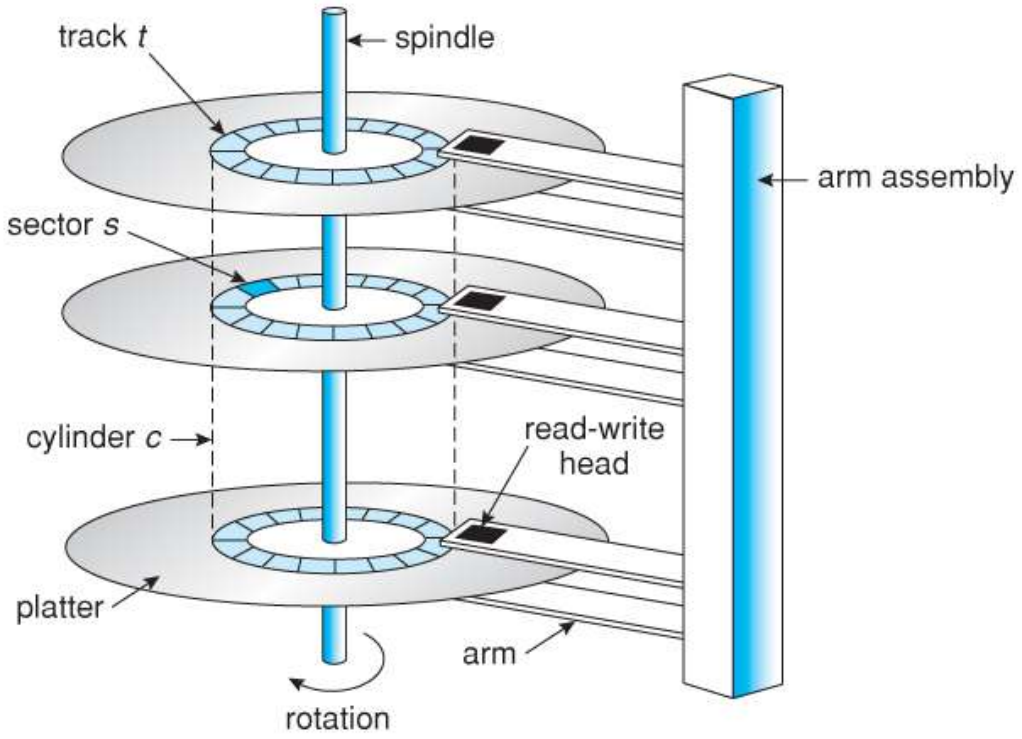

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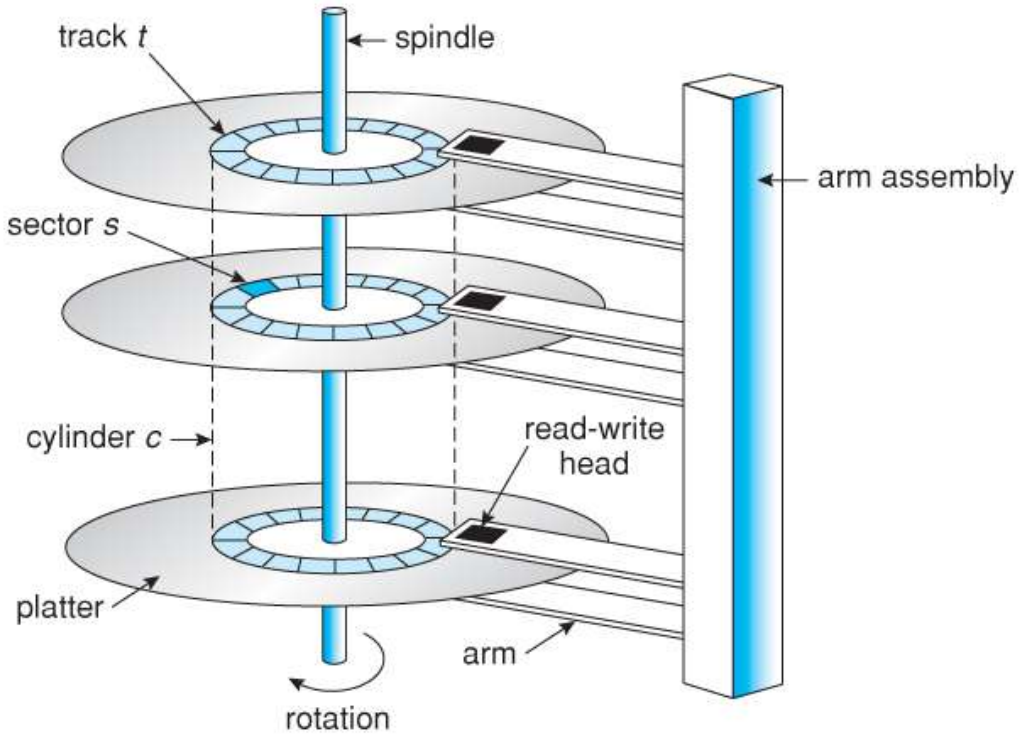

