CS & IT ENGINEERING

Operating System

File System

(One Shot)

By- Vishvadeep Gothi sir

Recap of Previous Lecture

Topic Inverted Paging

Topic Hashed Page table

Topics to be Covered

- Topic: File System
- Topic: Blocks and File Allocation Methods
- Topic: Disk Scheduling
- Topic: SSTF, Scan, Look

Topic : File

A file is a named collection of related information that is recorded on secondary storage.

Topic : File Attributes

1. Name
2. Extension
3. Size
4. Date
5. Author
6. Created, Modified, Accessed
7. Attributes: Read-only, hidden
8. Default Program
9. Security Details

Topic : File Directory

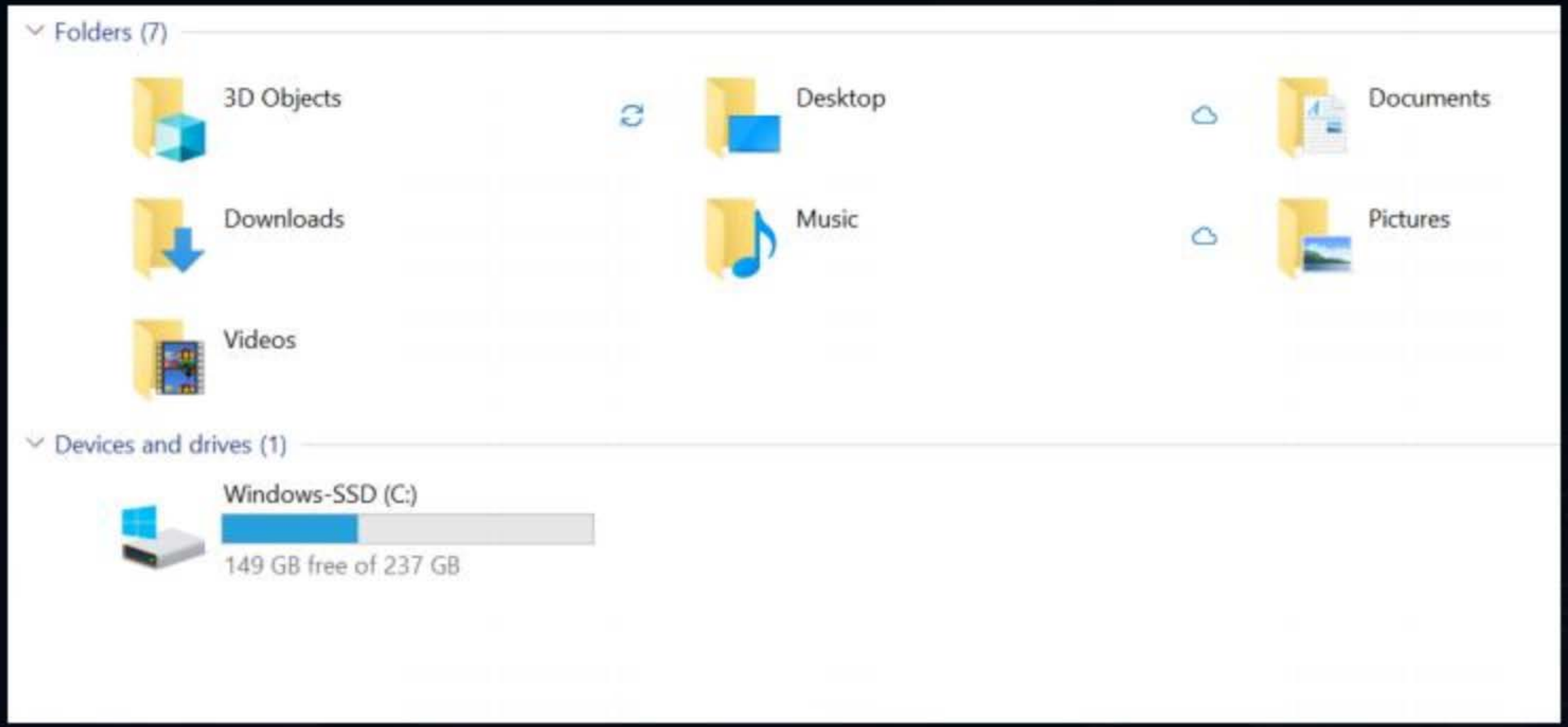
folder

Collection of files

Topic : File System

Module of OS which manages, controls and organizes files and related structures

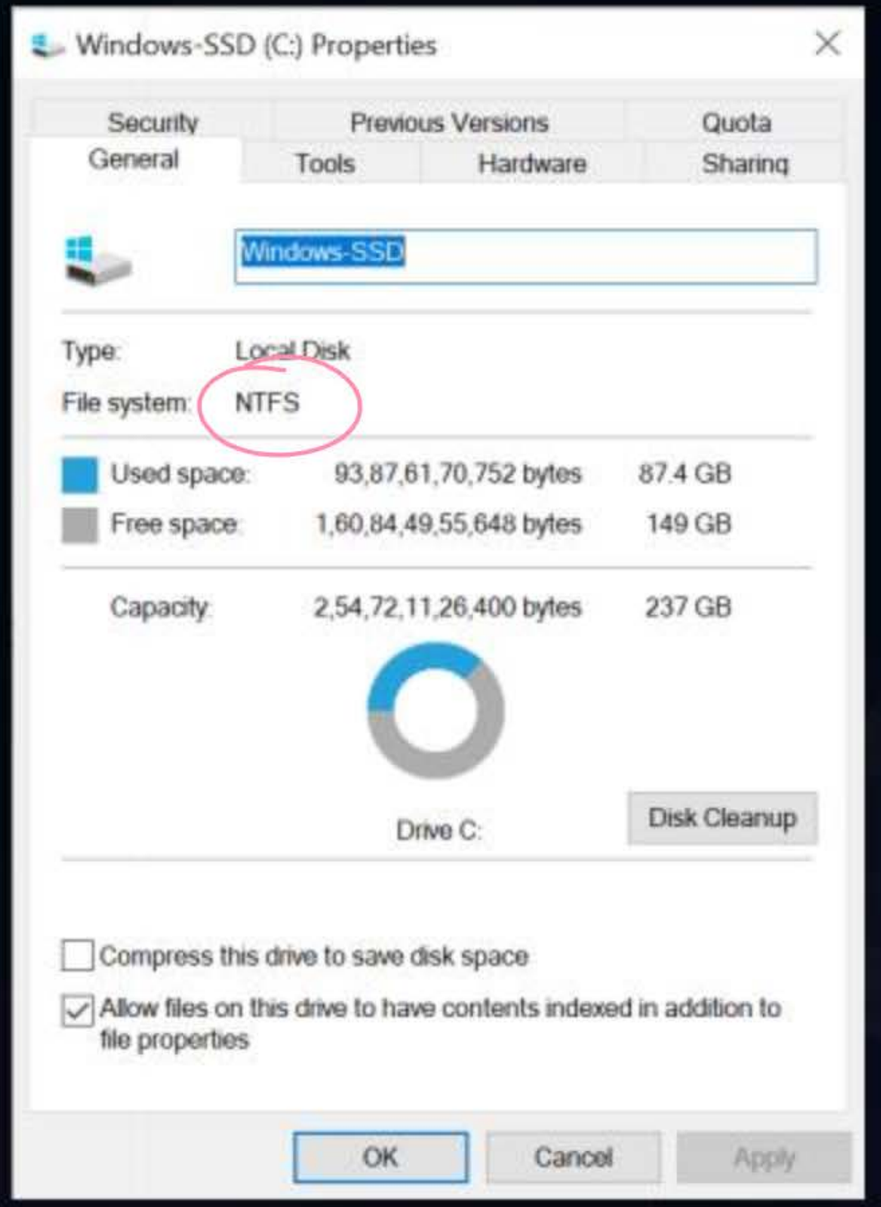
Topic : File System



Topic : Types of File Systems

1. FAT32
2. NTFS → windows
3. HFS+ → iOS or macOS
4. Ext2 / Ext3 / Ext4 → linux / unix
5. Swap

Topic : File System



Topic : Disk Formatting

Low level formatting (physical)

creating tracks and sectors on disk.

Done by manufacturer

High level formatting (logical)

