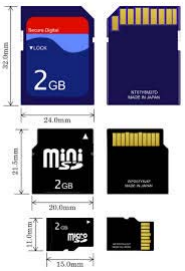
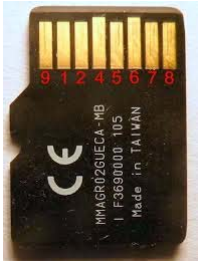
EE445M/EE380L.12
Embedded and Real-Time Systems/ Real-Time Operating Systems

Lecture 8:
Filesystems

Lab 4 File System

- Layered software architecture
  - SSI <-> SDC
  - eDisk <-> physical blocks
    - Optional DMA for transfers
  - eFile <-> logical data





Reference EE445M book, Chapter 7

Know Your problem

- Read access
  - Sequential versus random access
- Write access
  - Sequential versus random access
  - Insert/Append/Remove
  - Write once (data logger, flight recorder)
- Size, bandwidth, response time
- Reliability
- Security (fail-safe)

Know your disk

- Block size
- Disk size
- Read/write speed
- Types and chances of error
  - Wear leveling
  - Conditional probability

File System Responsibilities

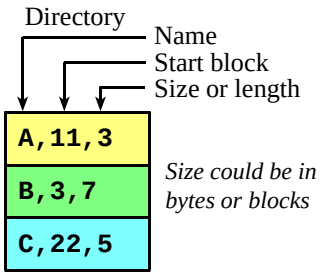
- Logical to physical translation
  - Byte number to block number
- Directory
  - File name to physical translation
- Free space
  - Used
  - Free
  - Damaged

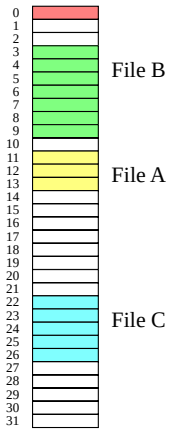
File System Performance

- File size
- Disk size
- Number of files
- Speed
  - Time to create, open, close
  - Write bandwidth
  - Read bandwidth
- Fragmentation
  - External if max file size < total free space

File System Allocation (1)

- Contiguous allocation
  - First fit
  - Best fit
  - Worst fit



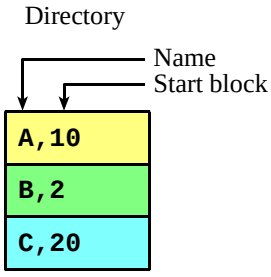


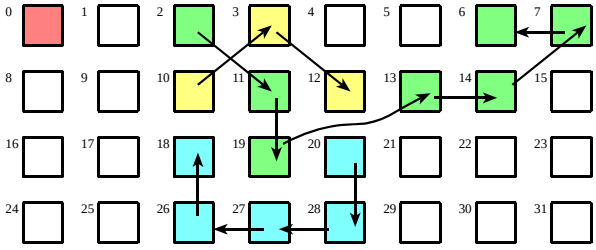
Good for sequential write, never erase
Fast random read access

Internal fragmentation: on average, each file wastes 1/2 block
External fragmentation: largest file size to allocate < free space

File System Allocation (2)

- Linked allocation



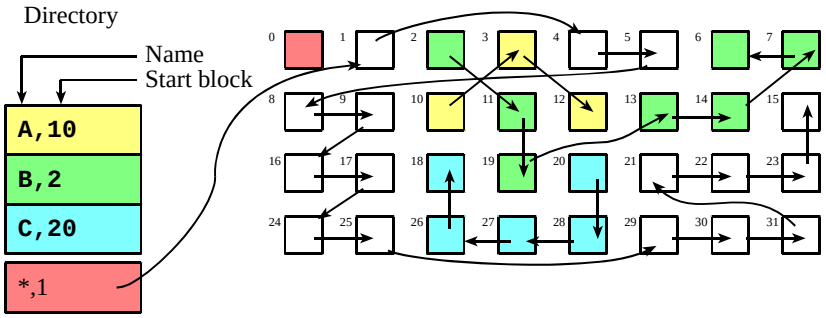


Each block has a link and a size

Good for erase, append, delete
Slow for random access
Internal fragmentation: on average, each file wastes 1/2 block
No external fragmentation