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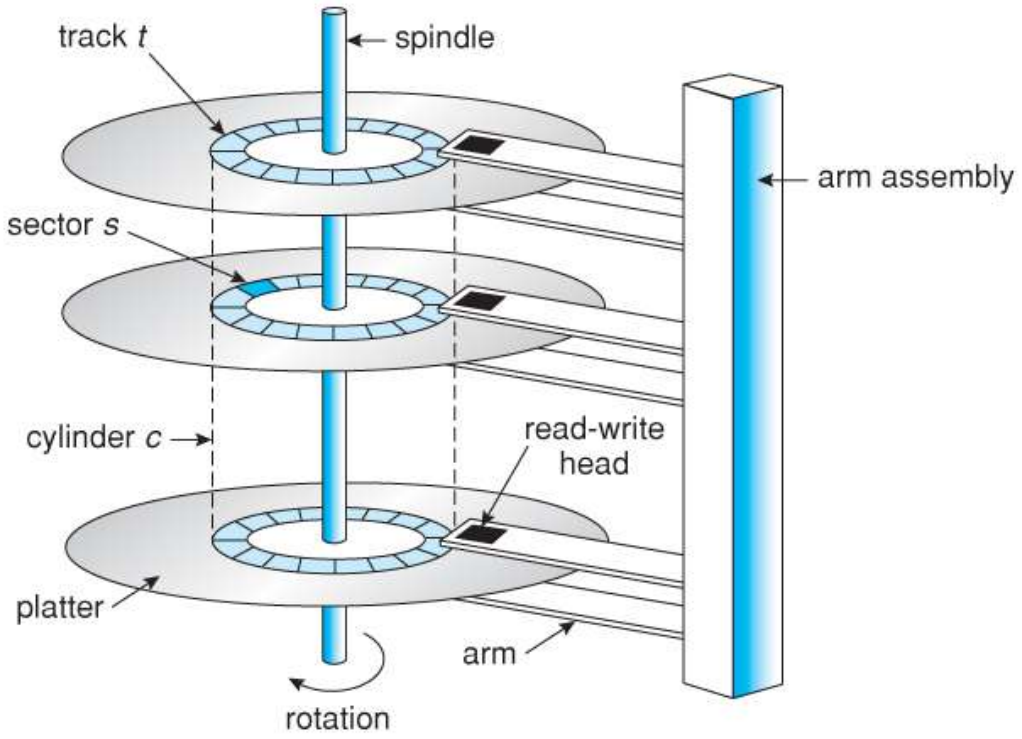

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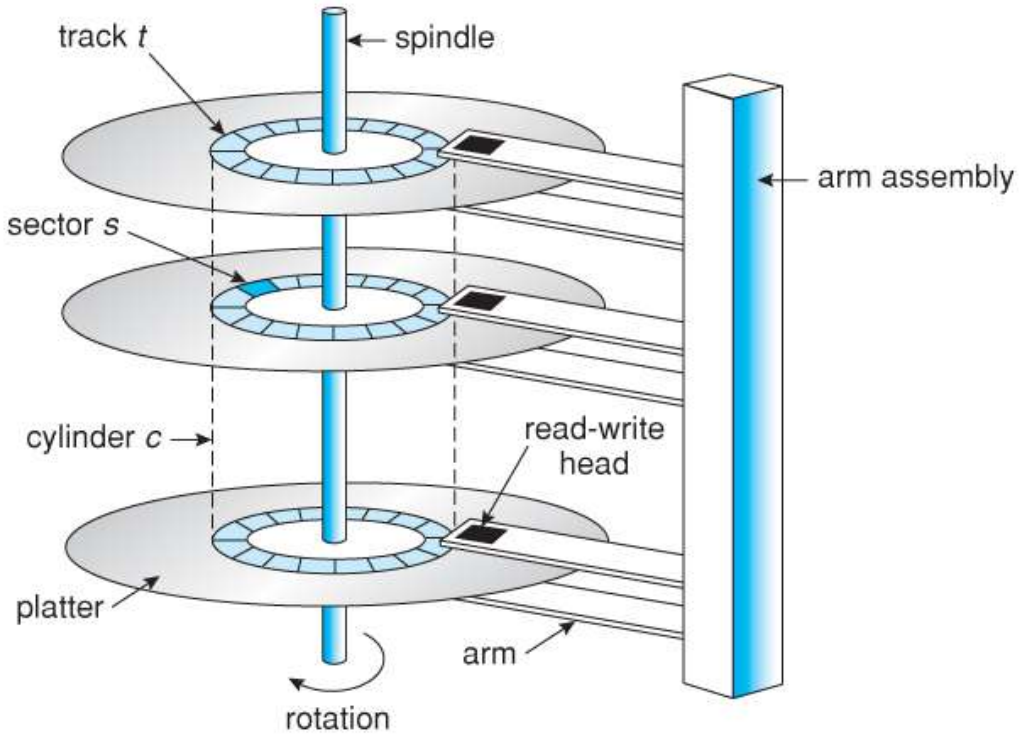
$C = H * T * S * B$

