

Sistemi Operativi I

Corso di Laurea in Informatica
2022-2023



SAPIENZA
UNIVERSITÀ DI ROMA

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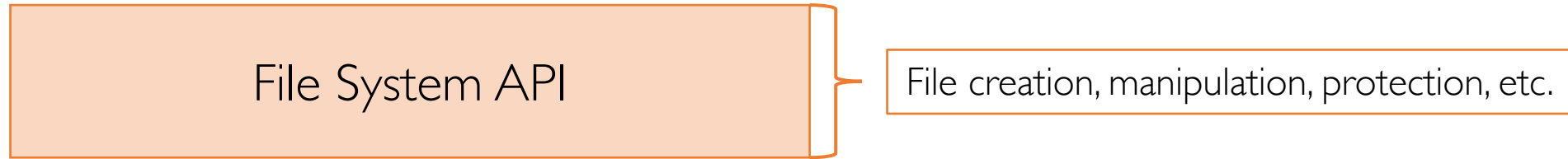
tolomei@di.uniroma1.it

File System's Logical View

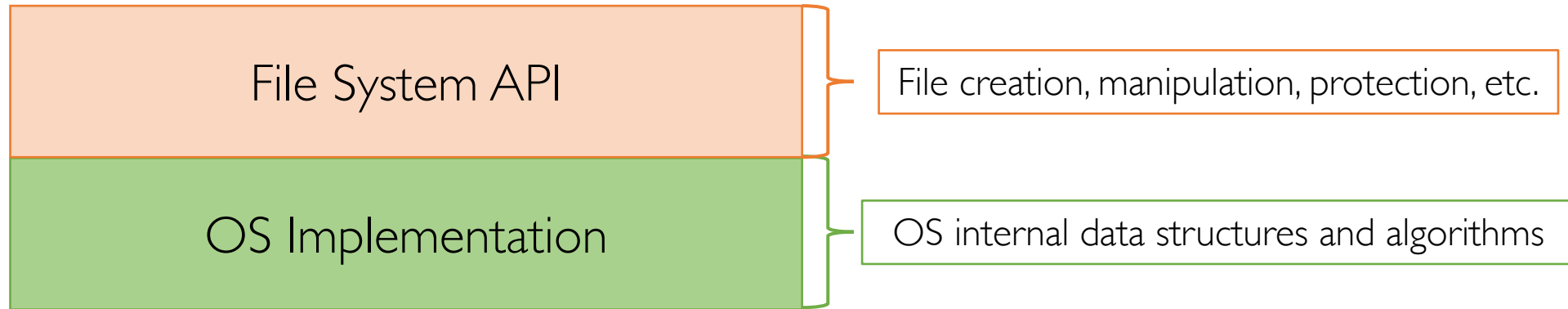


File System API

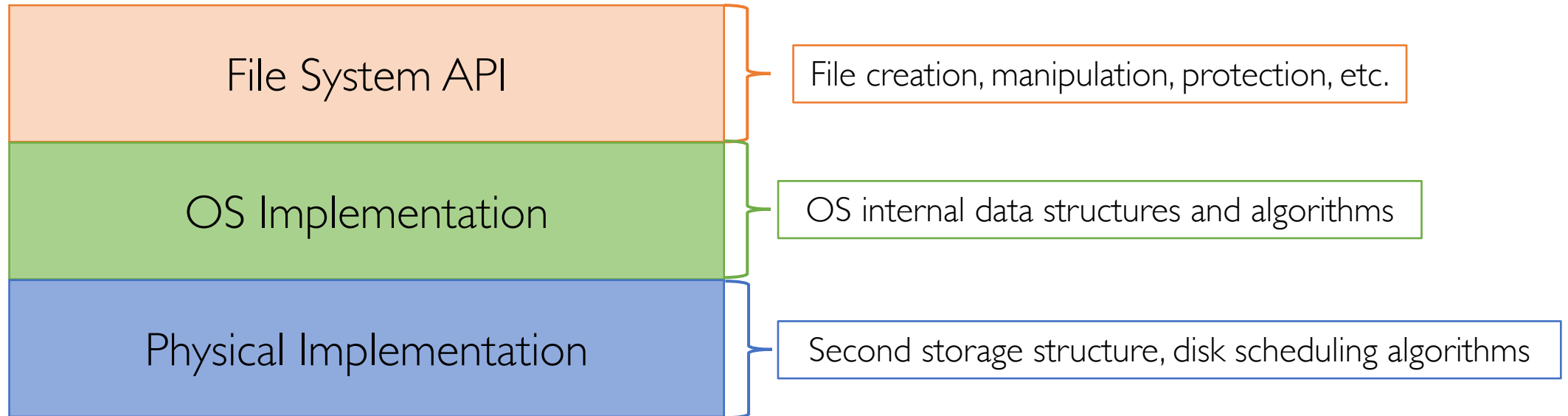
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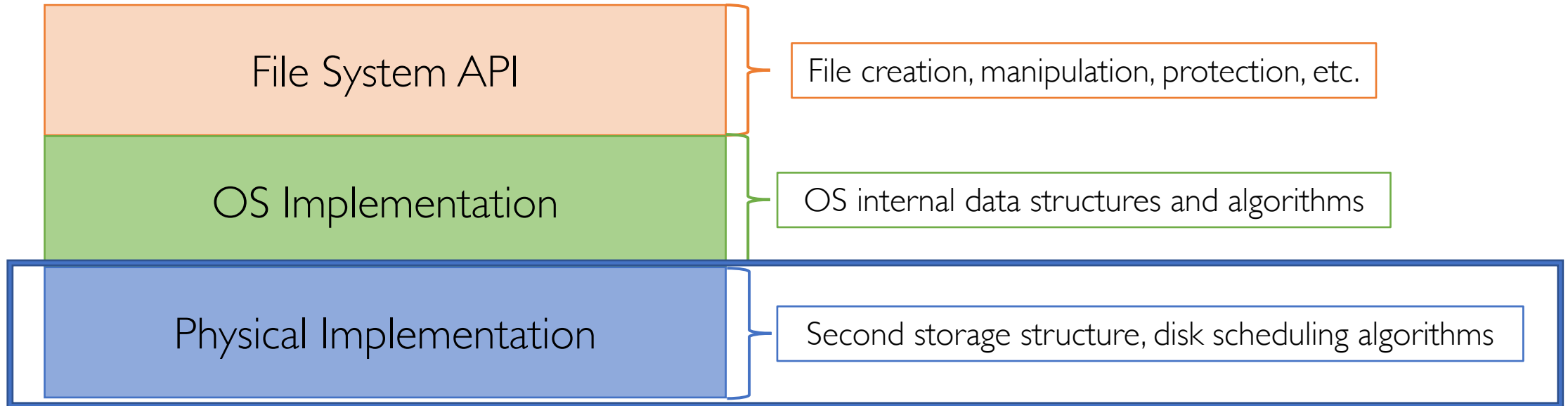
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Part V: Storage Management

Overview of Mass-Storage Structure

3 categories of mass-storage devices

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Magnetic Disks



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Magnetic Disks



Solid-State Disks



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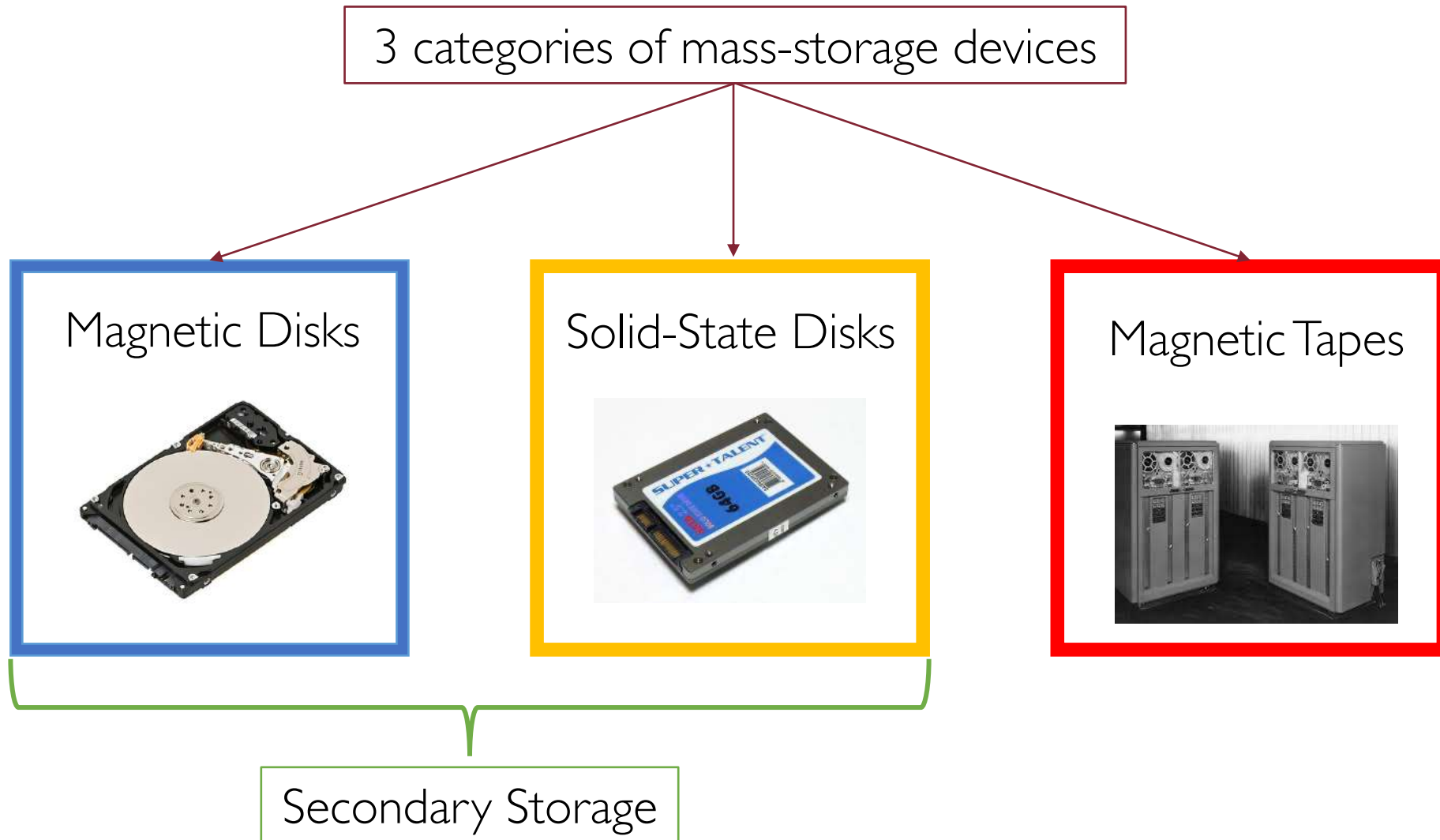
Solid-State Disks



