ĐẠI HỌC ĐÀ NẴNG
TRƯỜNG ĐẠI HỌC CÔNG NGHỆ THÔNG TIN VÀ TRUYỀN THÔNG VIỆT - HÀN
Vietnam - Korea University of Information and Communication Technology

CHAPTER 4 – FILE SYSTEMS

- Files
- Directories
- File system implementation
- Example file systems

File Systems

Files
File Concept

- Long-term Information Storage
  - Must store large amounts of data
  - Information stored must survive the termination of the process using it
  - Multiple processes must be able to access the information concurrently
- File
  - Used to store information on disks and other extenal media in units
  - Process can read them and write new ones if need be
- File system
  - Part of operating system dealing with files
  - Includes two independent parts: set of file and directory structure, organize and provide information about all files in system

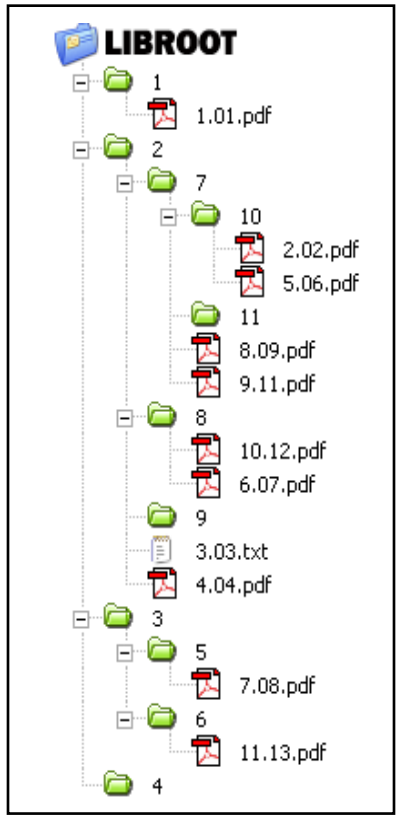
Files

File Concept

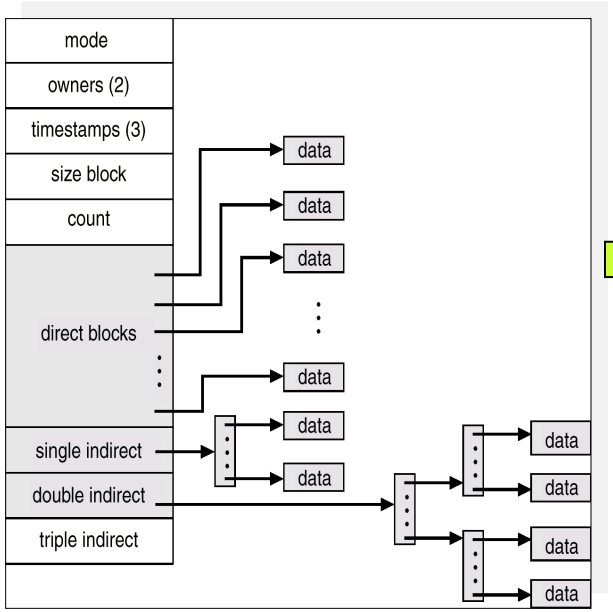
User Abstraction		Hardware Resource
Process/Thread		CPU
Address Space	⇐ **OS** ⇒	Memory
Files		Disk