OVERALL CAPACITY

Magnetic Disks: Storage Capacity



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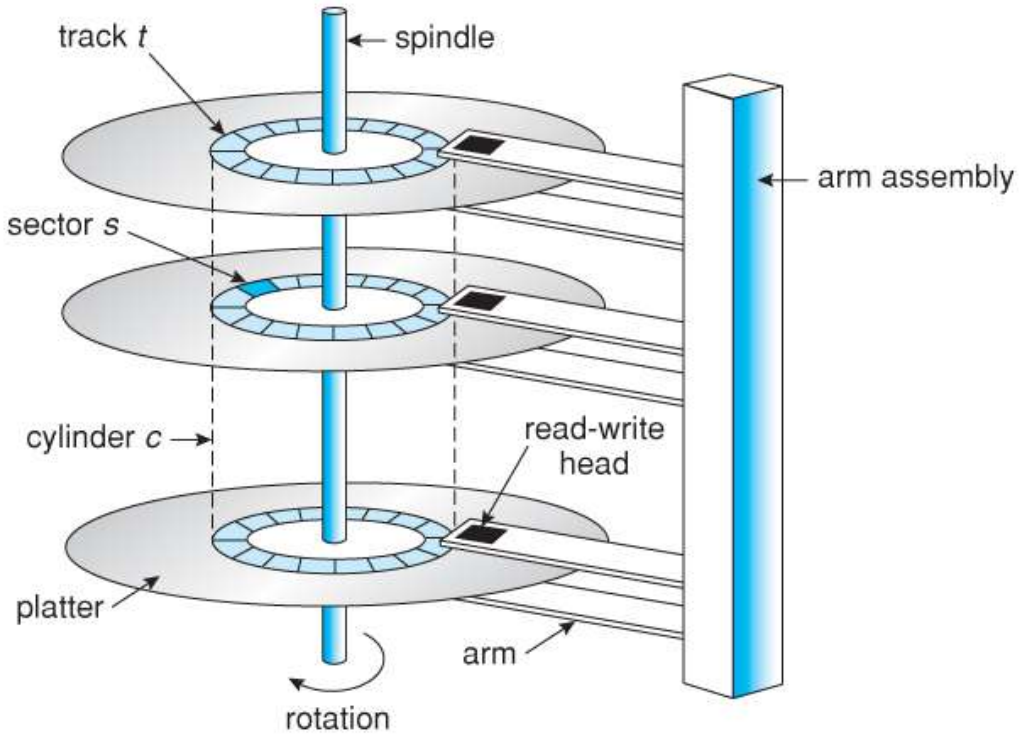

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Therefore, the bit density in the inner sectors was much higher than in the outer sectors

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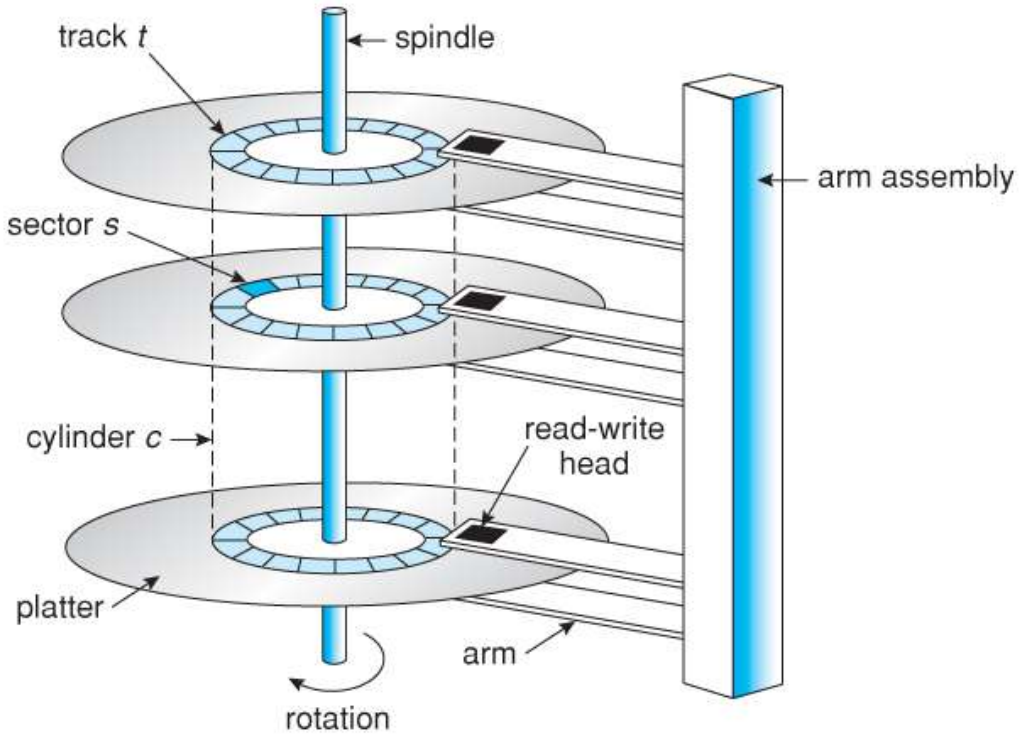