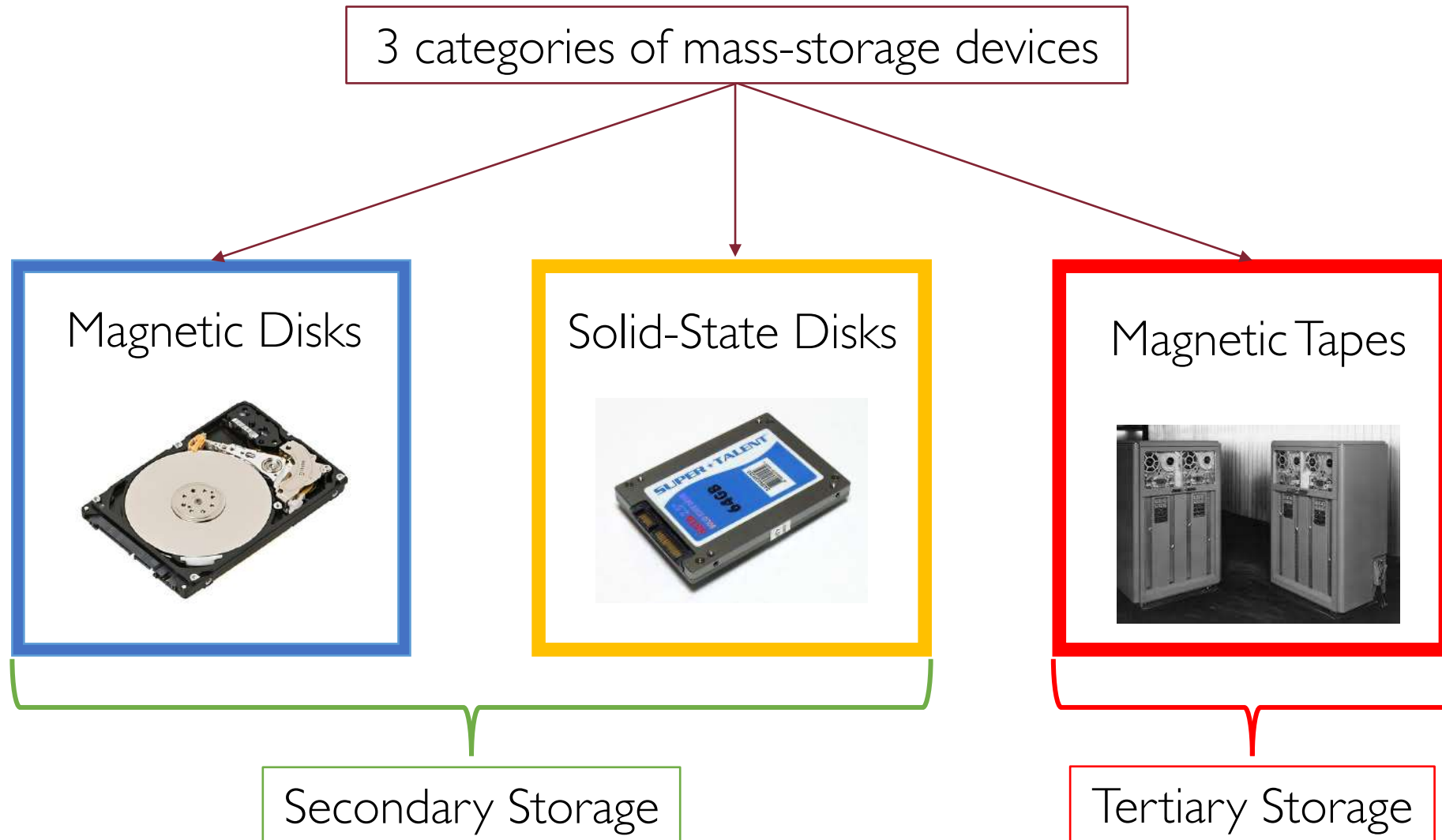
Magnetic Tapes



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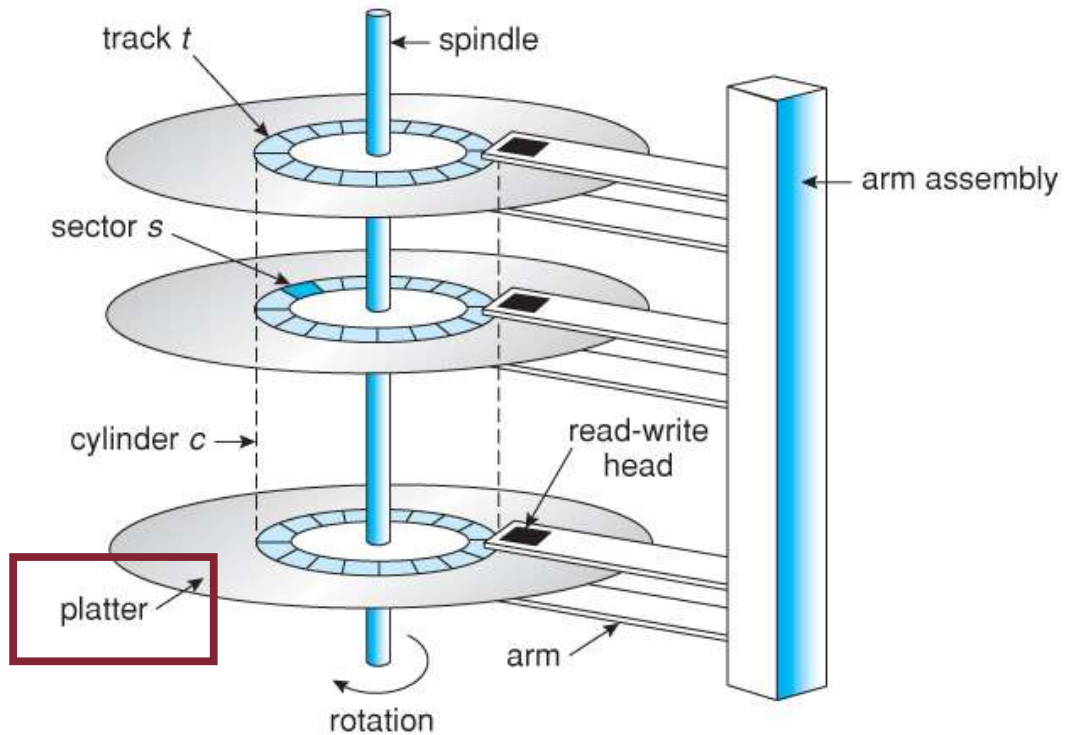


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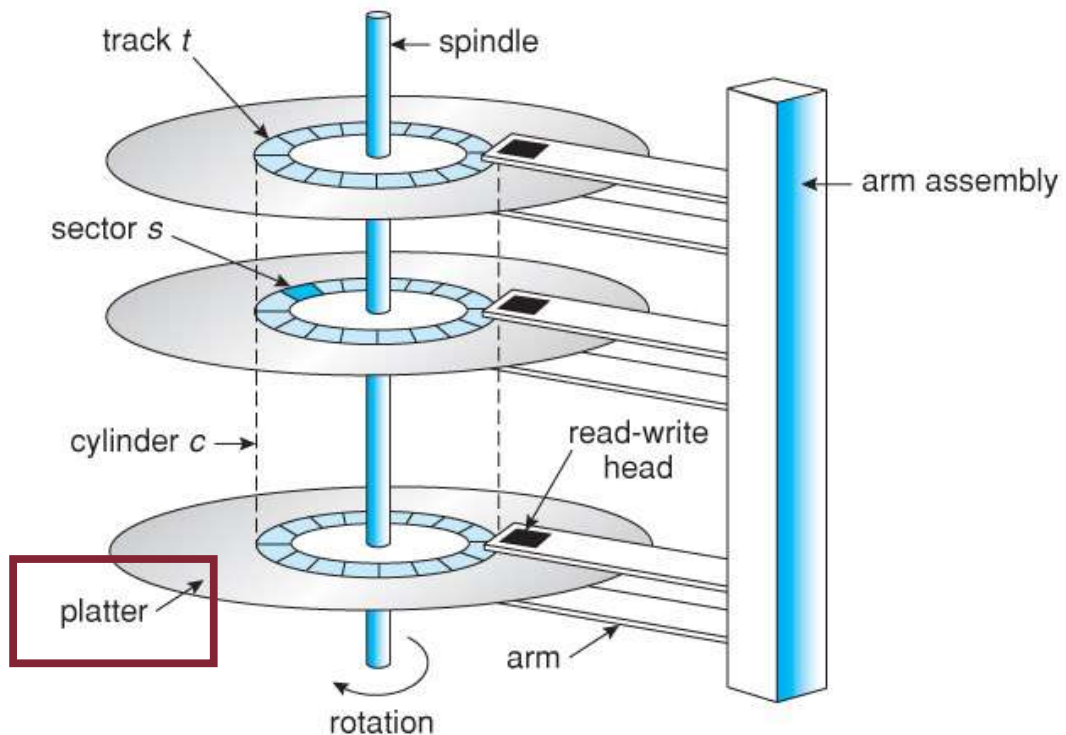


Magnetic Disks: Structure

One or more **platters** covered with **magnetic media**



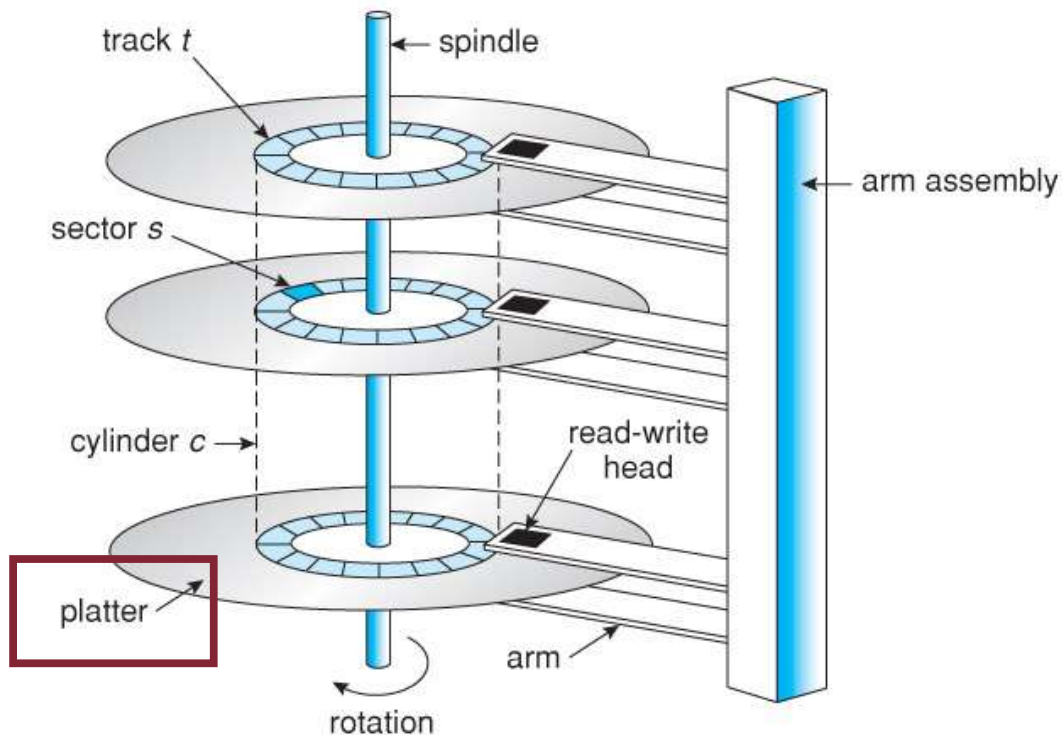
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Hard disk
rigid metal