Files

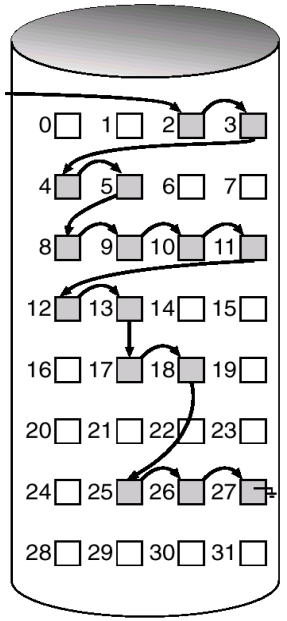
File Concept



file system



operating system



physical disk

Files

File Naming

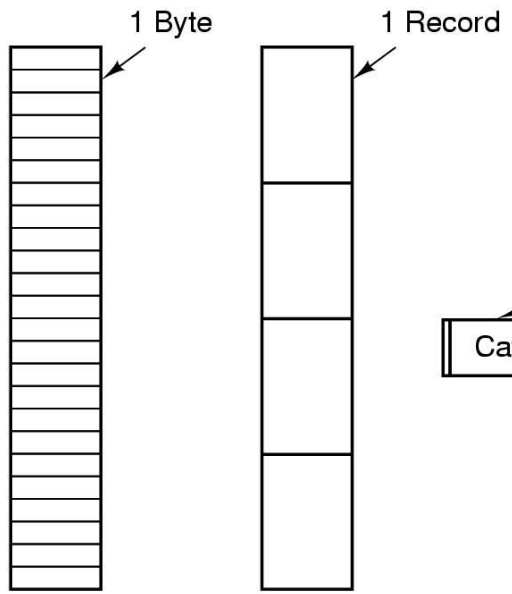
Typical file extensions.

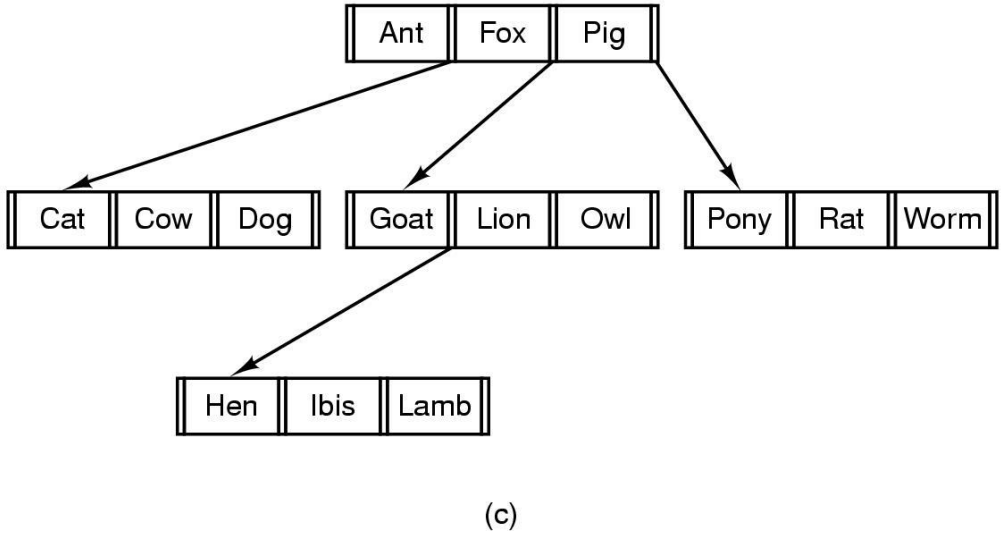
Extension	Meaning
file.bak	Backup file
file.c	C source program
file.gif	Compuserve Graphical Interchange Format image
file.hlp	Help file
file.html	World Wide Web HyperText Markup Language document
file.jpg	Still picture encoded with the JPEG standard
file.mp3	Music encoded in MPEG layer 3 audio format
file.mpg	Movie encoded with the MPEG standard
file.o	Object file (compiler output, not yet linked)
file.pdf	Portable Document Format file
file.ps	PostScript file
file.tex	Input for the TEX formatting program
file.txt	General text file
file.zip	Compressed archive

Files

File Structure

- Three kinds of files
  - (a) byte sequence
  - (b) record sequence
  - (c) tree