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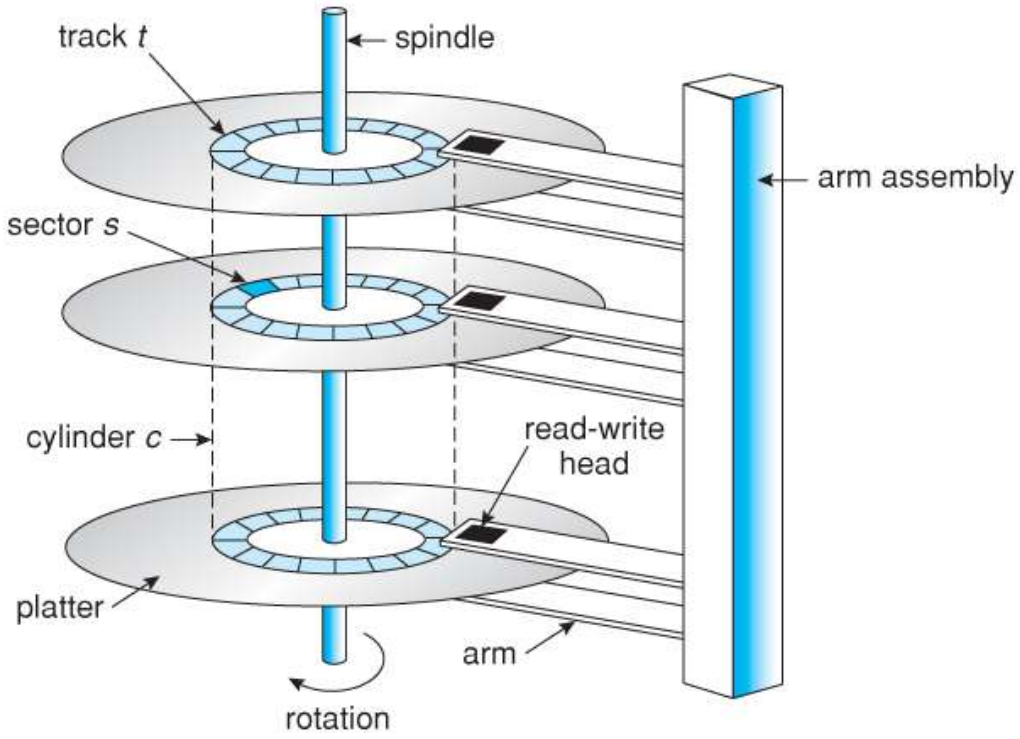

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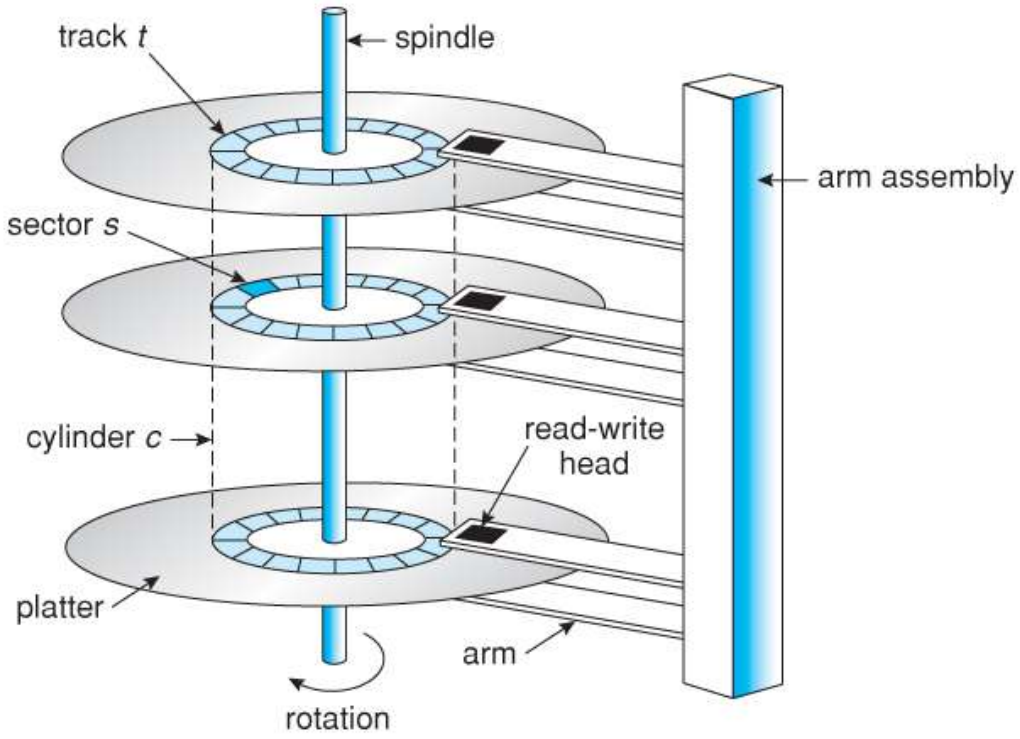