Free Space Management

- Linked allocation of free space

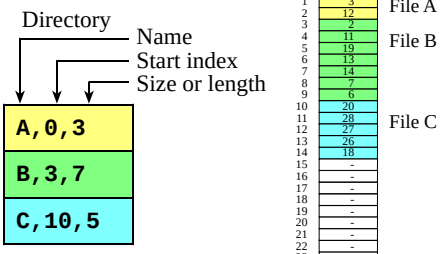


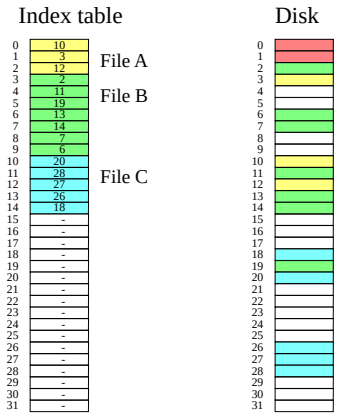
What if bad block?

To handle wear-leveling
free to one end of list
allocate from other end

File System Allocation (3)

- Indexed allocation





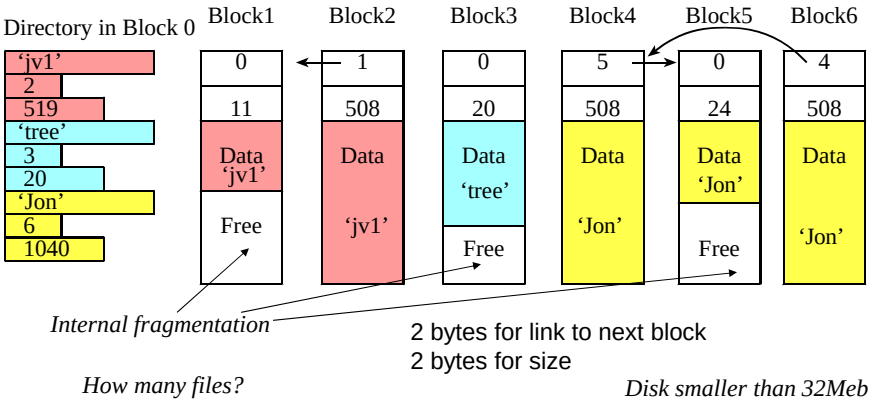
Good for erase, append, delete
Fast for random access
No external fragmentation

Reliable?

Two level index table?

Directory

- Name, Type, Date, Size, How to access



Directory

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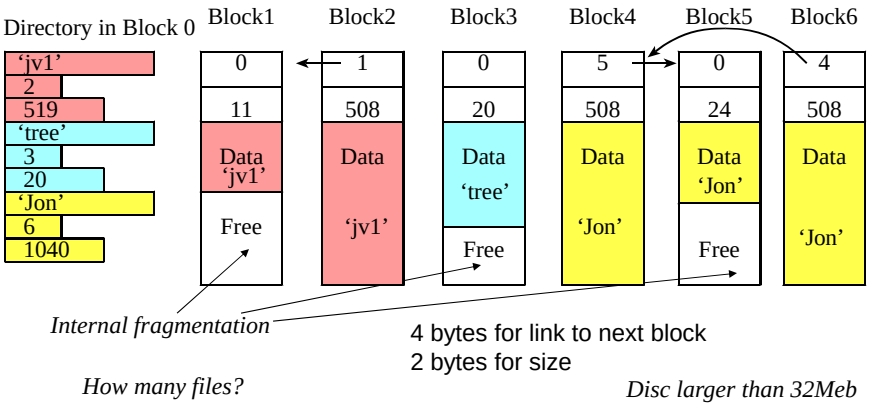
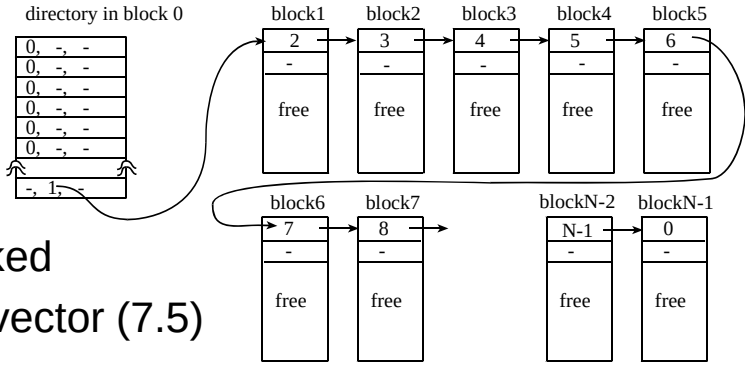