⇒ creating drives (partitions) on disk like C:\ E:\ F:\

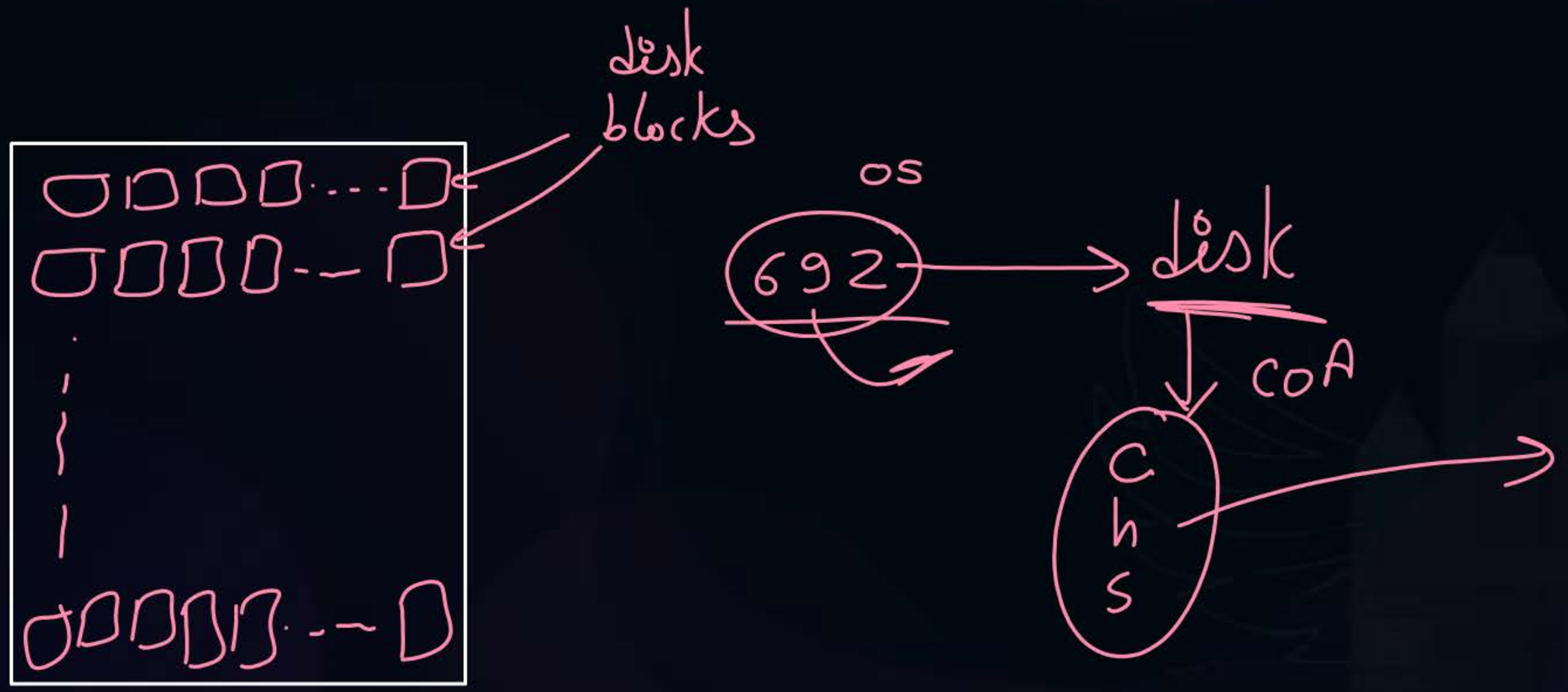
→ creating blocks.

⇒ 2 types of partitions

- Primary → OS + user files
- extended → user files

Topic : Disk Blocks

smallest logical unit of disk (1 sector ⇒ 1 block)



Topic : Disk Blocks

Number of disk blocks = 2^{16}

Size of each block = 1KB

Total Size of disk?

$\Rightarrow$ Disk block address (D.B.A.) = 16 bits

$2^{16} * 1KB = 2^{26} B = 64MB$

Topic : Disk Blocks

Disk block address= 24-bits $\Rightarrow$ no. of blocks $= 2^{24}$

Size of each block = 2KB

Total Size of disk? $= 2^{24} * 2KB = 2^{35} B = 32 GB$

Topic : Disk Blocks

Total disk size = 256GB

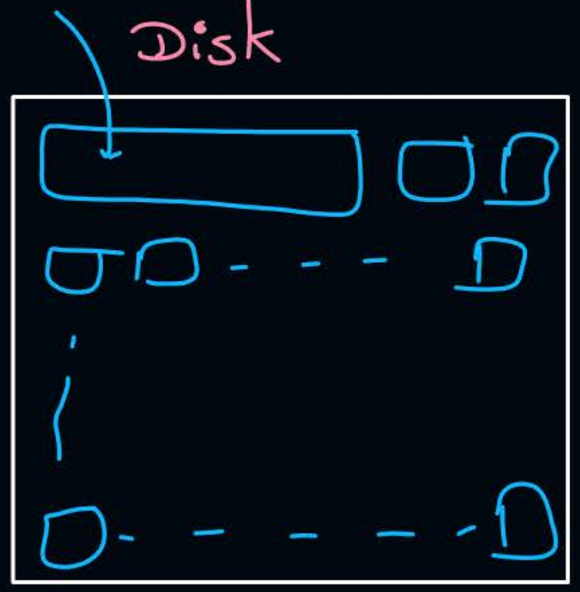
Block Size = 2KB

Disk block address?

$$\text{no. of blocks} = \frac{256\,GB}{2\,KB} = \frac{2^{38}}{2^{11}} = 2^{27}$$

$$D.B.A. = 27 \text{ bits}$$

some blocks are used to store file directory info^n



↓

which file stored where and how

ex:-

A disk has 256 blocks each of size 2KB. starting 10 blocks are used for storing directory entries.