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- Different frequencies and timing from innermost to outermost tracks

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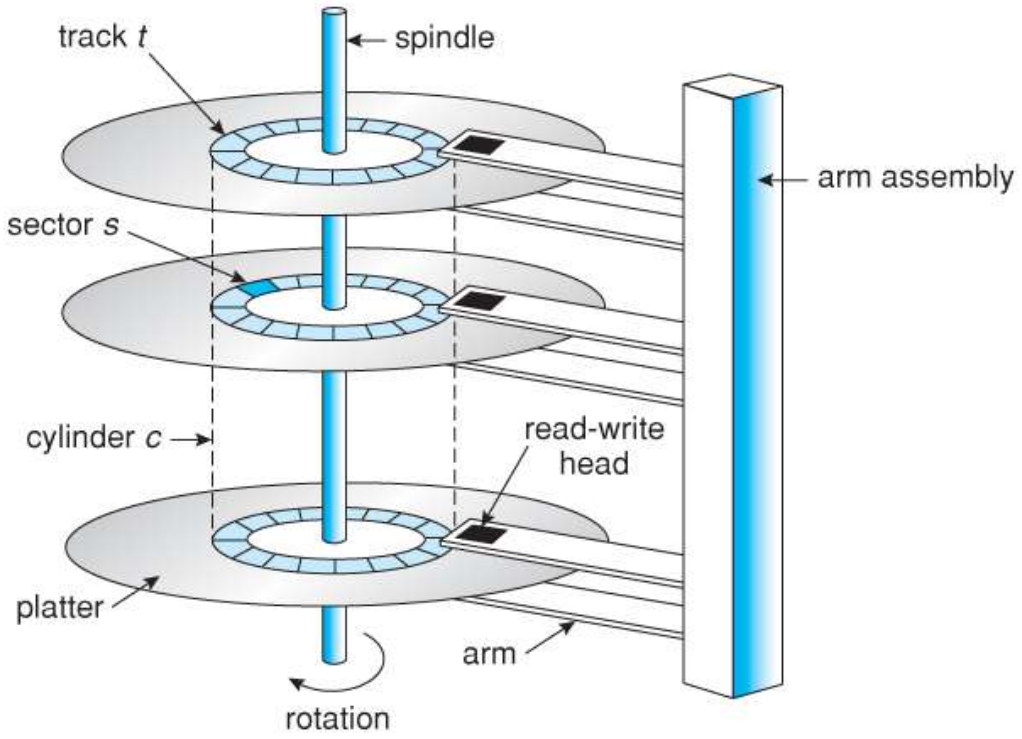