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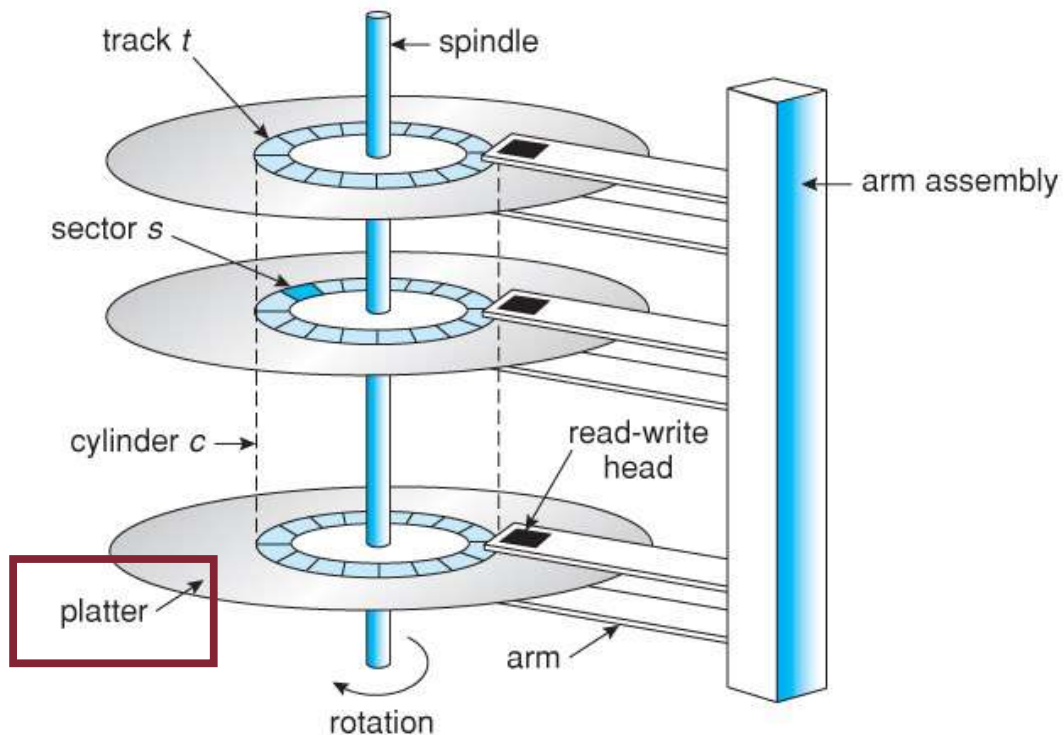


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Hard disk
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Floppy disk
flexible plastic

Magnetic Disks: Structure



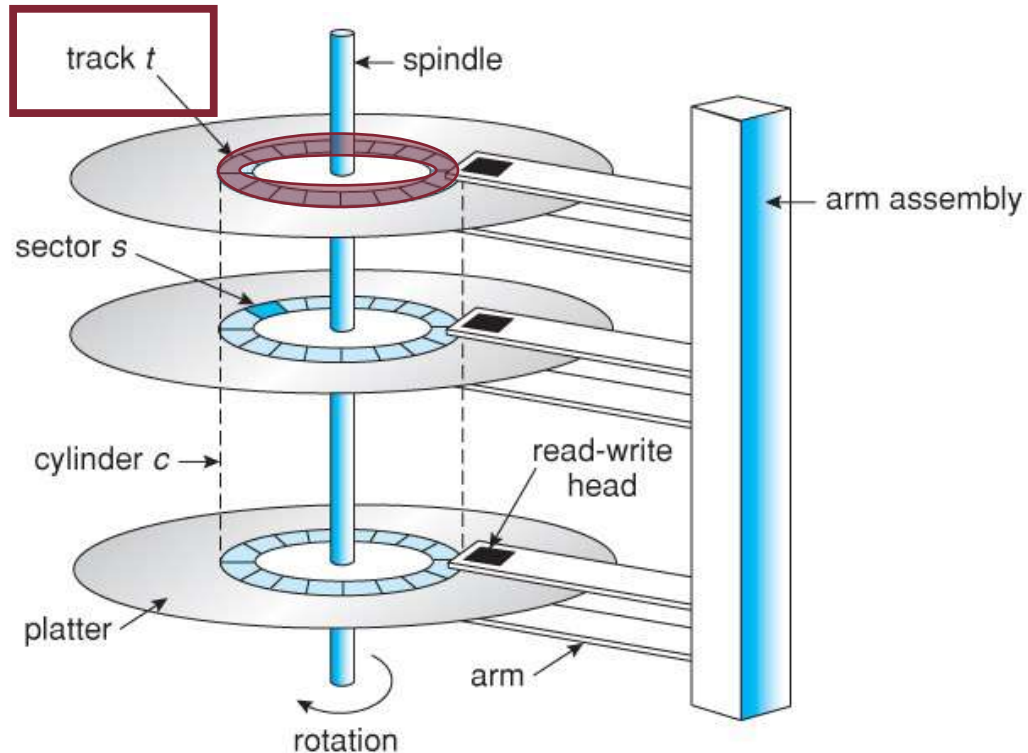
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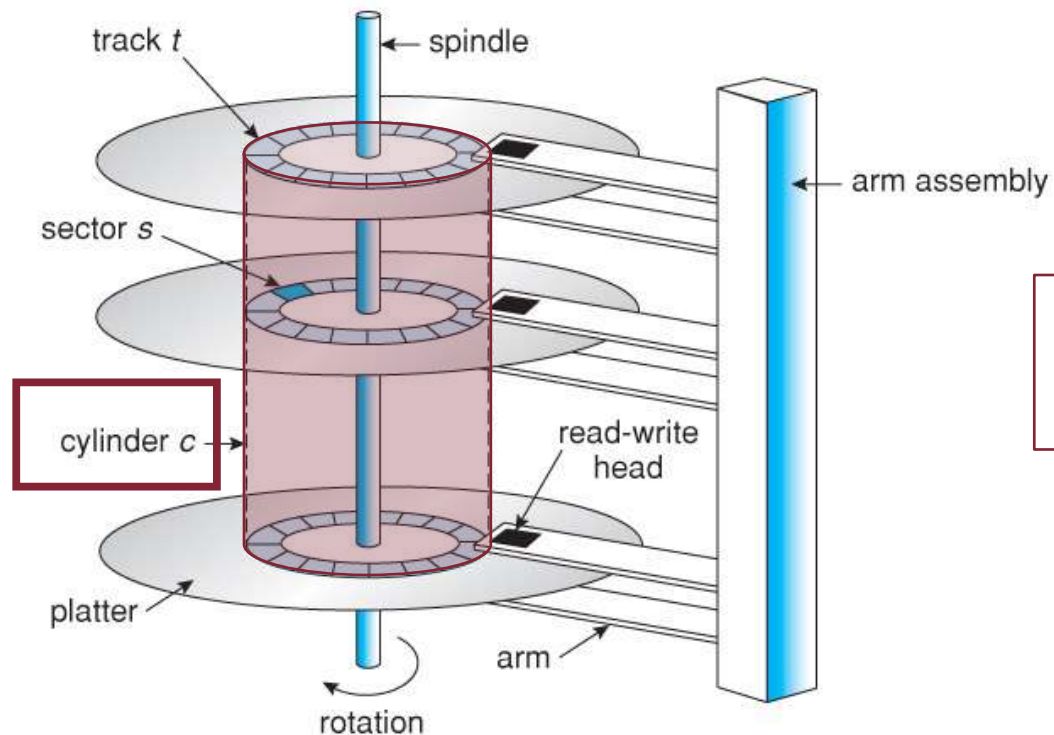
Each platter has **2** working **surfaces**

Magnetic Disks: Tracks and Cylinders



Each surface is divided into a number of concentric rings, called **tracks**

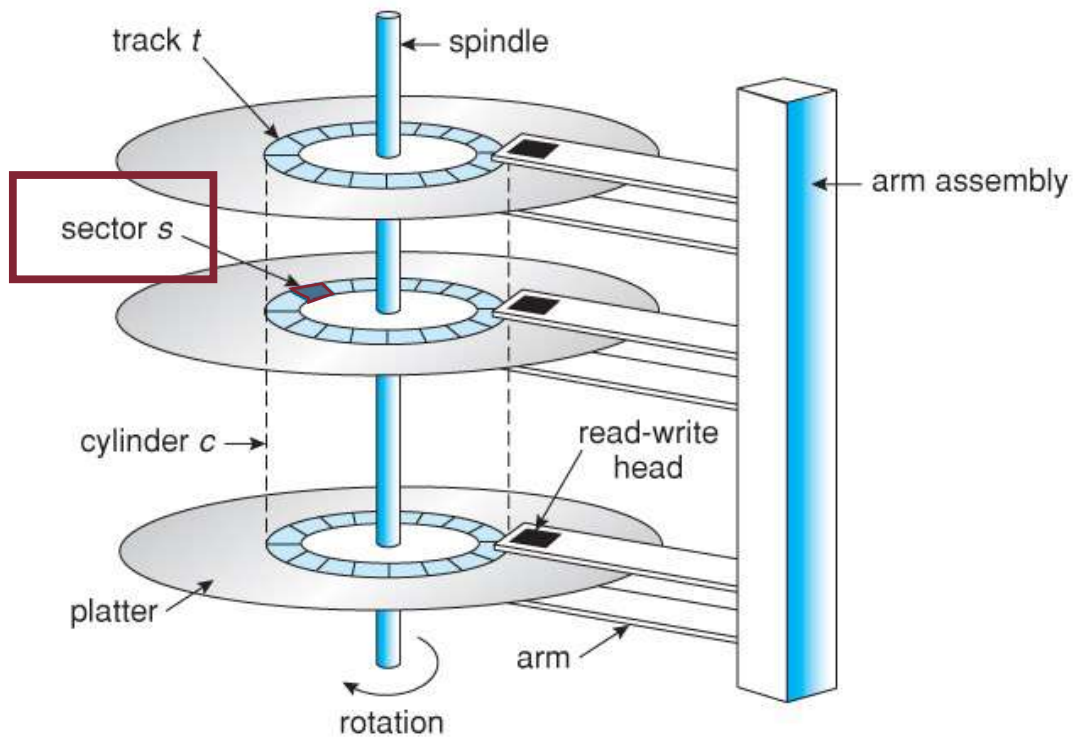
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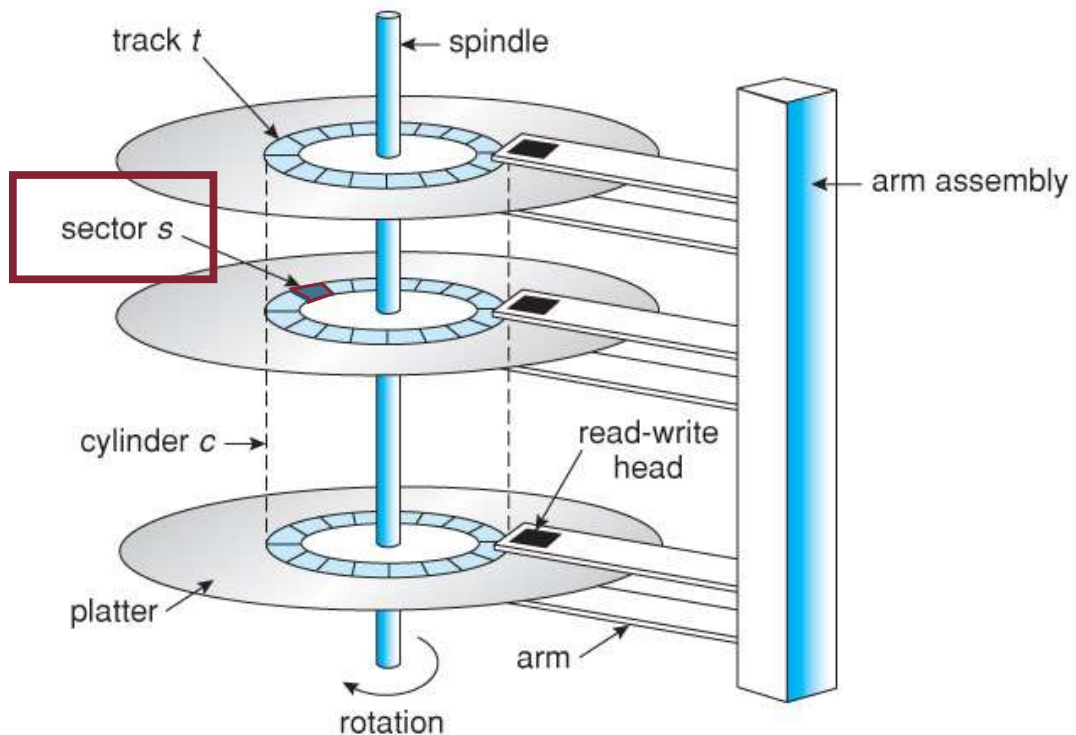
The set of all tracks that are the same distance from the edge of the platter is called a **cylinder**