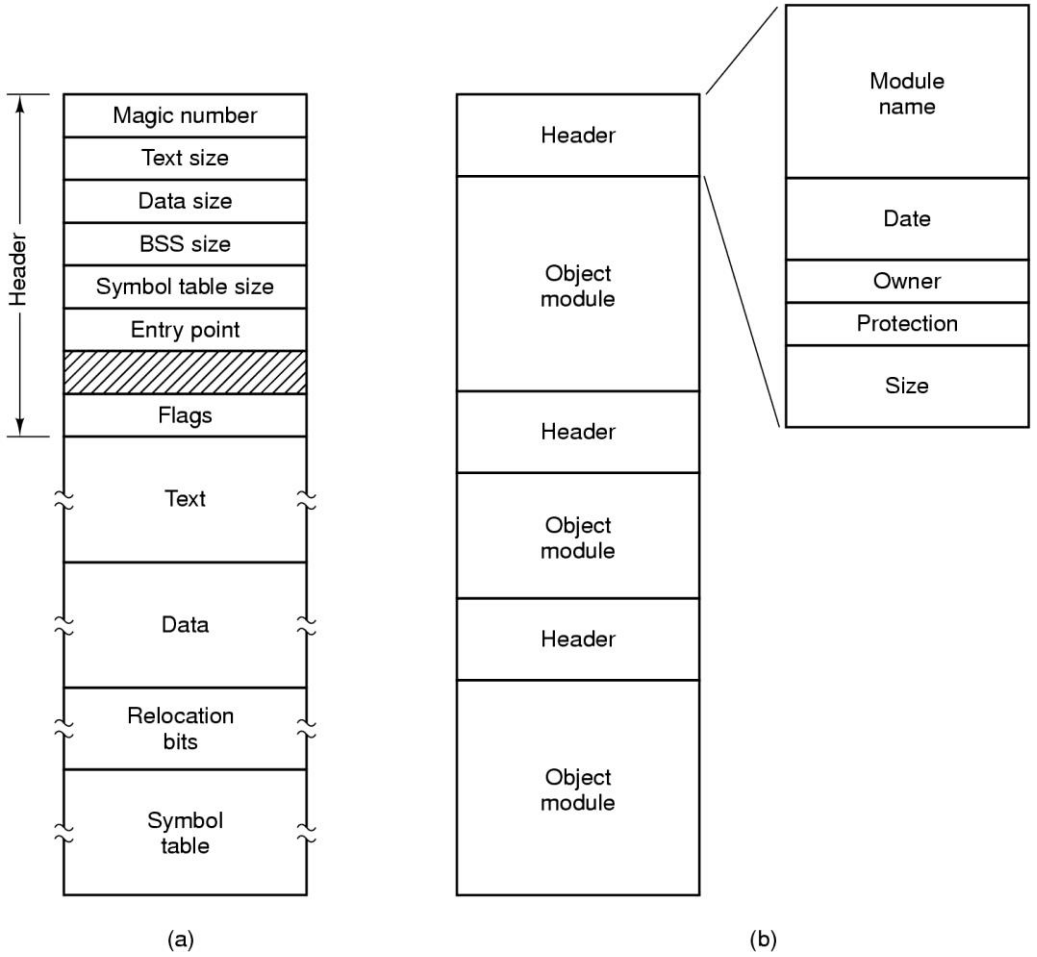
Files
File Types

- Contiguous logical address space
- Types:
  - Data
    - ✓ numeric
    - ✓ character
    - ✓ binary
  - Program
    - ✓ Source
    - ✓ Object
    - ✓ Executable
  - Regular, special (character, block)

Files

File Types

(a) An executable file (b) An archive



Files
File Access

- Sequential access
  - read all bytes/records from the beginning
  - cannot jump around, could rewind or back up
  - convenient when medium was mag tape
- Random access
  - bytes/records read in any order
  - essential for data base systems
  - read can be …
    - ✓ move file marker (seek), then read or …
    - ✓ read and then move file marker

Files
File Attributes

Possible file attributes

Attribute	Meaning
Protection	Who can access the file and in what way
Password	Password needed to access the file
Creator	ID of the person who created the file
Owner	Current owner
Read-only flag	0 for read/write; 1 for read only
Hidden flag	0 for normal; 1 for do not display in listings
System flag	0 for normal files; 1 for system file
Archive flag	0 for has been backed up; 1 for needs to be backed up
ASCII/binary flag	0 for ASCII file; 1 for binary file
Random access flag	0 for sequential access only; 1 for random access
Temporary flag	0 for normal; 1 for delete file on process exit
Lock flags	0 for unlocked; nonzero for locked
Record length	Number of bytes in a record
Key position	Offset of the key within each record
Key length	Number of bytes in the key field
Creation time	Date and time the file was created
Time of last access	Date and time the file was last accessed
Time of last change	Date and time the file has last changed
Current size	Number of bytes in the file
Maximum size	Number of bytes the file may grow to