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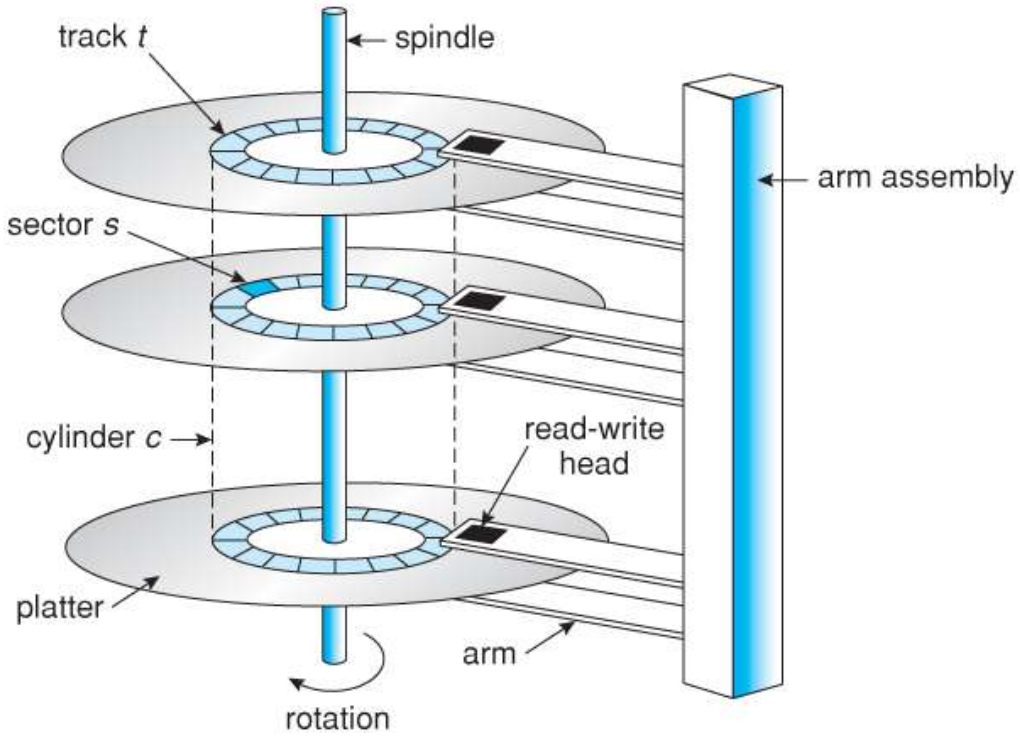

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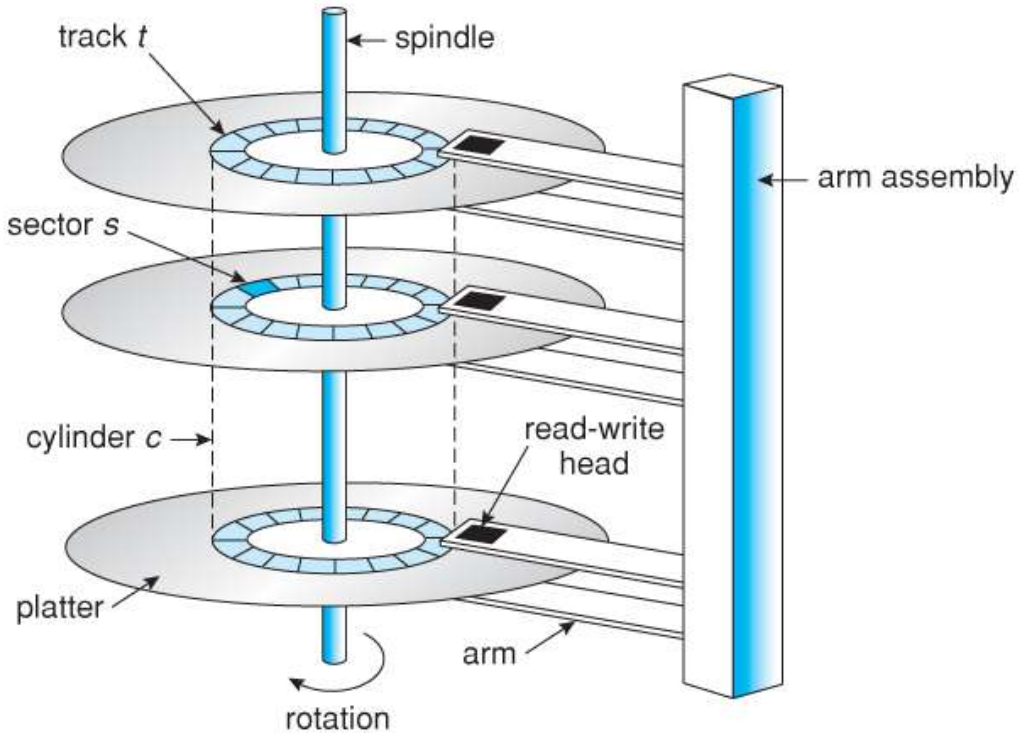