Magnetic Disks: Sectors



Each track is further divided into
sectors

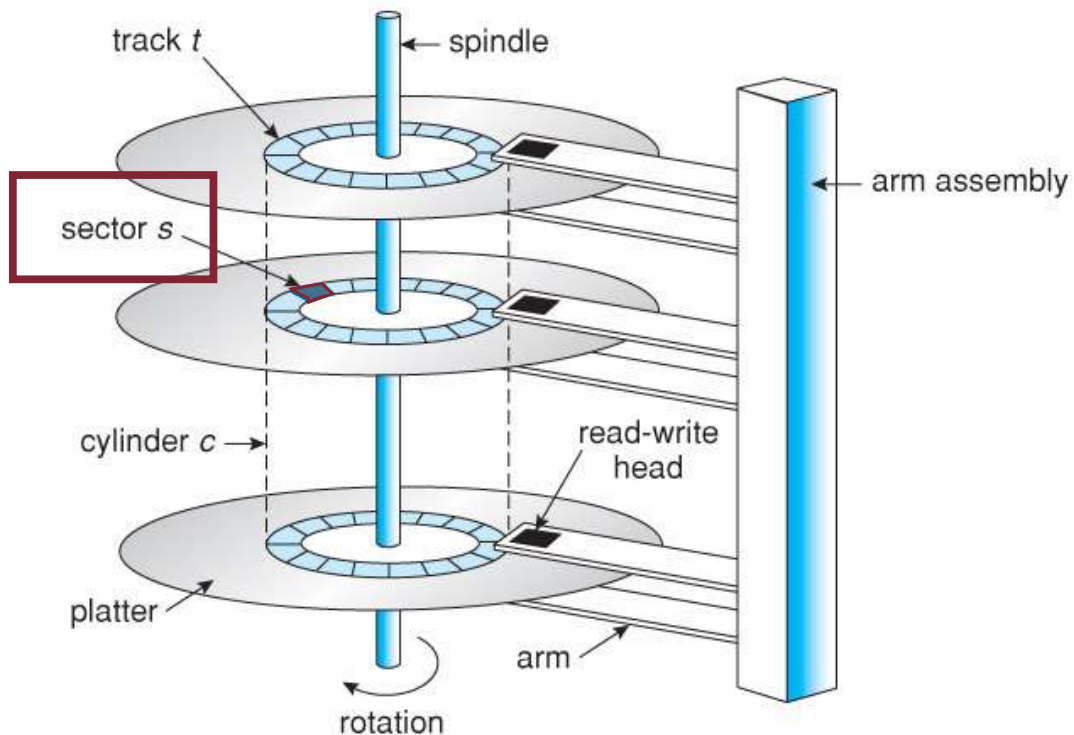
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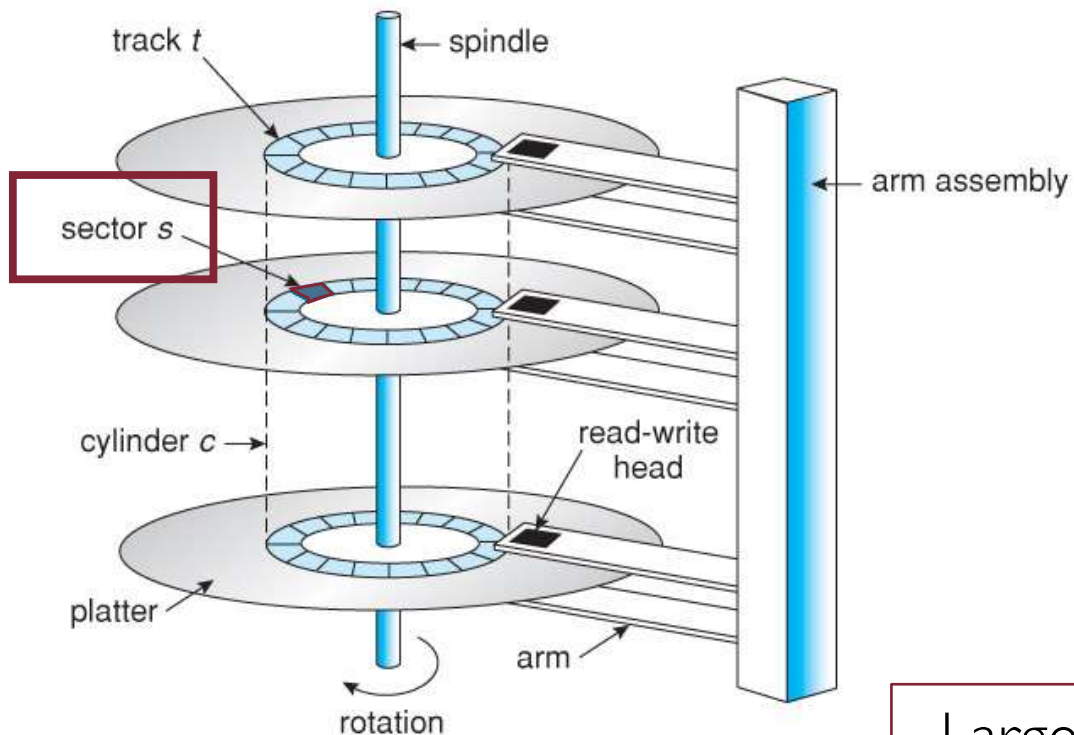


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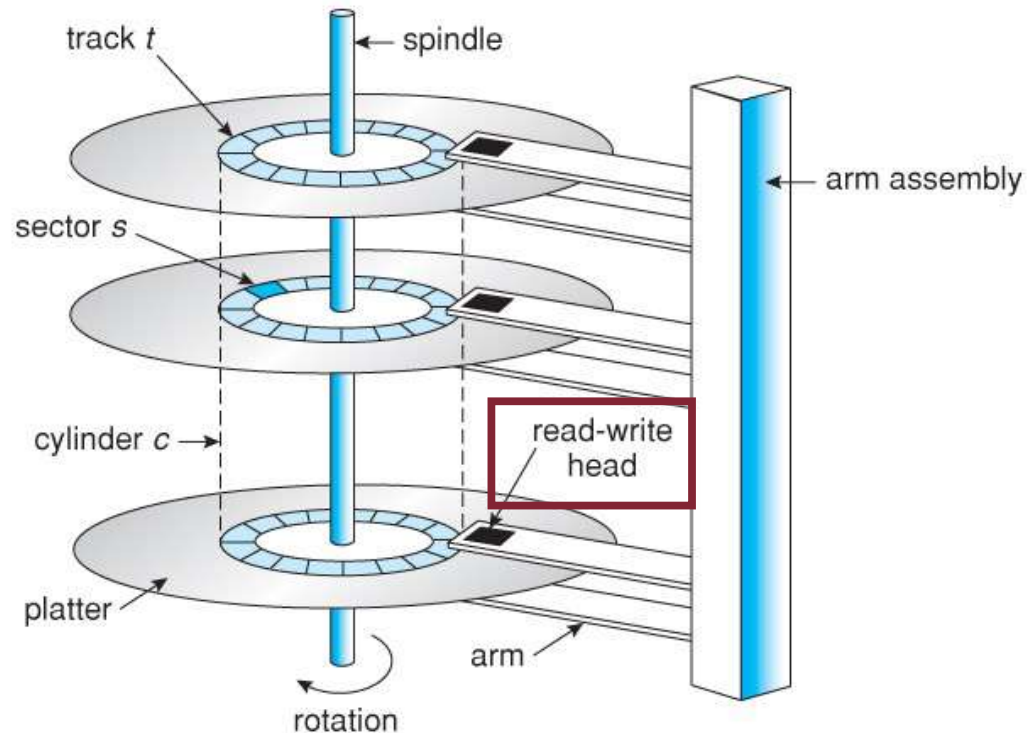
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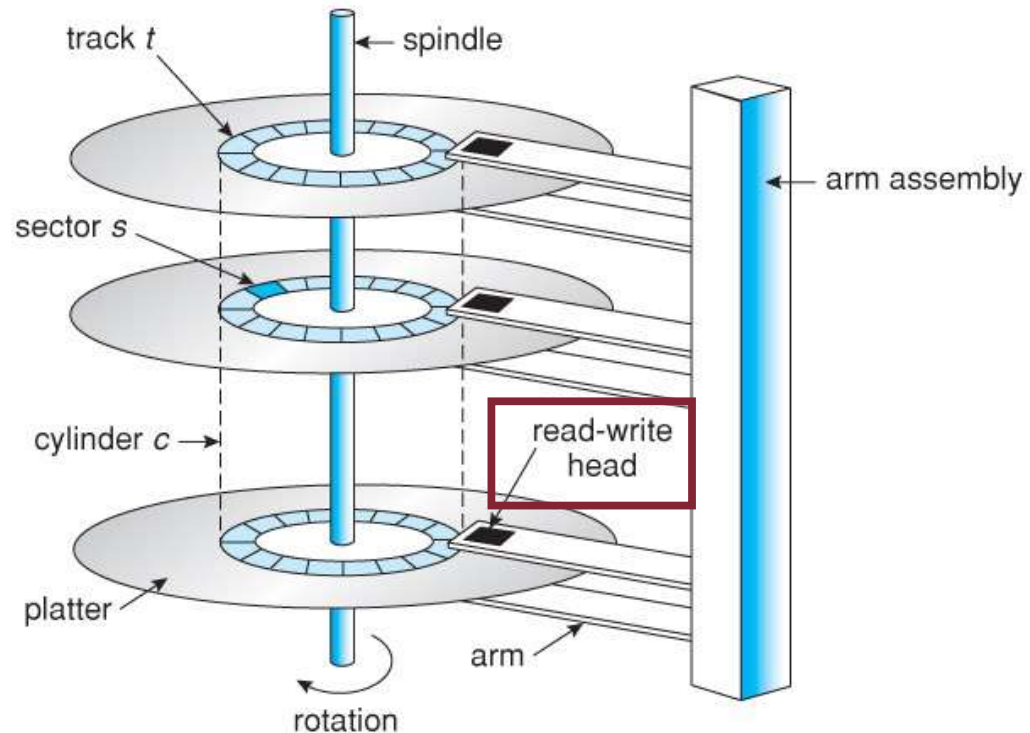
Larger sector sizes reduce the space wasted by headers and trailers, but increase internal fragmentation