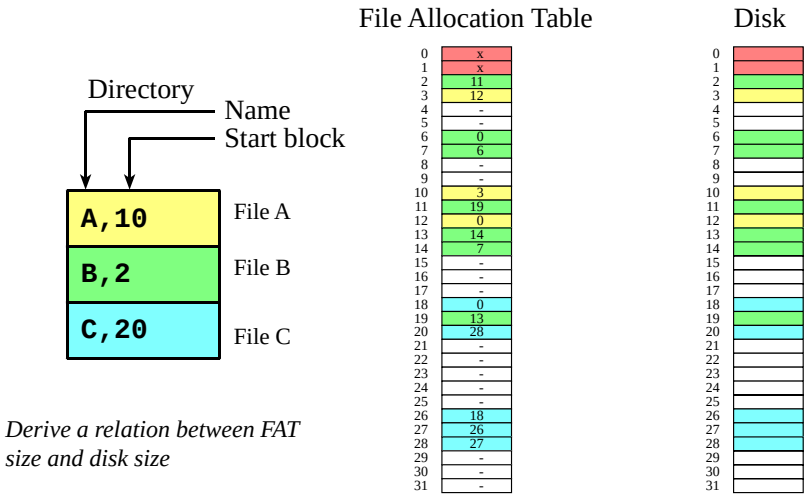
Free Space Management



- Linked
- Bit vector (7.5)

What percentage of the disk is wasted using a) linked; b) bit vector?

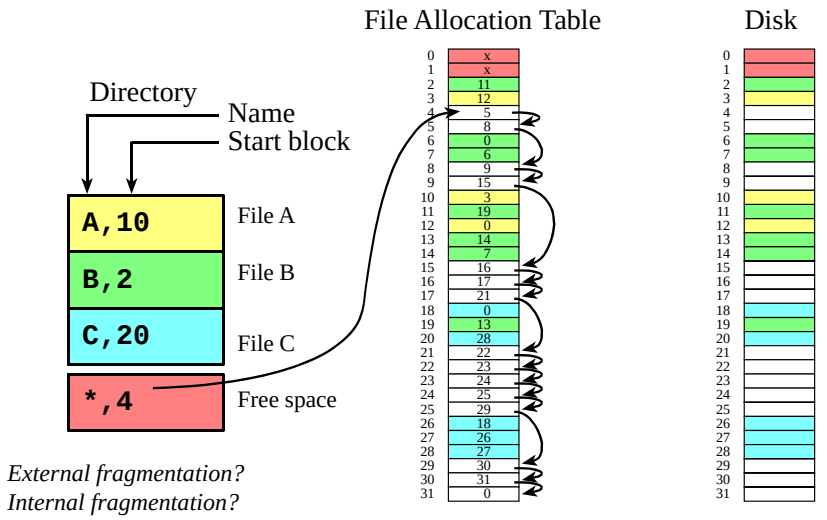
File Allocation Table (FAT)



Derive a relation between FAT size and disk size

What if bad block?

File Allocation Table (FAT)



Why cluster?

File System Summary

- Internal fragmentation
- External fragmentation
- Speed
  - Random versus sequential
  - Read versus write
- Clustering
- Size
- Number of files
- Legacy
- Low voltage
- Reliability, recover from errors
  - Error detection
  - Redundant Array of Independent Disks
  - Wear-leveling