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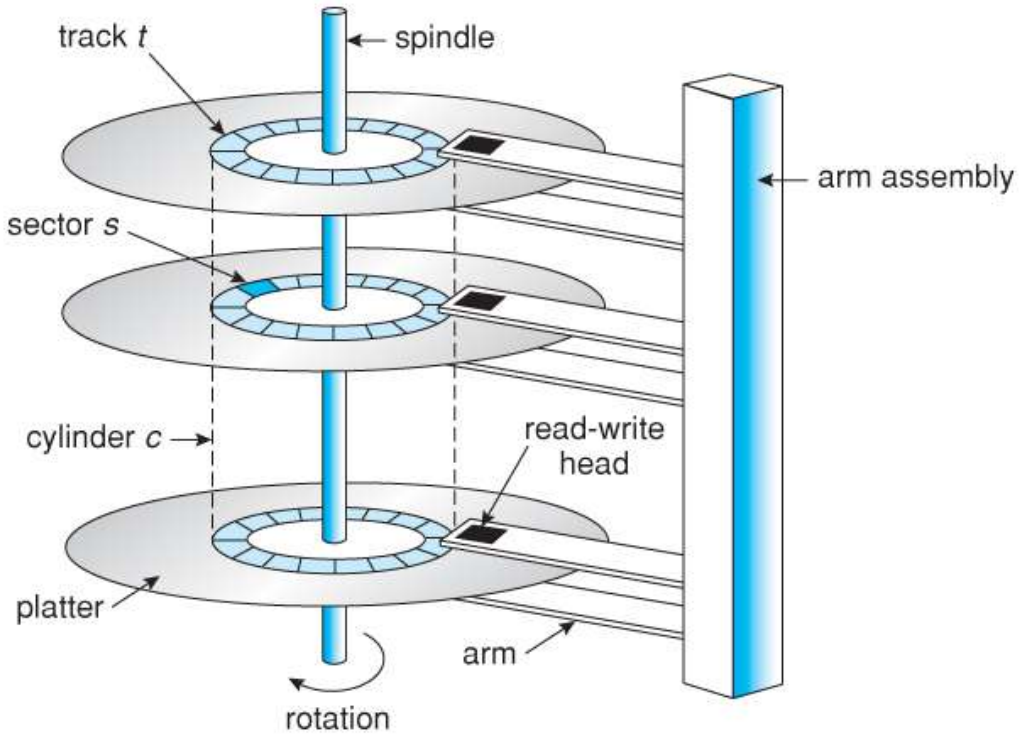

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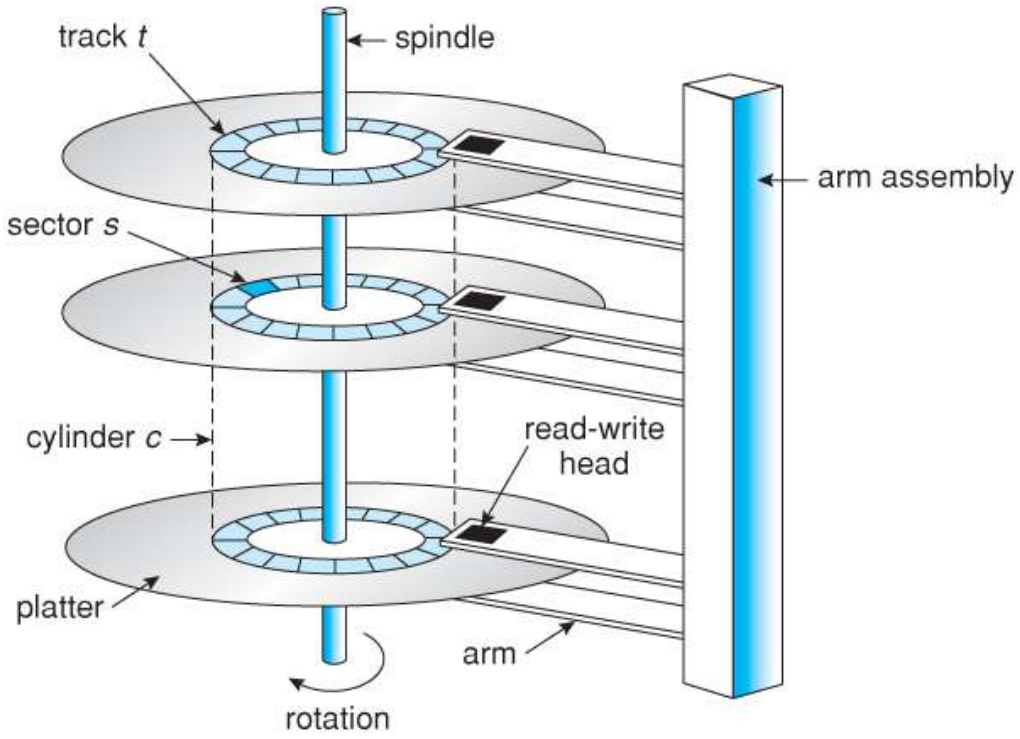