Max size of disk remaining to store files ?

Soln blocks remaining for file = 256 − 10

= 246

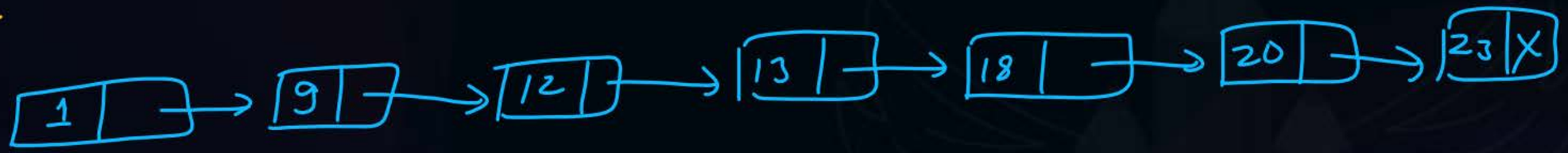
Size for file = 246 * 2KB = 492 KB

Topic : Free Space Management

1. Free List (linked list of block numbers of all free blocks)
2. Bitmap Method (one bit per block)

esc:- blocks 1, 9, 12, 13, 18, 20, 23 free

free list:-



Bitmap:- { 0 ⇒ occupied
1 ⇒ free

Block add starts from 0 ⇒ 0100000001001100001010 01

Topic : Free Space Management

1. No searching in free list, but in bitmap we search for first free block
2. Free list is faster in allocating a free block
3. Free list size is variable, where as bitmap size is constant

Topic : Question

A particular disk unit uses a bit string to record the occupancy or vacancy of its disk blocks with '0' denoting vacant block and '1' denoting occupied block. A 32-bit part of this string has Hexadecimal value of A3D4B055. The percentage of occupied blocks on the disk for this part is ?

1010	0011	1101	0100	1011	0000	0101	0101
2	2	3	1	3	0	2	2

$$\frac{15}{32} * 100\% = 46.875\%$$

Ques) A disk has block size = 2kB

no of blocks = 2^{24}

no. of blocks needed to store bitmap for free blocks = 1024 ?

Soln

no. of bits in bitmap = no. of blocks

$= 2^{24}$ bits

$= 16M$ bits

no. of blocks = $\frac{16M \text{ bits}}{2KB}$

$= \frac{2MB}{2KB}$

$= 1K$

$= 1024$

Topic : File Allocation Method

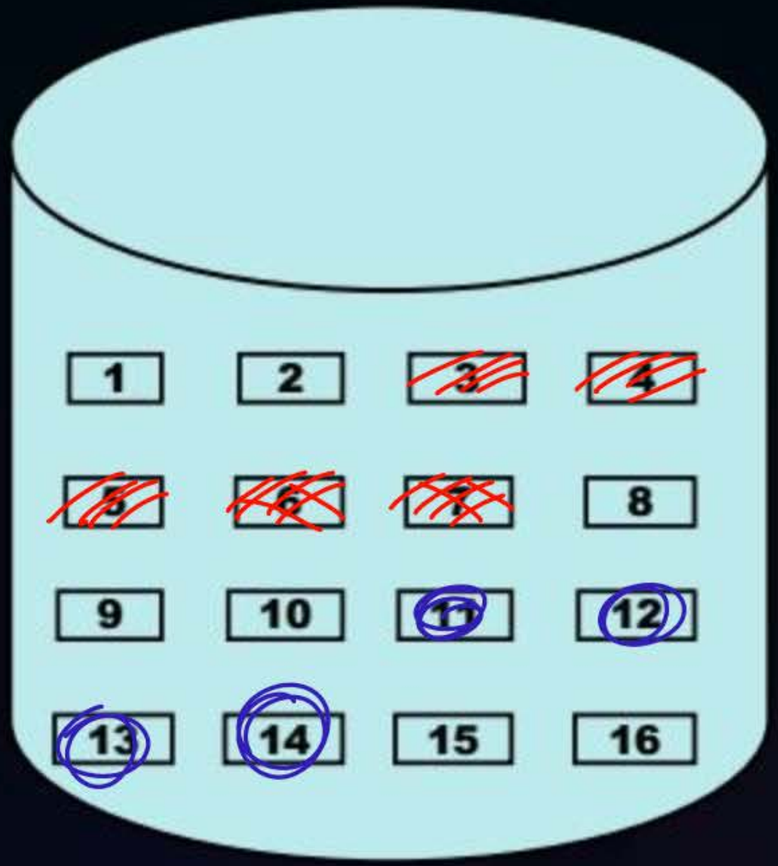
describes which disk blocks to be allocated to a file.

