

OPERATING SYSTEMS

File Management

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Implementing File-Systems – Disk Space Allocation Methods

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Slides Credits for all the PPTs of this course



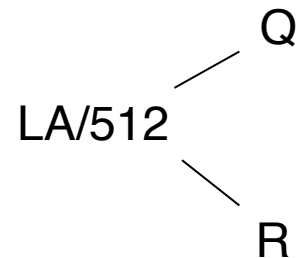
- The slides/diagrams in this course are an **adaptation, combination,** and **enhancement** of material from the following resources and persons:
 1. Slides of Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne - 9th edition 2013 and some slides from 10th edition 2018
 2. Some conceptual text and diagram from Operating Systems - Internals and Design Principles, William Stallings, 9th edition 2018
 3. Some presentation transcripts from A. Frank – P. Weisberg
 4. Some conceptual text from Operating Systems: Three Easy Pieces, Remzi Arpaci-Dusseau, Andrea Arpaci Dusseau

- ❑ An allocation method refers to how disk blocks are allocated for files:
- ❑ **Contiguous allocation** – each file occupies set of contiguous blocks
 - ❑ Best performance in most cases
 - ❑ Simple – only starting location (block #) and length (number of blocks) are required
 - ❑ Supports both sequential and direct access
 - ❑ Problems include finding space for file, knowing file size, external fragmentation, need for **compaction off-line** (**downtime**) or **on-line**

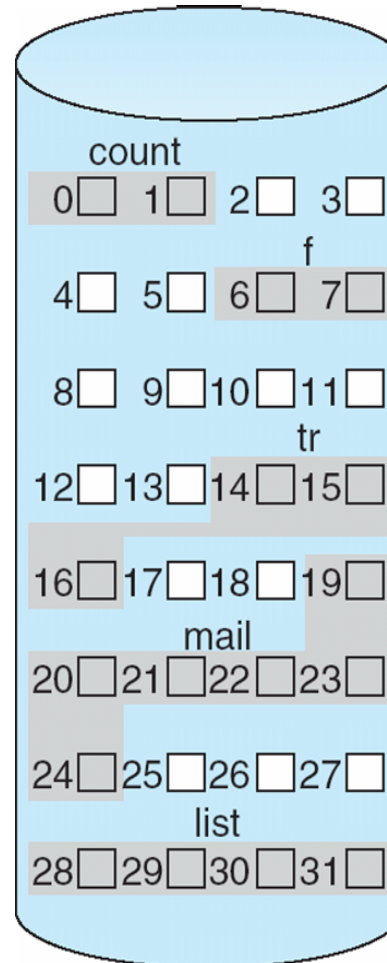
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Contiguous Allocation

? Mapping from logical to physical



- LA – Length of the area allocated for this file
- Q = displacement into index table
- Block to be accessed = Q + starting address
- Displacement into block = R