Magnetic Disks: Heads

Data on hard drive is read by read-write **heads**



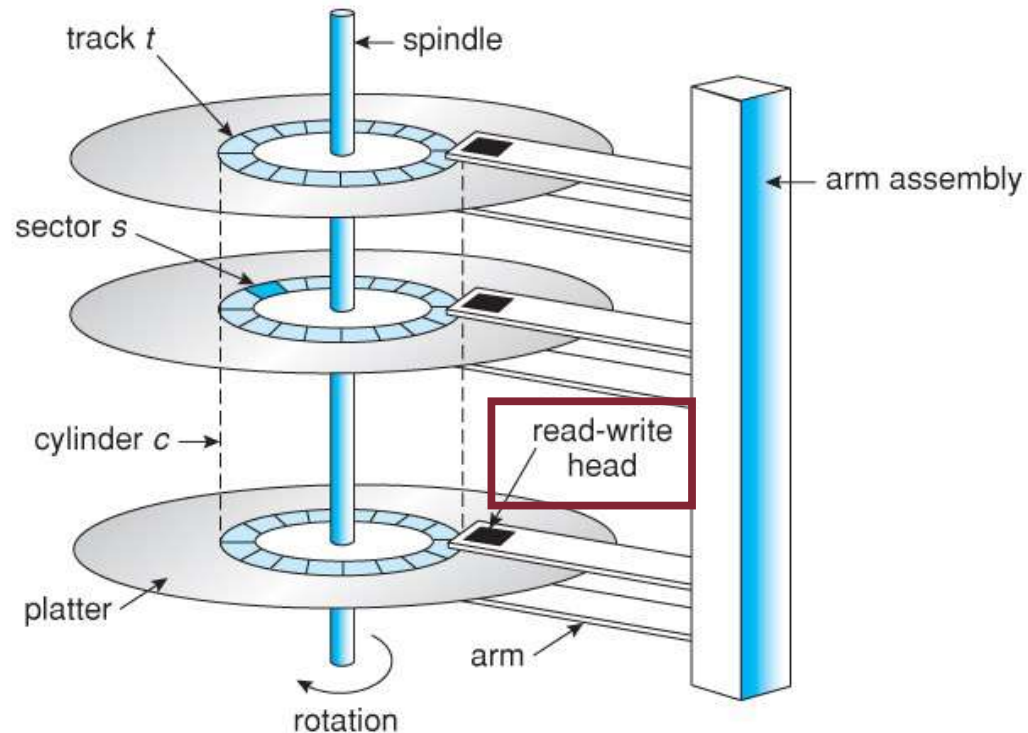
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Standard configuration uses one head per surface

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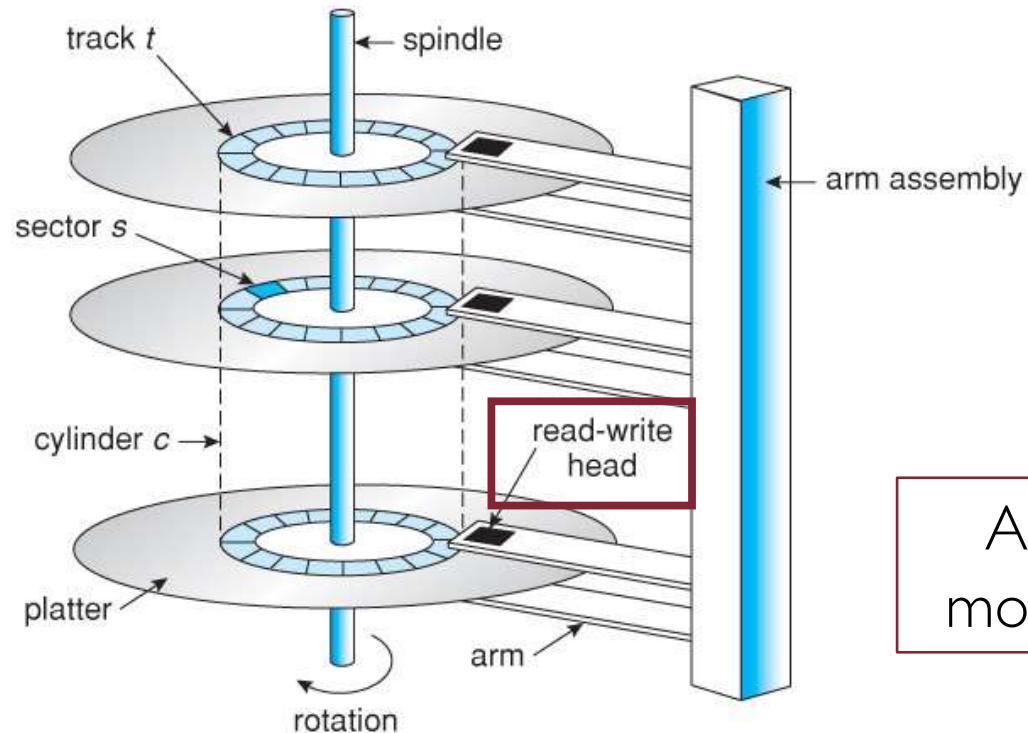


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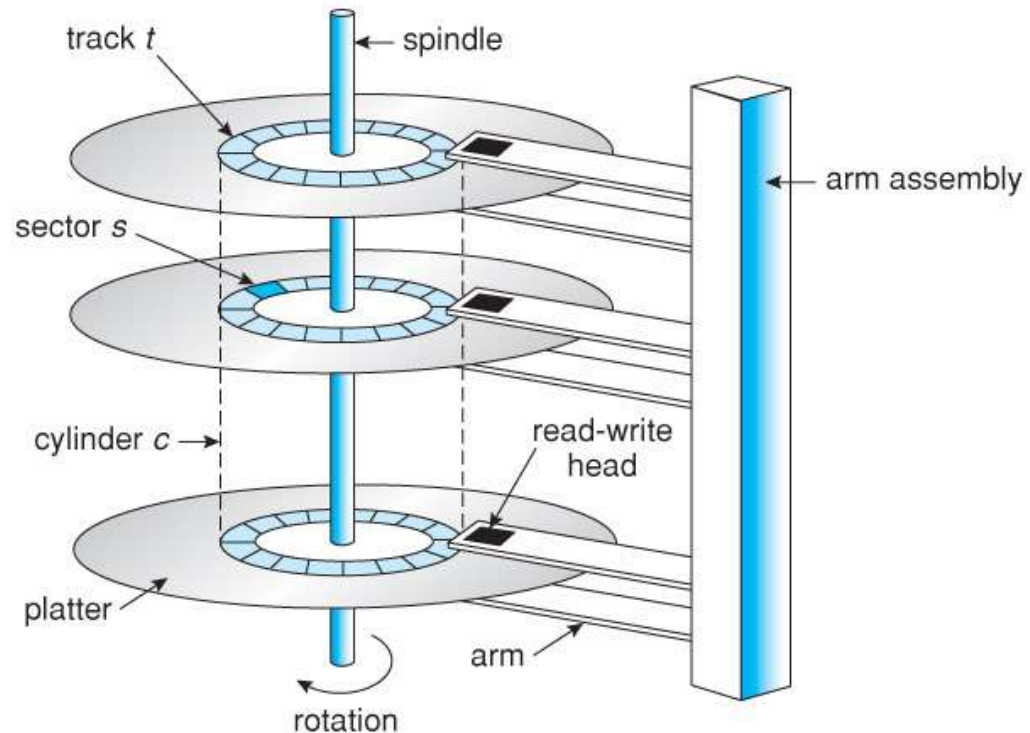
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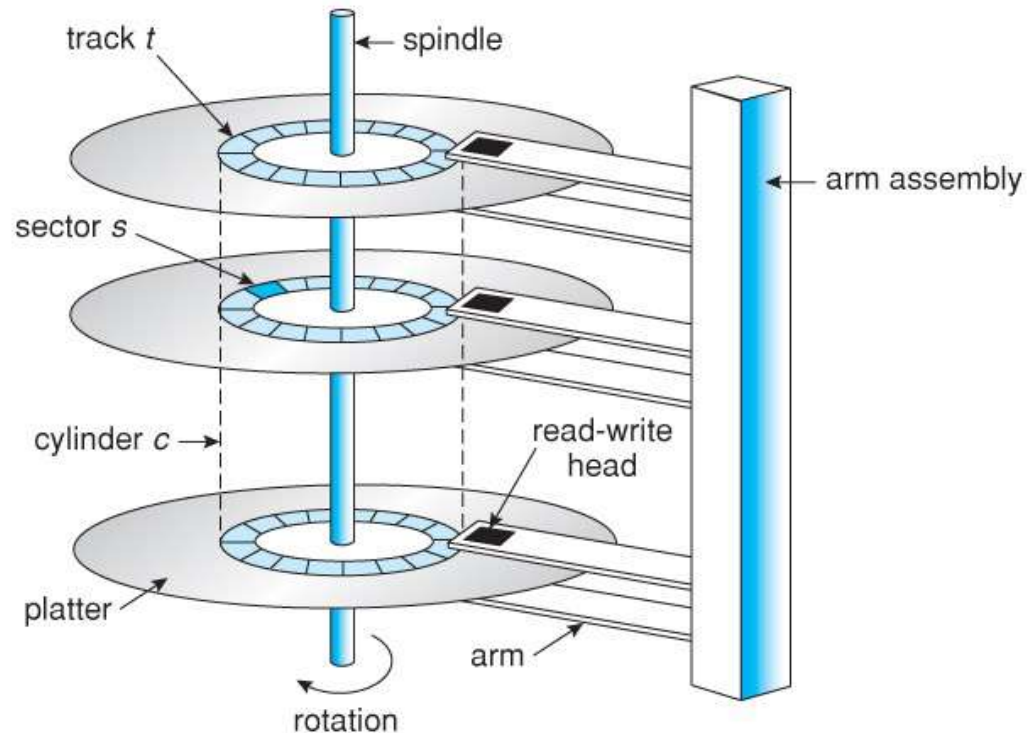
Arms are controlled by a common **arm assembly** moving simultaneously from one cylinder to another

Magnetic Disks: Storage Capacity

H = number of heads (working surfaces)