Topic : File Allocation Method

1. Contiguous Allocation
2. Linked Allocation
3. Indexed Allocation

Topic : Contiguous Allocation

Consecutive blocks are used to store file



file allocation

file name	starting block no.	no. of blocks
os.pdf	3	5
COA.pptx	11	4

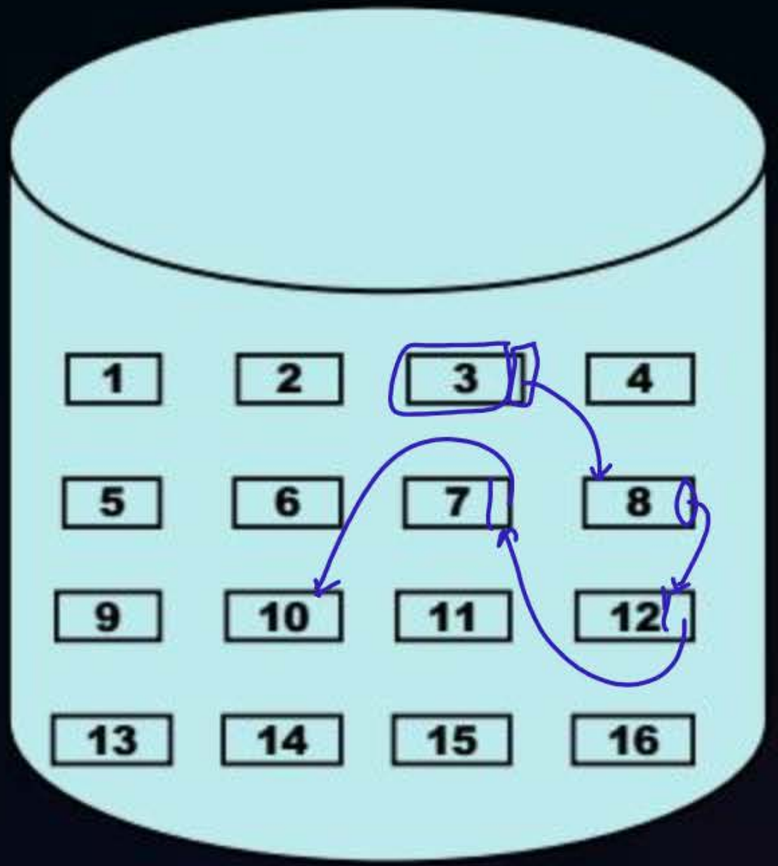
Topic : Contiguous Allocation

Performance:

1. Fragmentation: Internal, External
2. Increase in File size: Inflexible
3. Type of access: Sequential, Random/direct

Insertion of a new block in file at	no. of block accesses
Beginning	many block accesses needed
Middle	——— 11 ———
End	easy and lesser block accesses