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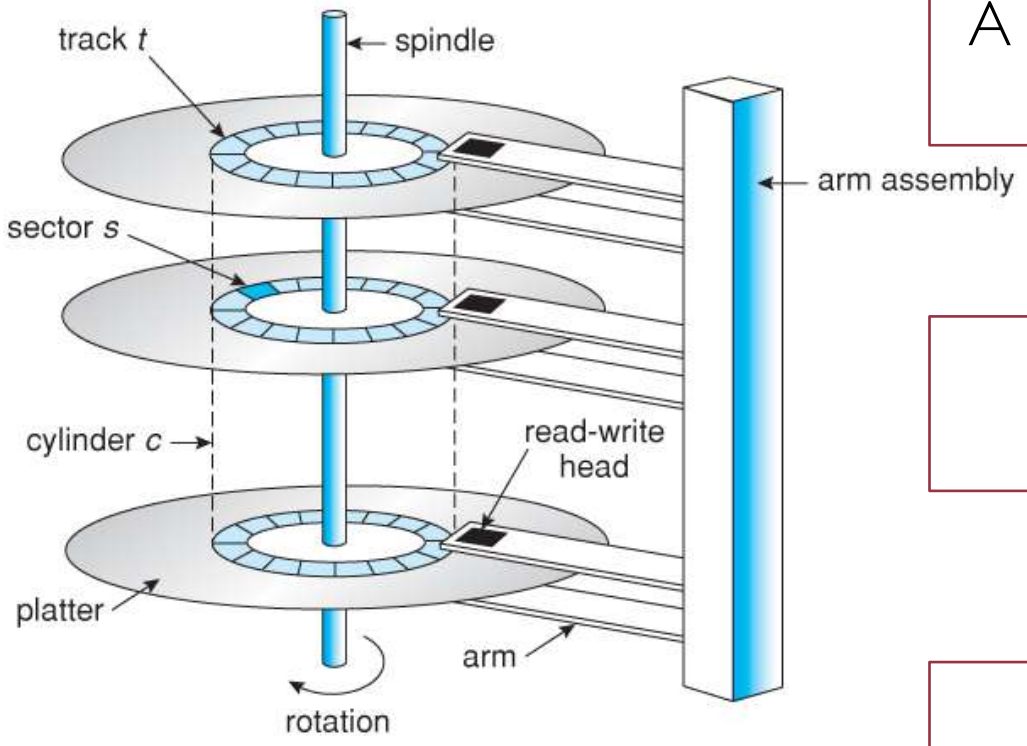
Zone Bit Recording (ZBR)

Magnetic Disks: (Logical) Referencing



A physical block of data is specified by the (head, cylinder, sector) number

Disk blocks are numbered starting at the outermost cylinder, identified by 0

Note that cylinder coincides with track

Magnetic Disks: Data Transfer

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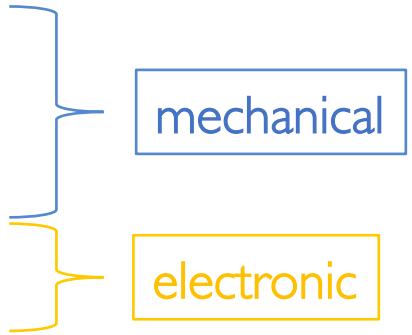

Magnetic Disks: Positioning (Seek) Time

- The time required to move the heads to a specific track/cylinder
- Includes the time needed for the heads to settle after the move
- Depends on how fast the hardware moves the assembly arm
- Typically, the slowest step in the entire process

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Bottleneck of overall disk data transfer

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The second highest bottleneck

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$$\text{Data Transfer Time} = \text{Seek Time} + \text{Rotational Delay} + \text{Transfer Time}$$

Sometimes the term transfer rate is used to refer to the overall data transfer time

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- The array of blocks is mapped onto disk sectors sequentially
- Sector 0 is the first sector of the first track of the outermost cylinder
  - The mapping proceeds in order through that track
  - Then through the rest of tracks in the same cylinder
  - Then through other cylinders (from the outermost to innermost)

Magnetic Disks: Risks

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- Parking heads means to move them off the disk or to an area where no data is stored

Magnetic Disks: Interfaces

- Hard drives may be removable as floppy disks, and some are even hot-swappable
  - they can be removed while the computer is running
- Disk drives are connected to the computer via the I/O bus
- Some of the common interface formats include:
  - Enhanced Integrated Drive Electronics (EIDE);
  - Advanced Technology Attachment (ATA) and Serial ATA (SATA);
  - Universal Serial Bus (USB);
  - Fiber Channel (FC);
  - Small Computer Systems Interface (SCSI)

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- Finally, data is transferred from that cache to the host controller and the motherboard memory at electronic speeds

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Hardware Optimization

Minimize Data Transfer Time

- How can the OS help minimize data transfer time?
- Schedule disk operations so as to minimize head movement
- Lay out data on disk so that related data are located on close tracks
- Place commonly-used data on a specific portion of the disk
- Pick carefully the block size contained on each sector:
  - Too small → more seeks are needed to transfer the same amount of data
  - Too large → more internal fragmentation and space wasted

Summary

- Disks are slow devices compared to CPUs (and main memory)
- Manage those device efficiently is crucial
- Minimize seek and rotational delay on magnetic disks
- HW optimizations are limited → OS needs to take the lead here!