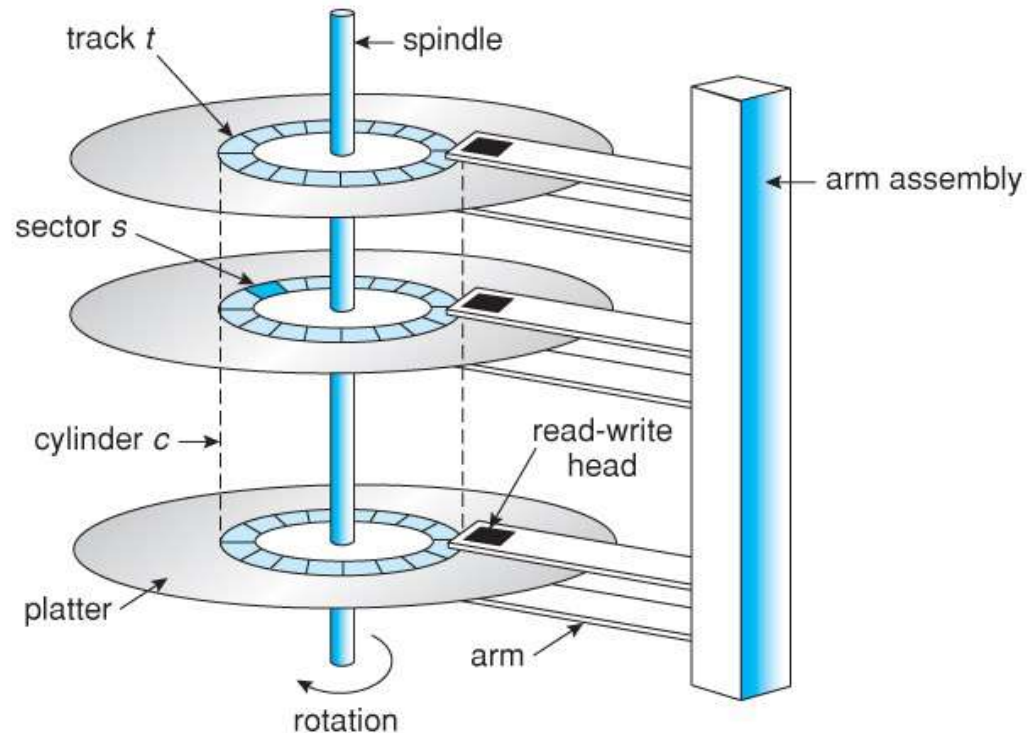
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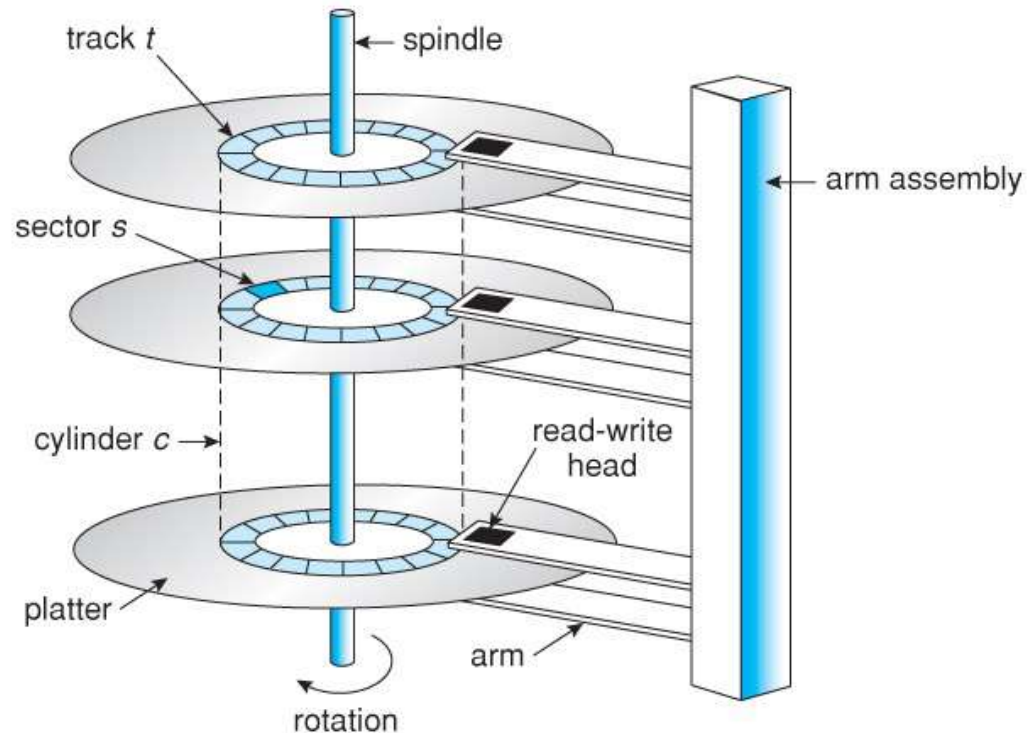


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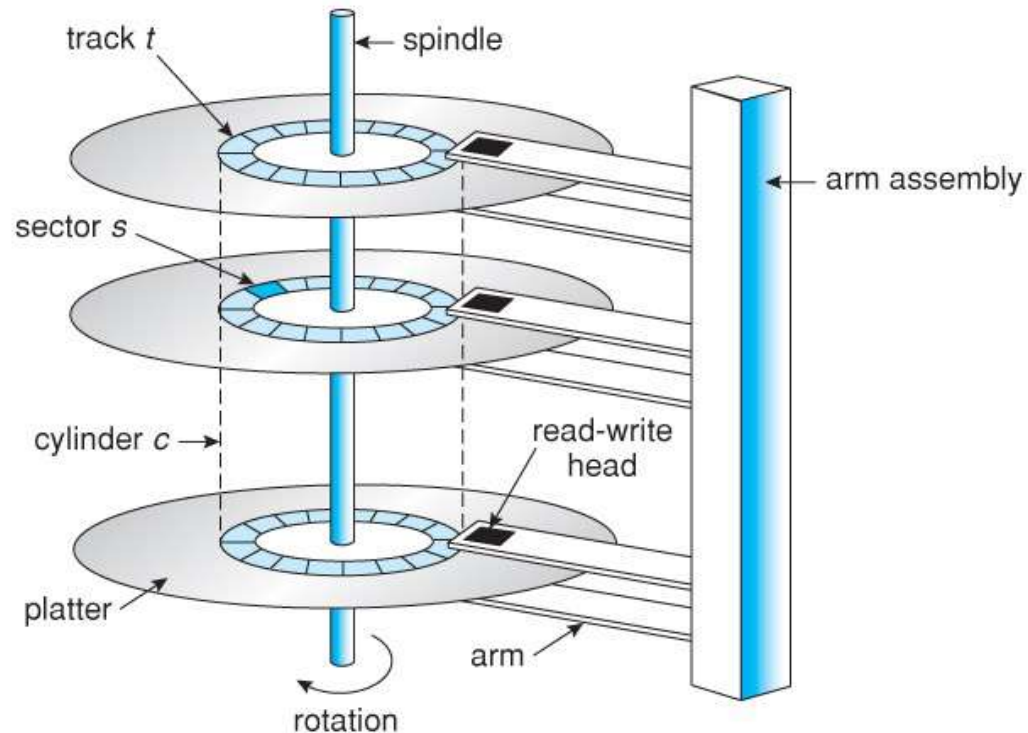
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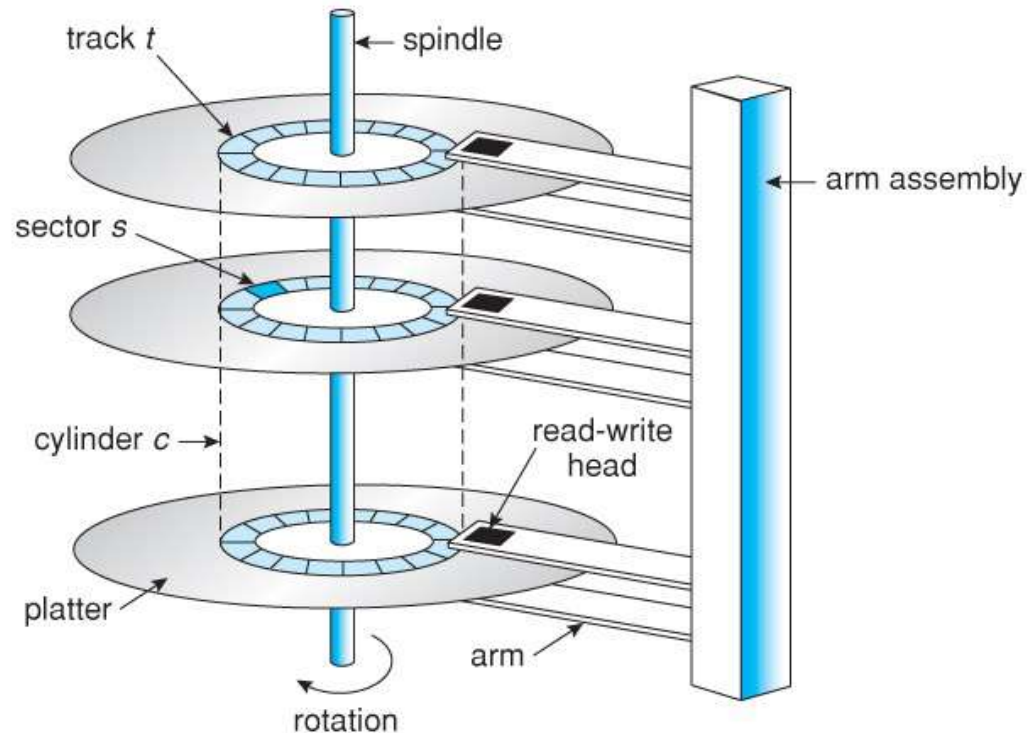
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$$C = H * T * S * B$$

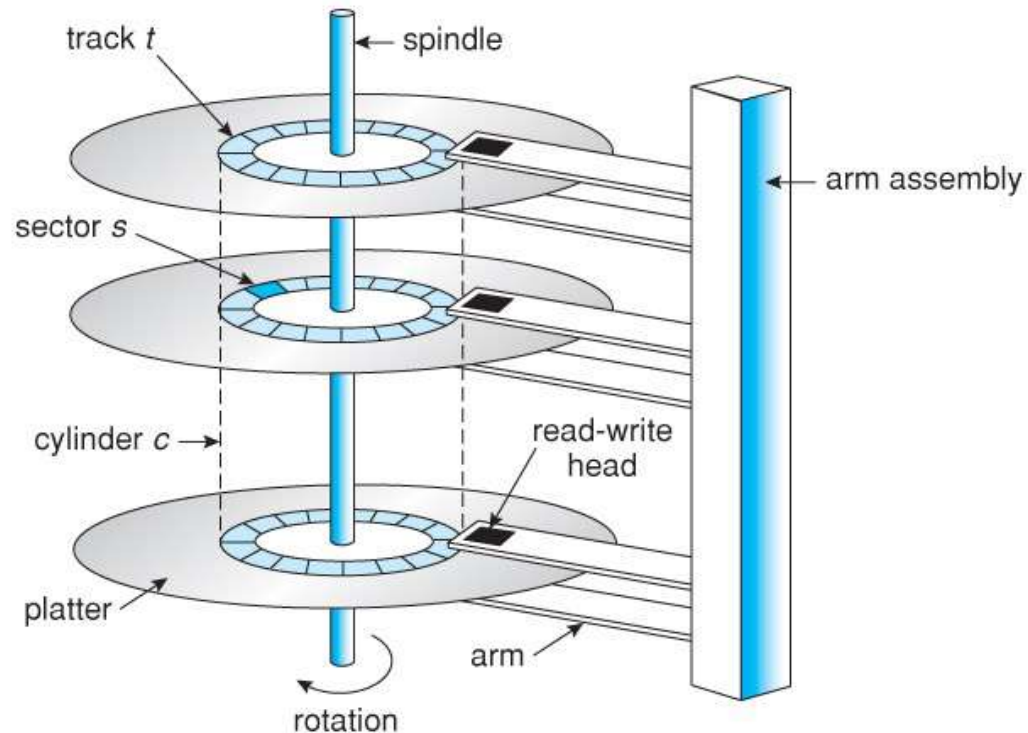
OVERALL CAPACITY

Magnetic Disks: Storage Capacity

Until the end of 1980s, every track had the same number of sectors with the same number of bits