Topic : Linked Allocation



file name	starting block no.	last block no	no. of blocks
CoA. pptx	3	10	5

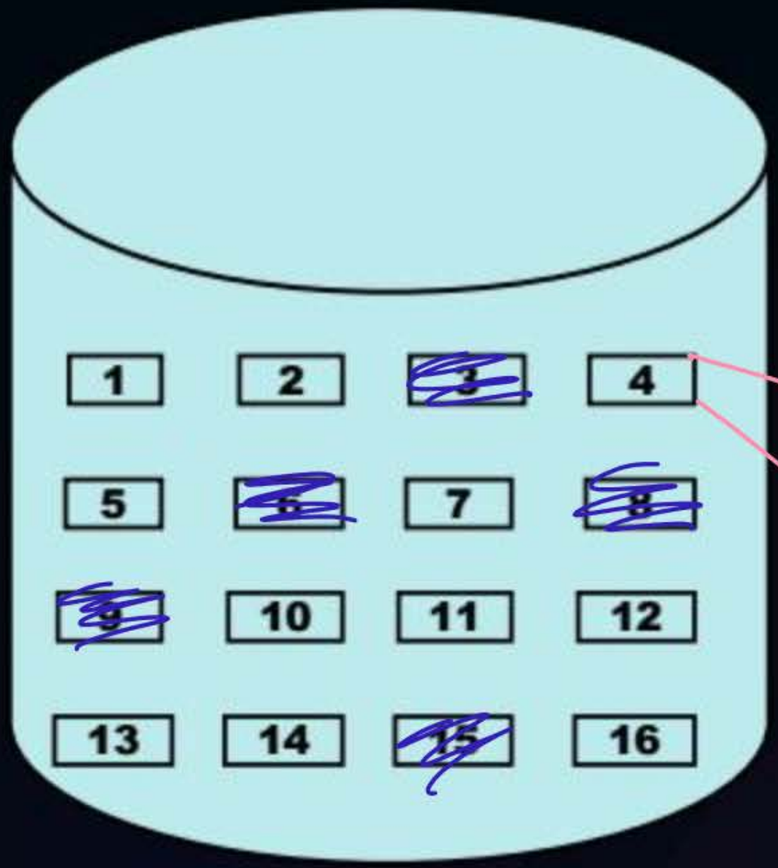
Topic : Linked Allocation

Performance:

1. Fragmentation: Internal
2. Increase in File size: Flexible
3. Type of access: Sequential

Insertion of a new block in file at	no. of blocks accessed
Beginning	very less
Middle	more (as traversal needed)
End	more (— 〃 —)

Topic : Indexed Allocation



Allocation table

file name	Index block no.
CoA.pptx	4

Indesc block

6
9
3
8

Topic : Indexed Allocation

Performance:

1. Fragmentation: Internal
2. Increase in File size: Flexible
3. Type of access: Sequential, Random/direct

If file is very big then use multilevel indexing

Insertion of a new block in file at	no. of block accesses
Beginning	very less
Middle	-11-
End	-11-

Topic : Question

H. W.

[GATE-2022]

#Q. Consider two files systems A and B , that use contiguous allocation and linked allocation, respectively. A file of size 100 blocks is already stored in A and also in B. Now, consider inserting a new block in the middle of the file (between 50^{th} and 51^{st} block), whose data is already available in the memory. Assume that there are enough free blocks at the end of the file and that the file control blocks are already in memory. Let the number of disk accesses required to insert a block in the middle of the file in A and B are n_A and n_B respectively, then the value of $n_A + n_B$ is_____?