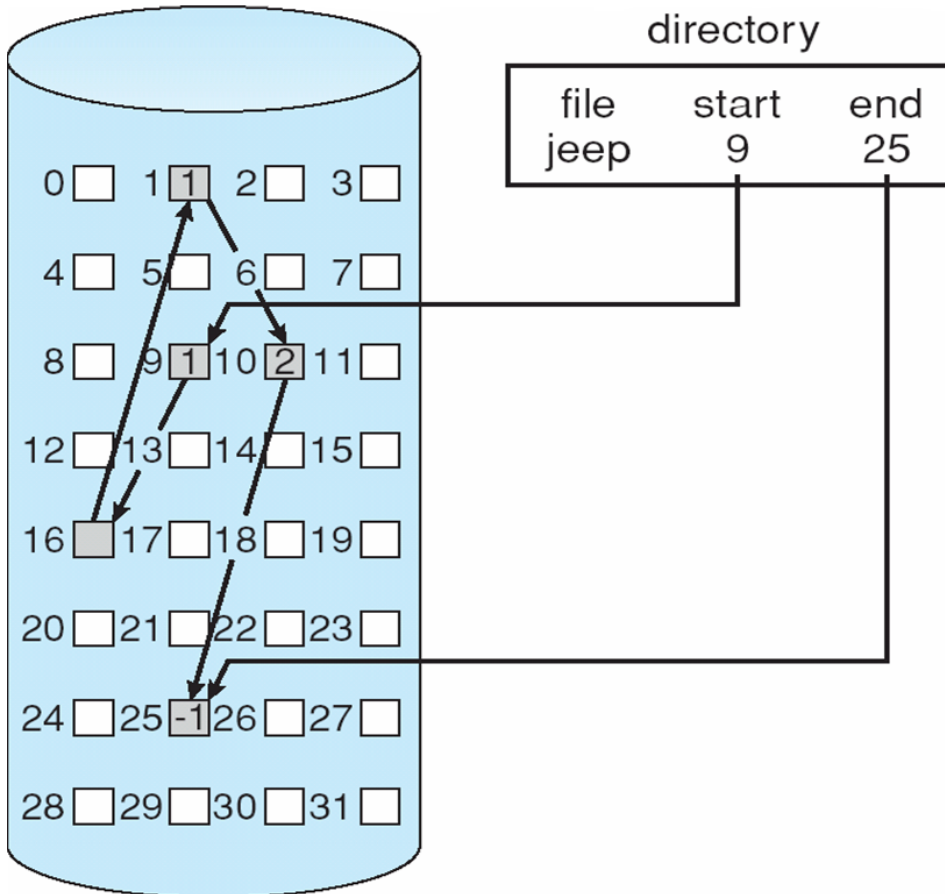
directory

file	start	length
count	0	2
tr	14	3
mail	19	6
list	28	4
f	6	2

- ❑ Many newer file systems (i.e., Veritas File System) use a modified contiguous allocation scheme
- ❑ Extent-based file systems allocate disk blocks in extents
- ❑ An **extent** is a contiguous block of disks
 - ❑ Extents are allocated for file allocation
 - ❑ A file consists of one or more extents

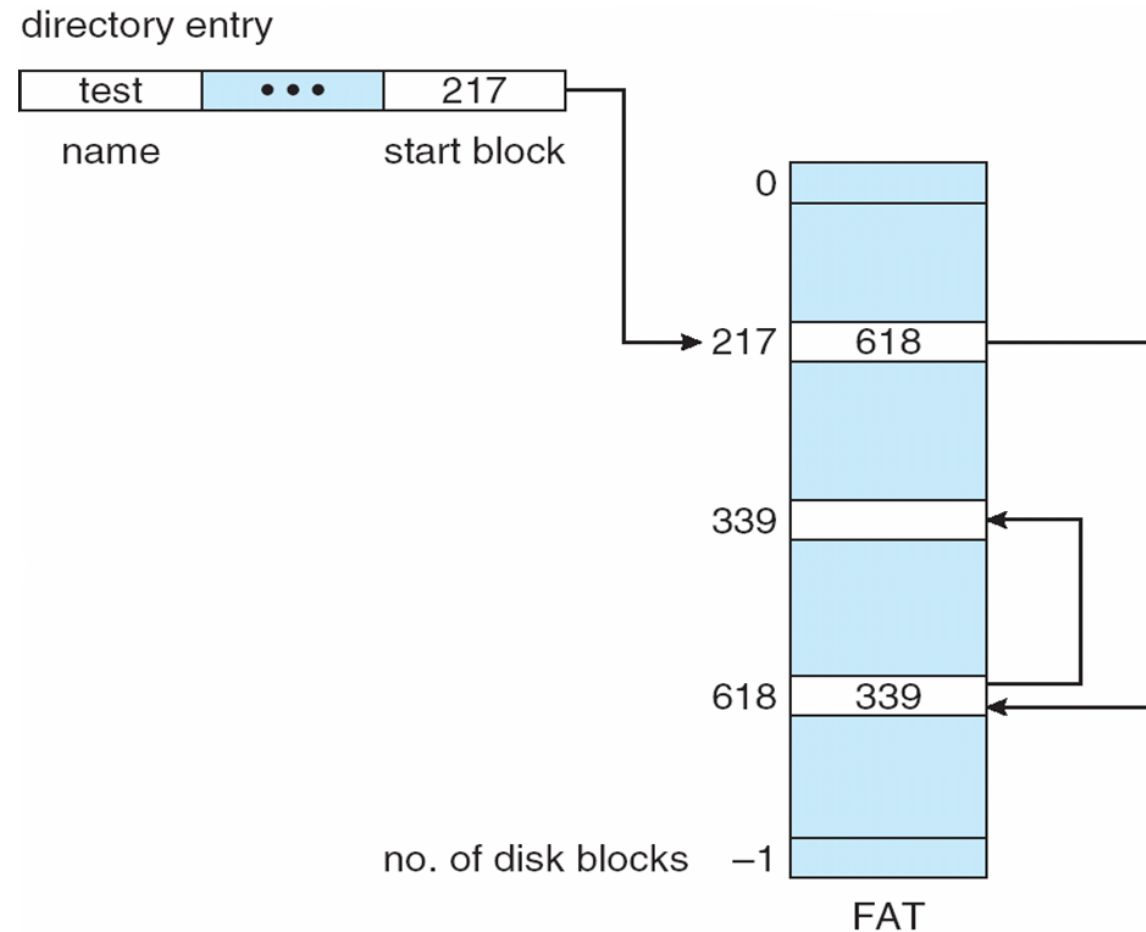
- ❑ **Linked allocation** – each file a linked list of blocks
 - ❑ File ends with null pointer
 - ❑ No external fragmentation
 - ❑ Each block contains pointer to next block
 - ❑ No compaction, external fragmentation
 - ❑ Free space management system called when new block needed
 - ❑ Improve efficiency by clustering blocks into groups but increases internal fragmentation
 - ❑ Reliability can be a problem
 - ❑ Locating a block can take many I/Os and disk seeks