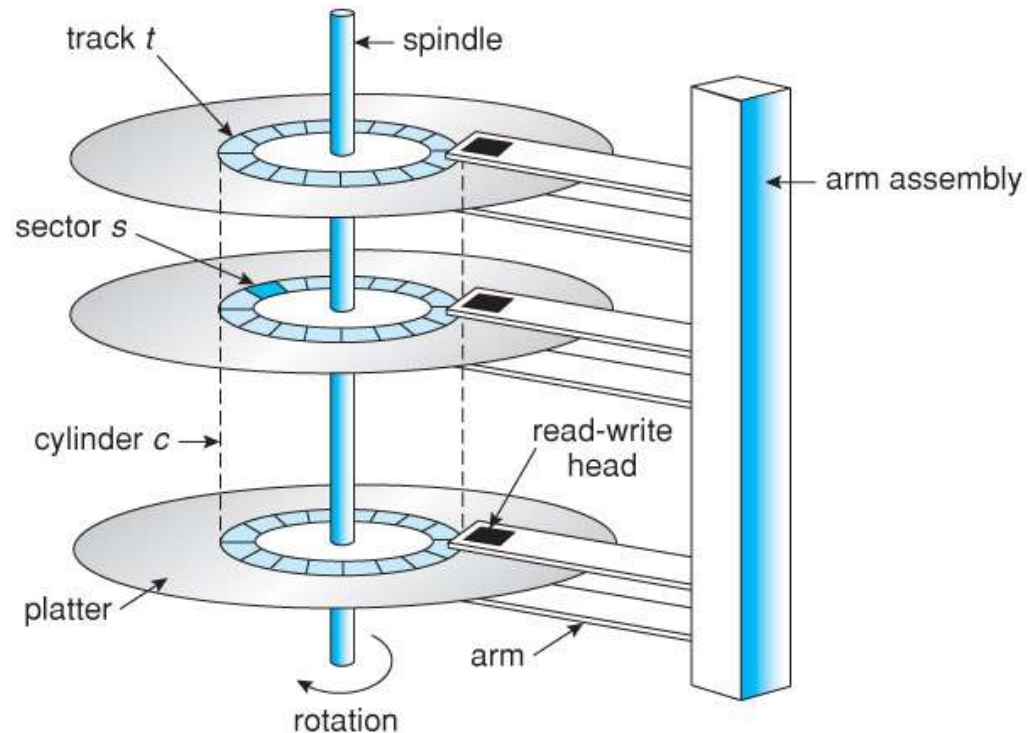
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Therefore, the bit density in the inner sectors was much higher than in the outer sectors

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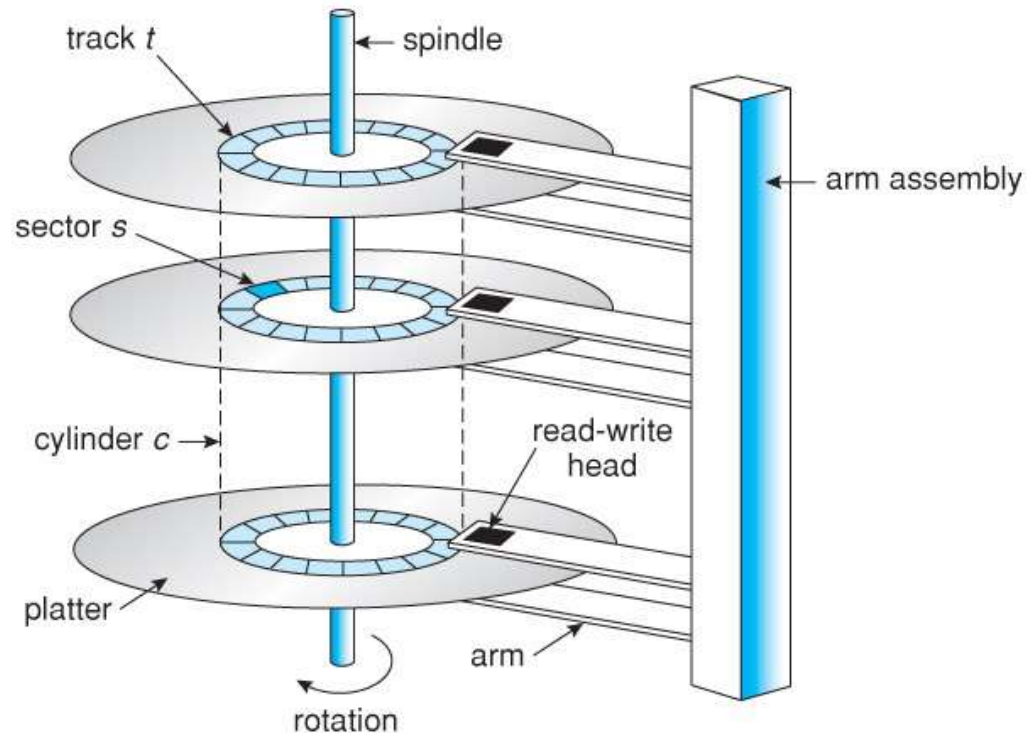


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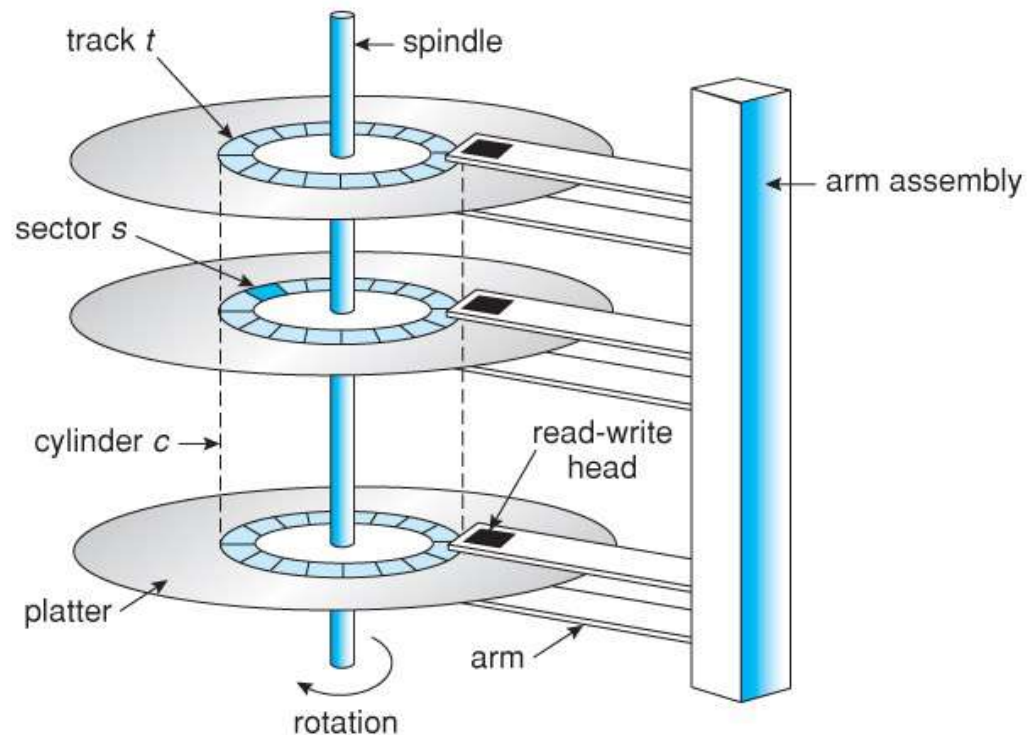
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- The capacity of the disk was determined by the maximum bit density a controller could handle

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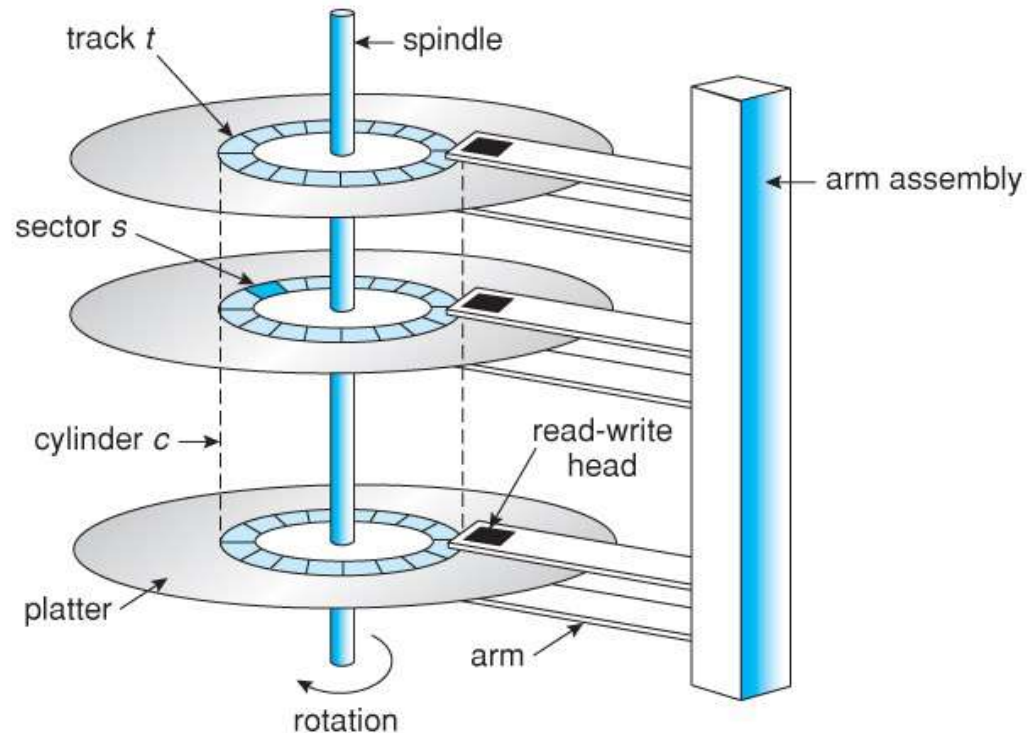
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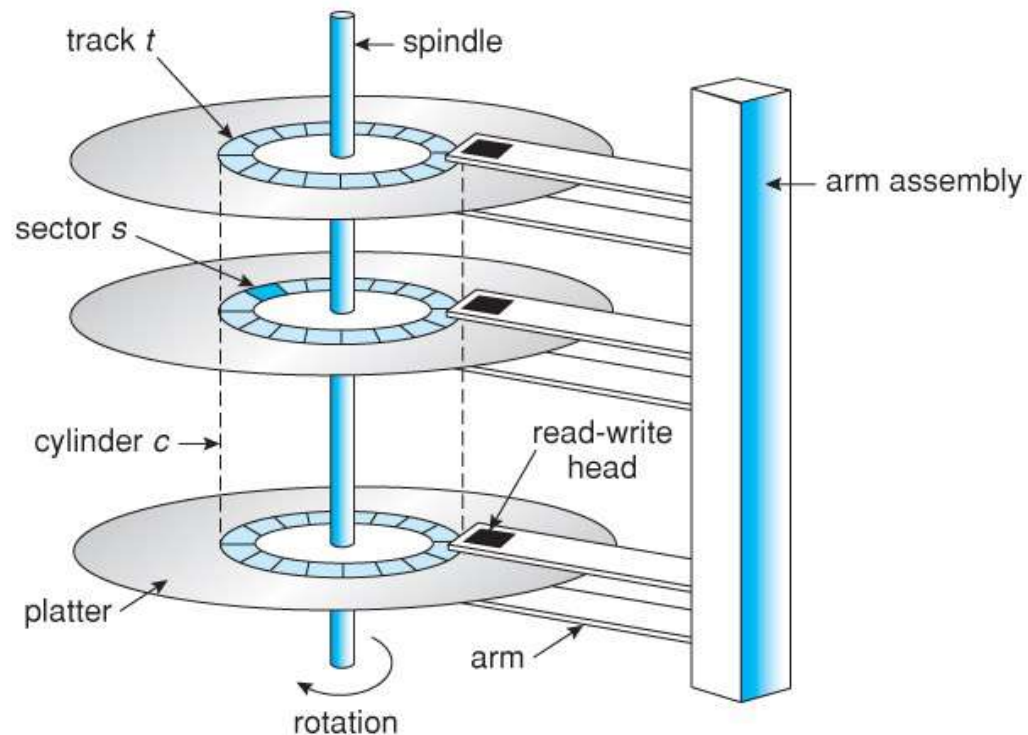
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- Different frequencies and timing from innermost to outermost tracks