Topic : Question

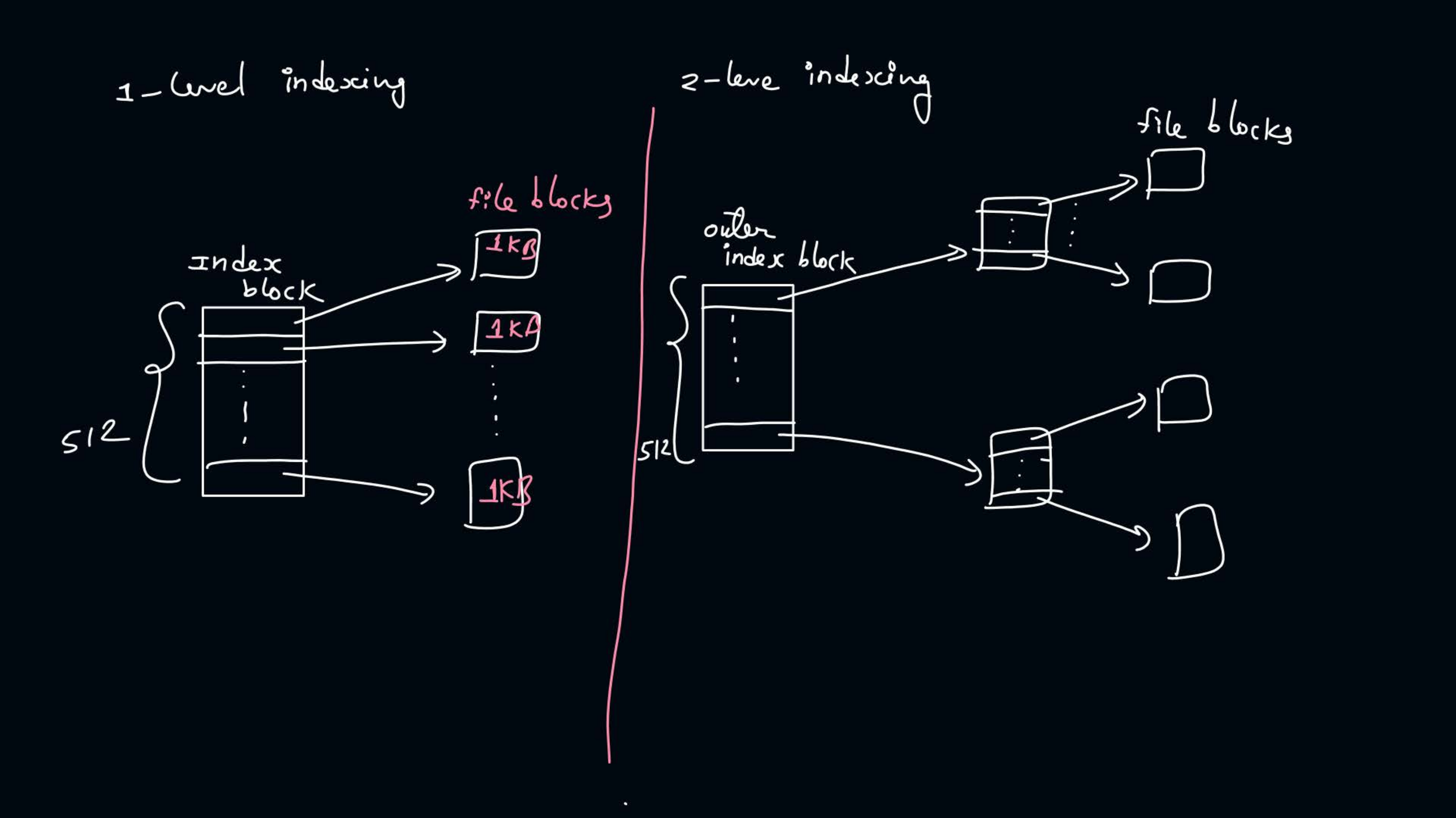
- Disk block address = 16 bits = 2B
- Disk block size = 1KB
- Index block = 1KB
- Maximum file size? (single level indexing)

no. of disk block numbers per block = $\frac{1KB}{2B}$

$= 512$

max file size = $512 * 1KB$

$= 512KB$


1-Level indexing
file blocks
index block
1KB
1KB
1KB
512
2-leve indexing
file blocks
outer index block
512

Topic : Question

- Disk block address = 16 bits = 2B
- Disk block size = 1KB
- Index block = 1KB
- Maximum file size? (double level indexing)