Files
File Operations

1. Create
2. Delete
3. Open
4. Close
5. Read
6. Write
7. Append
8. Seek
9. Get attributes
10. Set Attributes
11. Rename

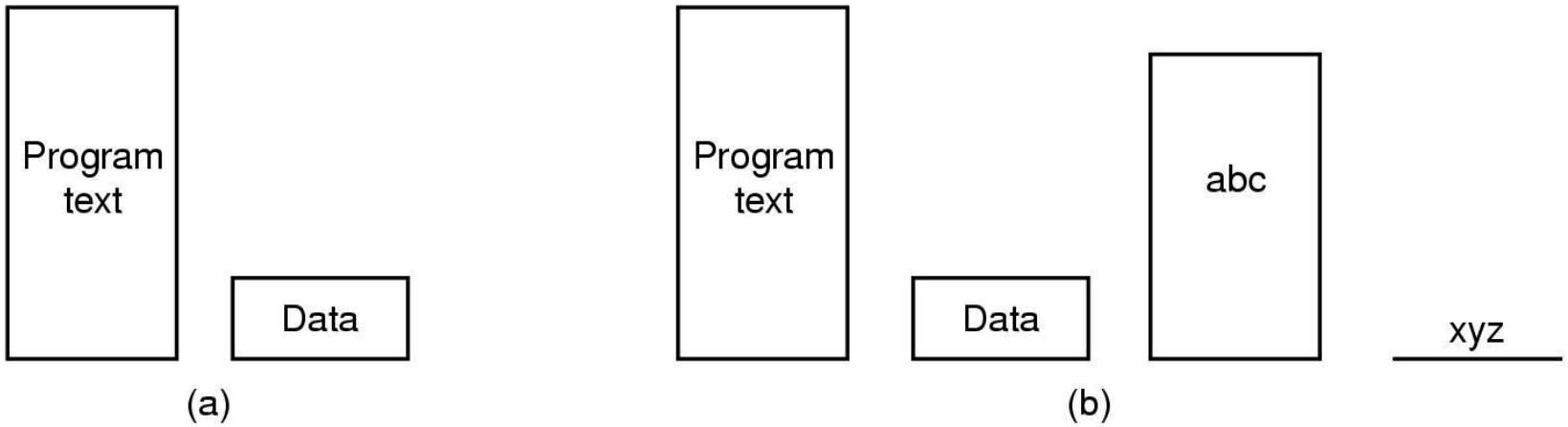
Files
Memory-Mapped Files

(a) Segmented process before mapping files into its address space

(b) Process after mapping

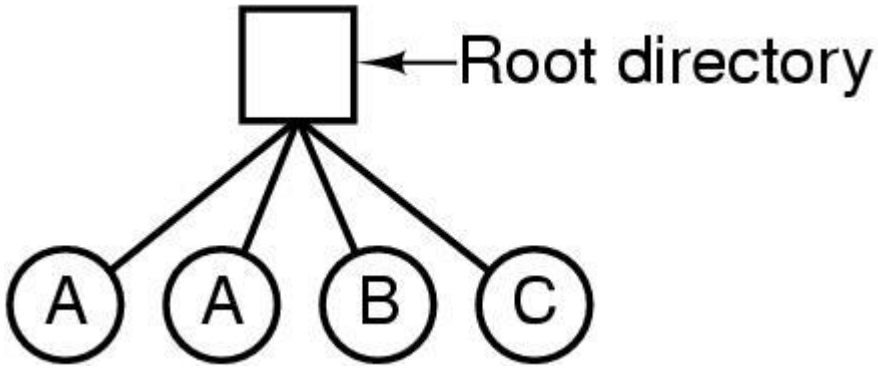
existing file *abc* into one segment

creating new segment for *xyz*



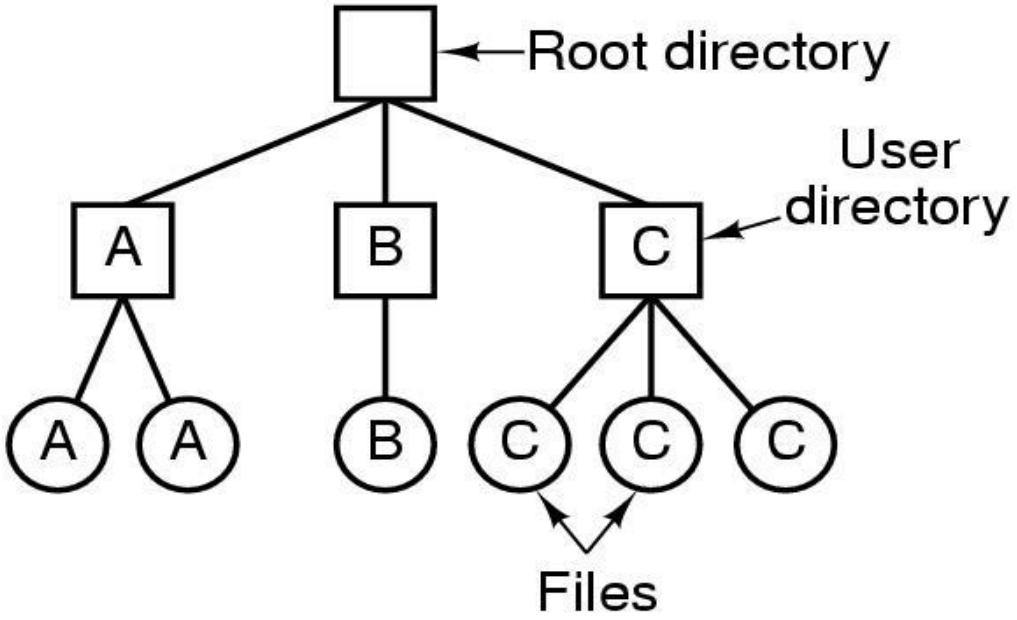
Directories
Single-Level Directory Systems

- A single level directory system
  - contains 4 files
  - owned by 3 different people, A, B, and C