- ❑ FAT (File Allocation Table) variation
 - ❑ Beginning of volume has table, indexed by block number
 - ❑ Much like a linked list, but faster on disk and cacheable
 - ❑ New block allocation simple



- Each block contains a pointer to the next block.
- If each block is 512 bytes and a disk address (pointer) requires 4 bytes then the user sees blocks of 508 bytes (i.e. some disk space is wasted)
- Collect blocks into multiples called **clusters** and allocate clusters rather than blocks

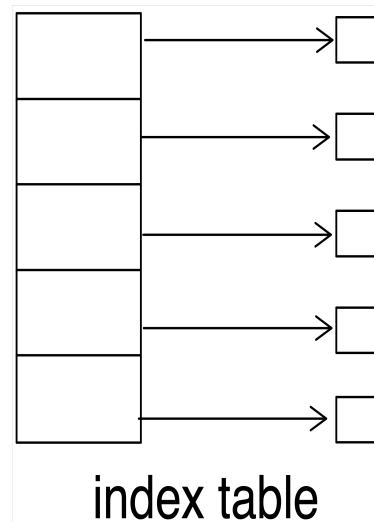
- Unused block is indicated by a table value of 0
- To allocate a new block to a file, find the first 0-valued table entry and replace the previous EOF value with the address of the new block.
- Then replace 0 with EOF value