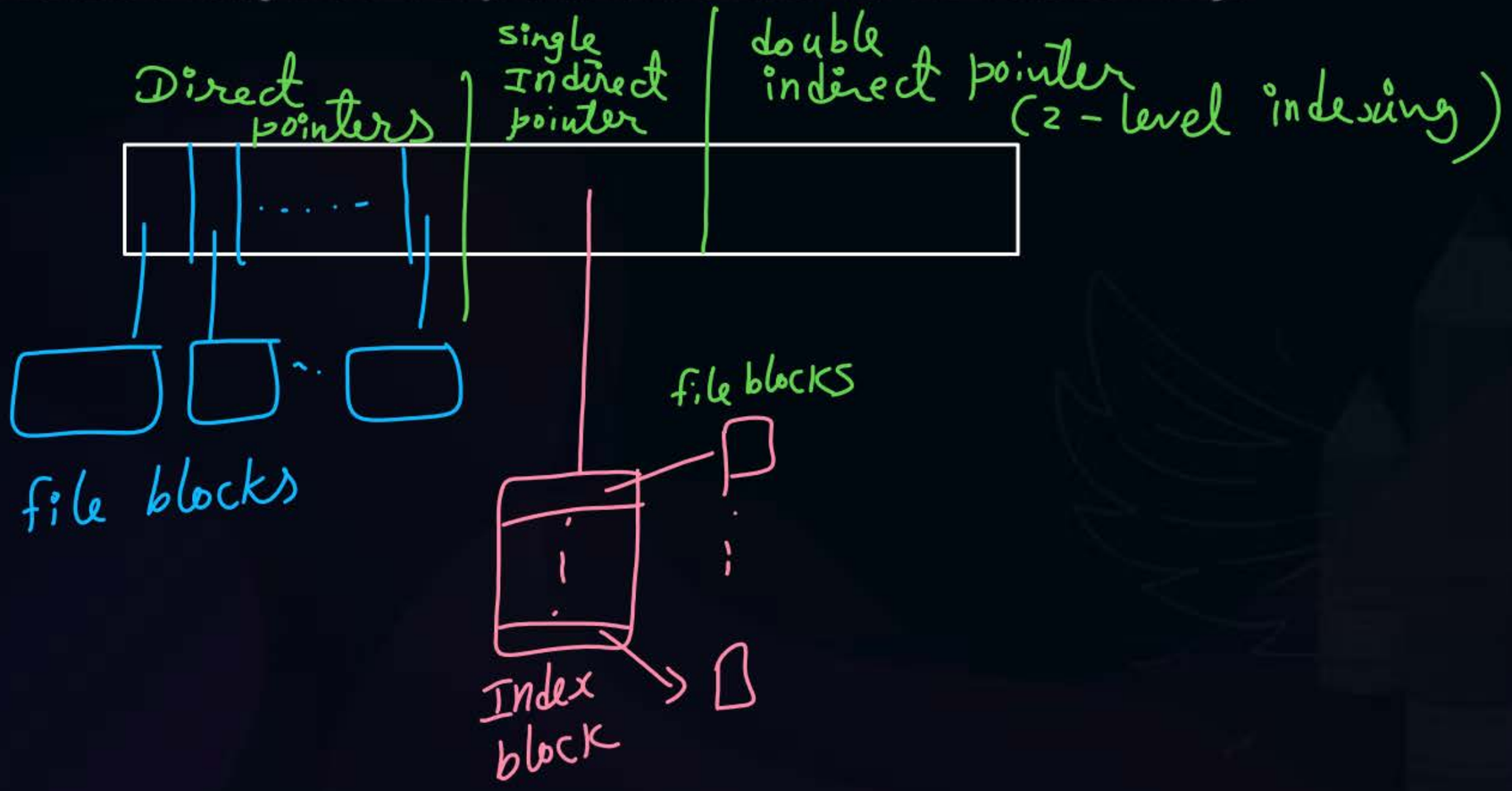
no. of disk block numbers per block = $\frac{1KB}{2B}$

$= 512 = 2^9$

max file size $= 2^9 * 2^9 * 1KB = 256MB$

Topic : Unix I-node Structure

The inode (index node) is a data structure in a Unix-style file system that describes a file-system object such as a file or a directory.



Topic : Unix I-node Structure

The inode (index node) is a data structure in a Unix-style file system that describes a file-system object such as a file or a directory.

- Each inode stores the attributes and disk block locations of the object's data.
- The number of Inode limits the total number of files/directories that can be stored in the file system.

Topic : Question

[GATE-2019]

#Q. The index node (inode) of a Unix-like file system has 12 direct, one single-indirect and one double-indirect pointer The disk block size is 4 kB, and the disk block addresses 32-bits long. The maximum possible file size is (rounded off to 1 decimal place) ___4.0___ GB?

4B

no. of indexes per block $= \frac{4KB}{4B} = 1k$

max file size $= (12 * 4KB) + (1K * 4KB) + (1K * 1K * 4KB)$

$= 48KB + 4MB + 4GB$

$\simeq 4.004048\,GB = 4.0GB$

Topic : Question

14.03.

[GATE-2005]

#Q. In a computer system, four files of size 11050 bytes, 4990 bytes, 5170 bytes and 12640 bytes need to be stored. For storing these files on disk, we can use either 100 byte disk blocks or 200 byte disk blocks (but can't mix block sizes). For each block used to store a file, 4 bytes of bookkeeping information also needs to be stored on the disk. Thus, the total space used to store a file is the sum of the space taken to store the file and the space taken to store the book keeping information for the blocks allocated for storing the file. A disk block can store either bookkeeping information for a file or data from a file, but not both.

What is the total space required for storing the files using 100 byte disk blocks and 200 byte disk blocks respectively?

A 35400 and 35800 bytes

B 35800 and 35400 bytes

C 35600 and 35400 bytes

D 35400 and 35600 bytes

Topic : Solution

File Size	No. of blocks to store file	No. of blocks to store bookkeeping	Total blocks	Total Size
11050 Bytes				
4990 Bytes				
5170 Bytes				
12640 Bytes				

Topic : Solution

File Size	No. of blocks to store file	No. of blocks to store bookkeeping	Total blocks	Total Size
11050 Bytes				
4990 Bytes				
5170 Bytes				
12640 Bytes				

2 mins Summary

Topic File System

Topic Blocks and File Allocation Methods

Topic Disk Scheduling

Topic SSTF, Scan, Look

Happy Learning

THANK - YOU