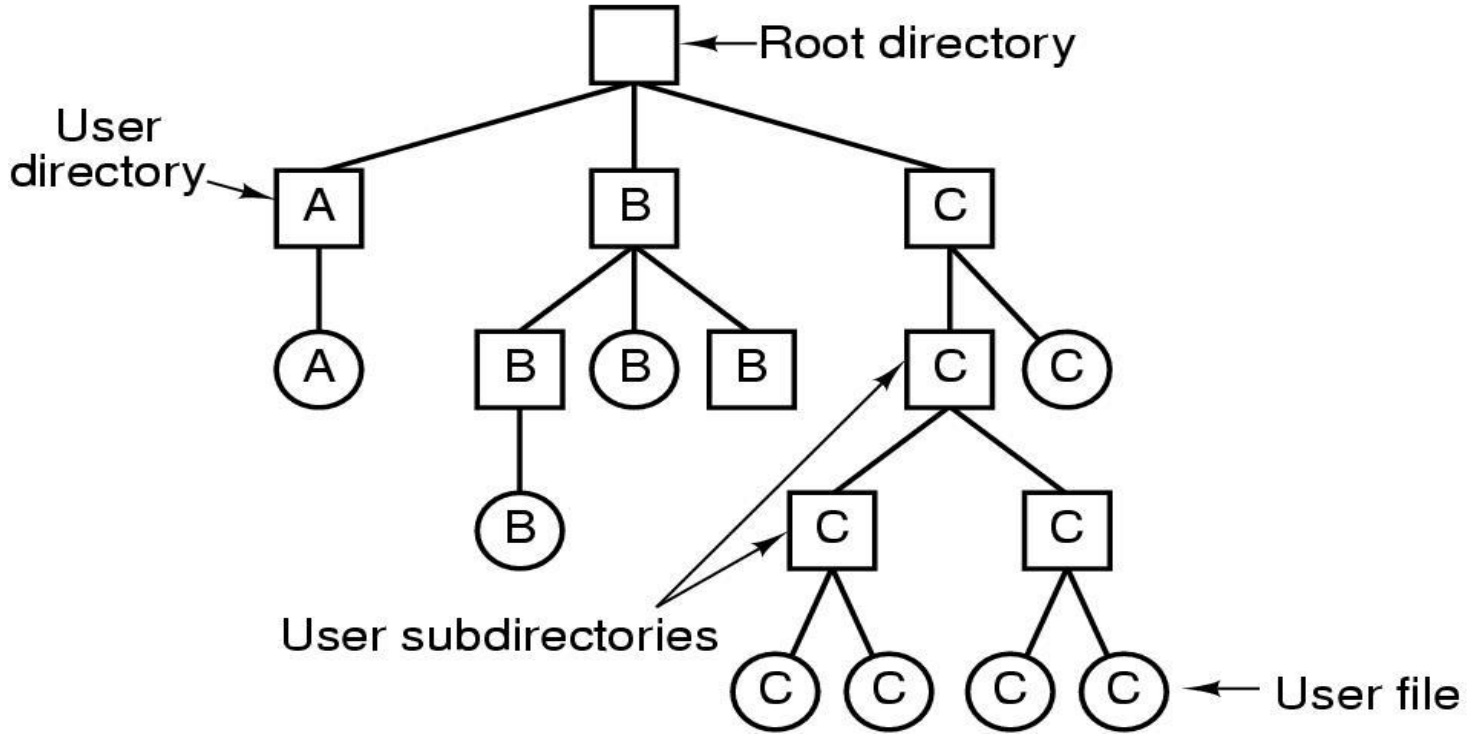
Directories
Two-level Directory Systems

Letters indicate *owners* of the directories and files