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In practice, the number of sectors per track (S) varies with the **radius** of the track on the platter

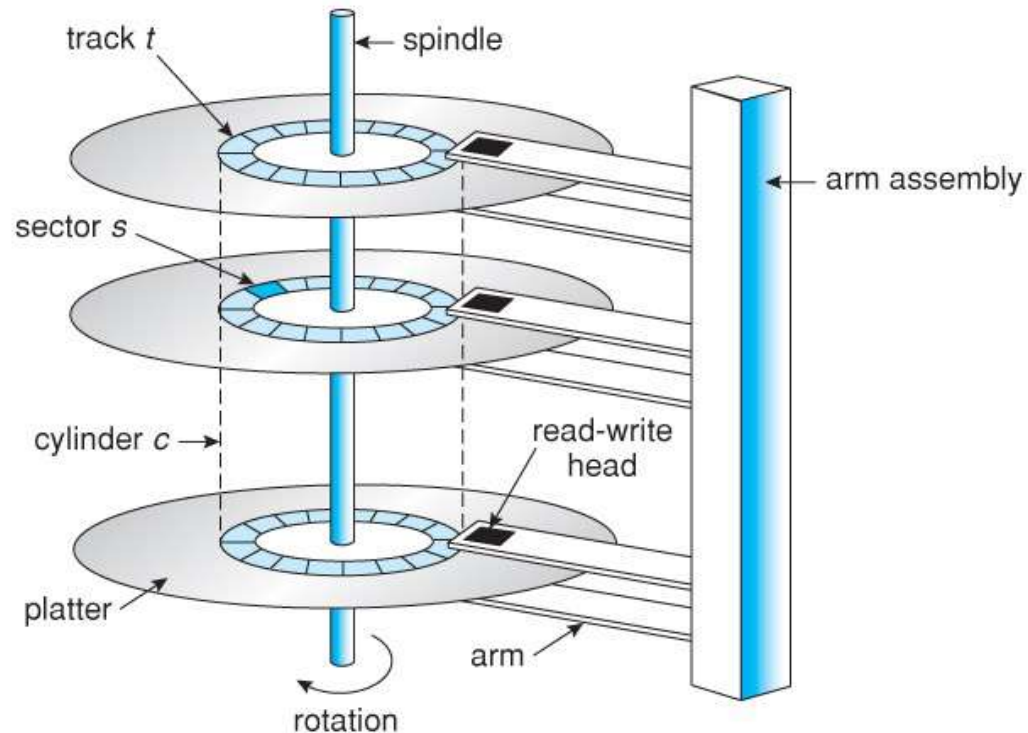
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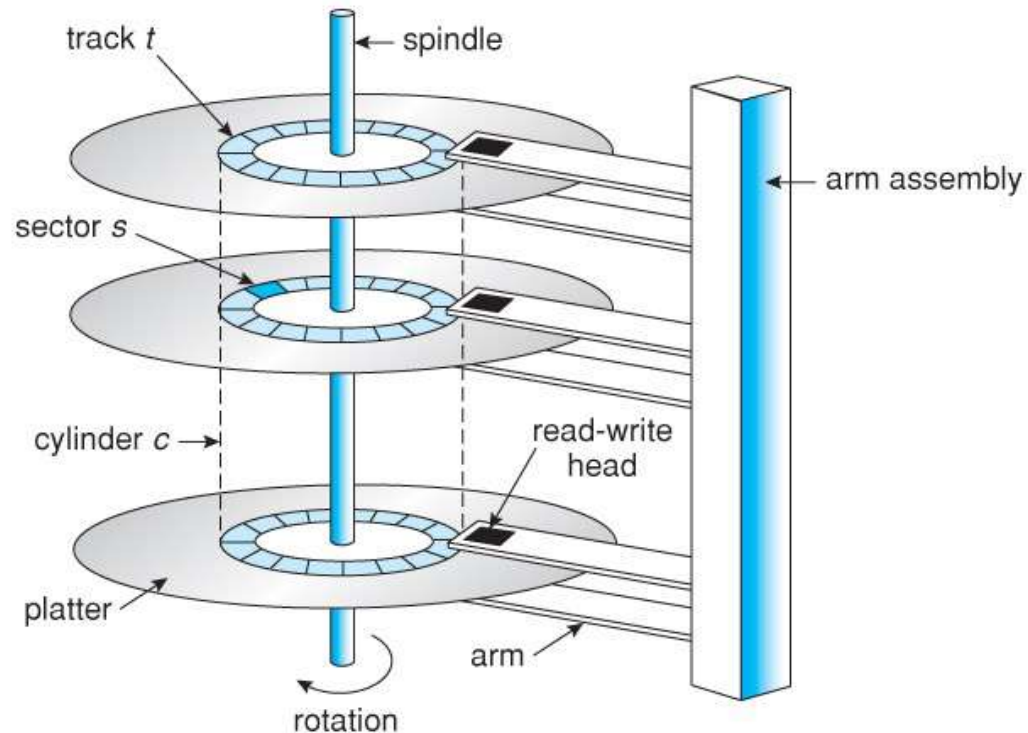


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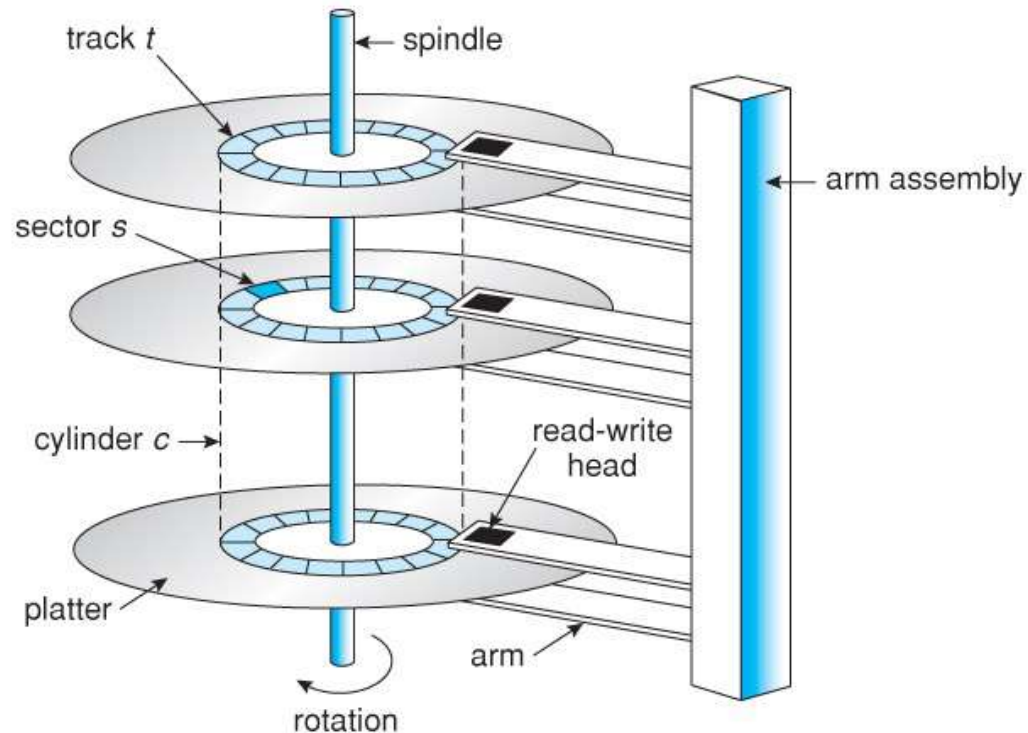
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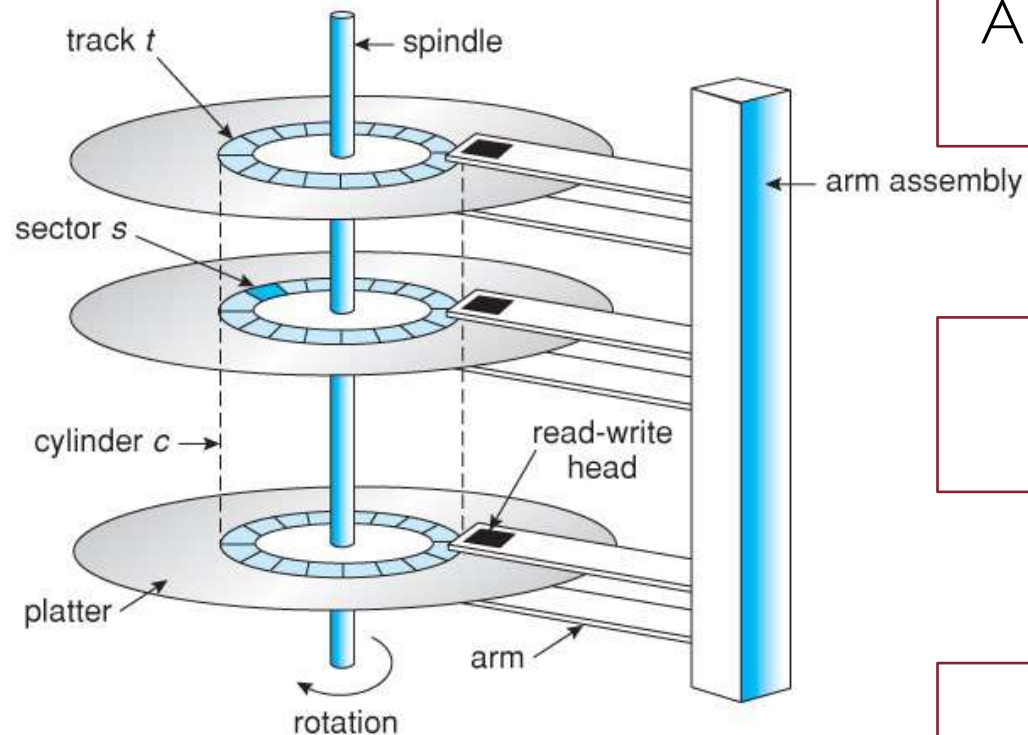
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Zone Bit Recording (ZBR)

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

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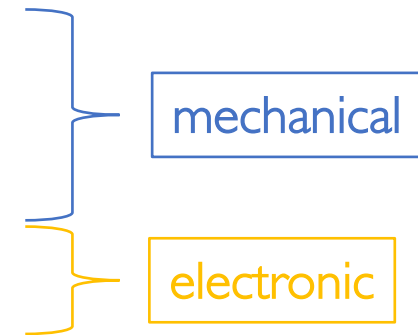
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mechanical

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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

Magnetic Disks: Structure

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- 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)

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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!