? Indexed allocation

? Each file has its own **index block**(s) of pointers to its data blocks

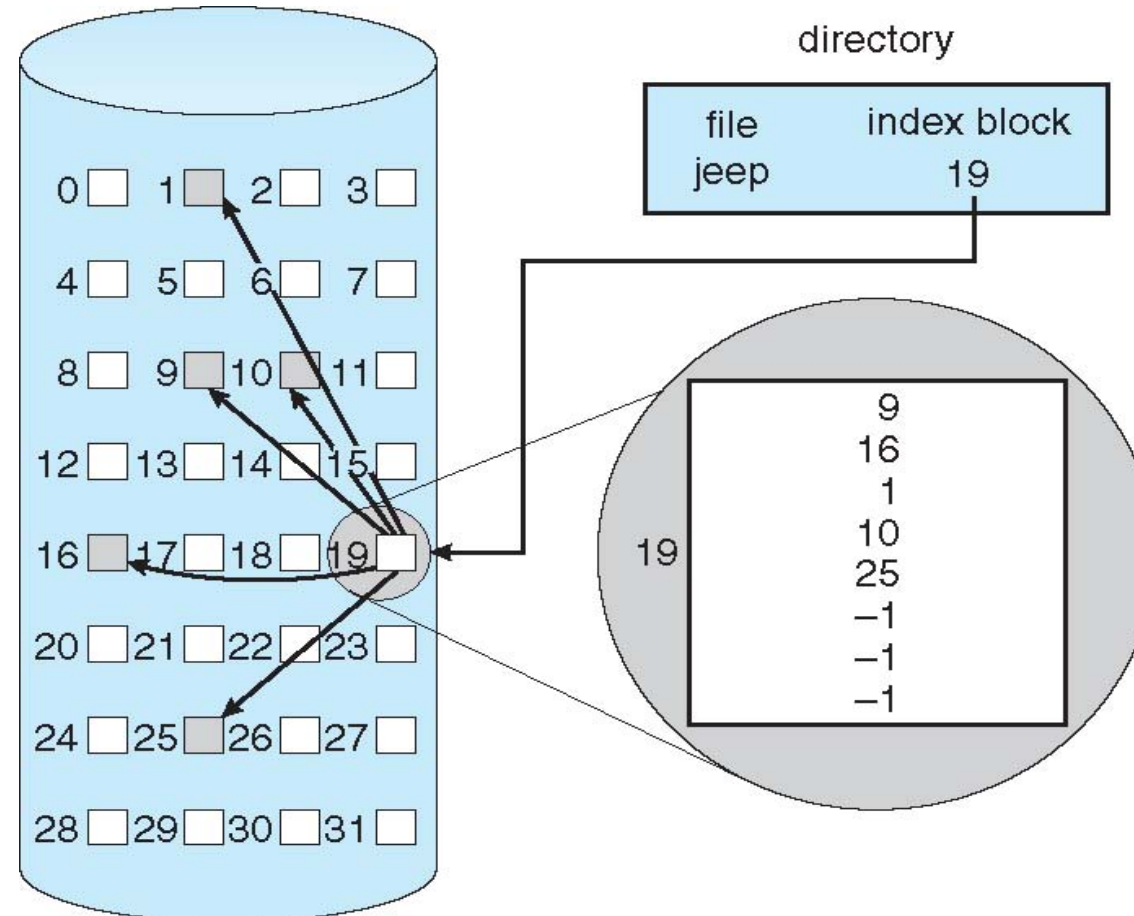
? Logical view



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Example of Indexed Allocation

- In this scheme, a special block known as the **Index block** contains the pointers to all the blocks occupied by a file.
- Each file has its own index block. The *i*th entry in the index block contains the disk address of the *i*th file block.
- The directory entry contains the address of the index block as shown in the figure.



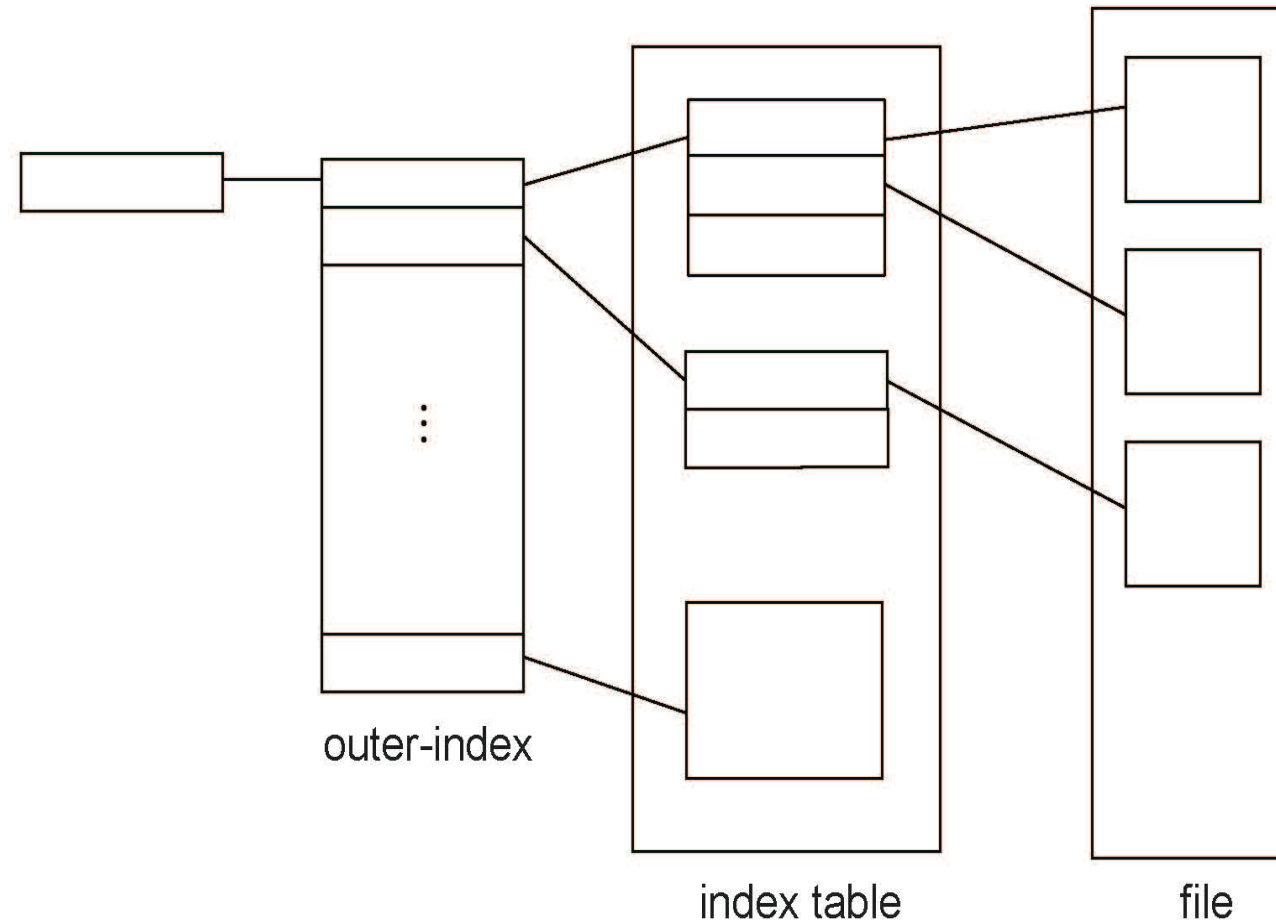
Advantages:

- This supports direct access to the blocks occupied by the file and therefore provides fast access to the file blocks.
- It overcomes the problem of external fragmentation.

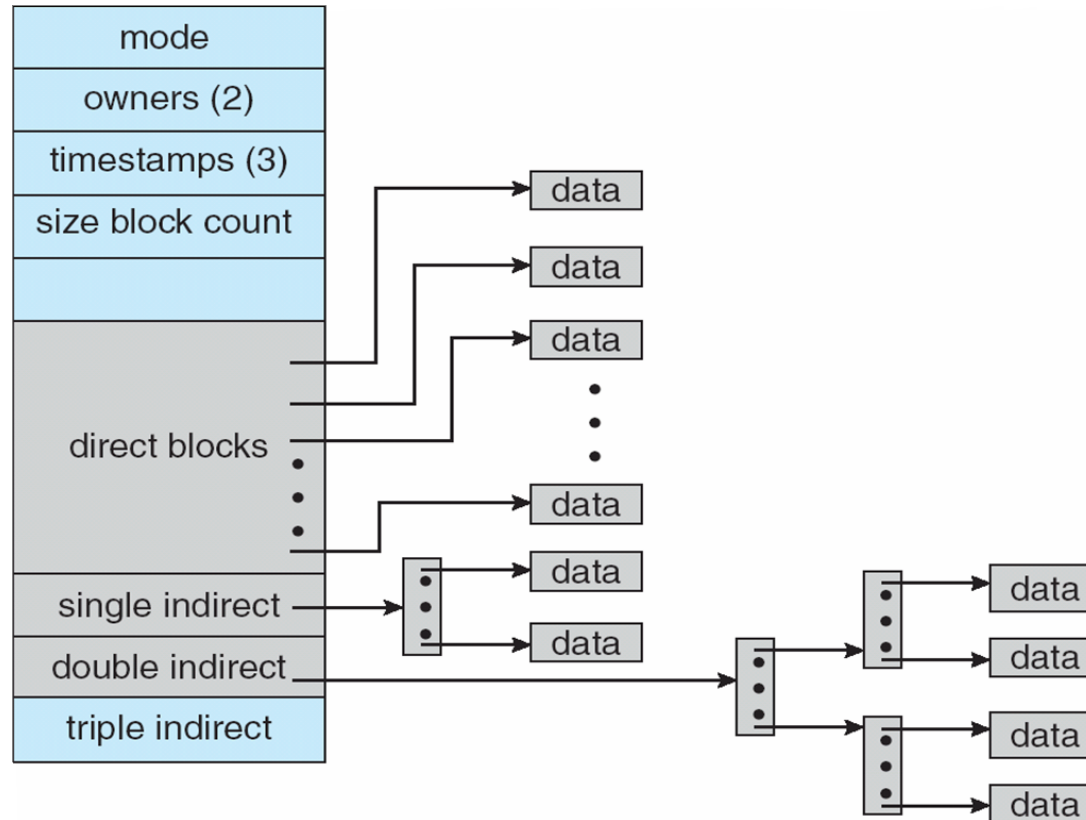
Disadvantages:

- The pointer overhead for indexed allocation is greater than linked allocation.
- For very small files, say files that expand only 2-3 blocks, the indexed allocation would keep one entire block (index block) for the pointers which is inefficient in terms of memory utilization. (Note: In linked allocation we lose the space of only 1 pointer per block.)

- For files that are very large, single index block may not be able to hold all the pointers.
- Other Schemes such as Linked scheme, Multilevel index and Combined Scheme are used.



4K bytes per block, 32-bit addresses



More index blocks than can be addressed with 32-bit file pointer

- ❑ Best method depends on file access type
 - ❑ Contiguous great for sequential and random
- ❑ Linked good for sequential, not random
- ❑ Declare access type at creation -> select either contiguous or linked
- ❑ Indexed more complex
 - ❑ Single block access could require 2 index block reads then data block read
 - ❑ Clustering can help improve throughput, reduce CPU overhead



THANK YOU

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