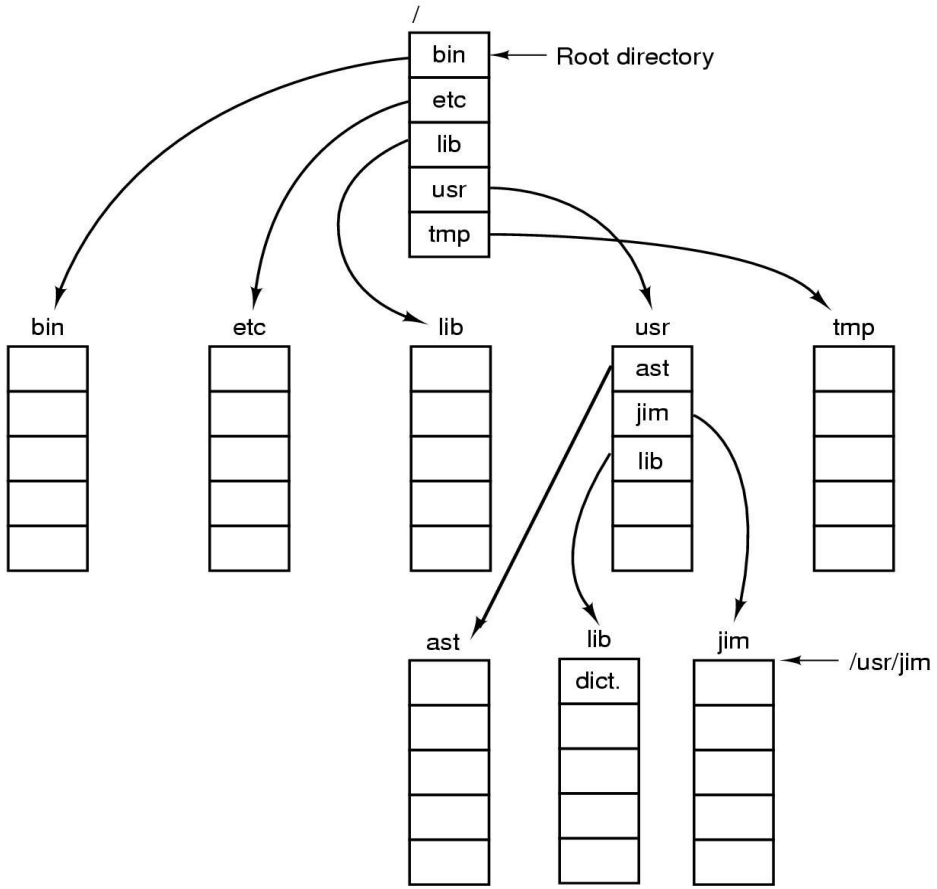
Directories
Hierarchical Directory Systems

A hierarchical directory system



Directories
Path Names

A UNIX directory tree



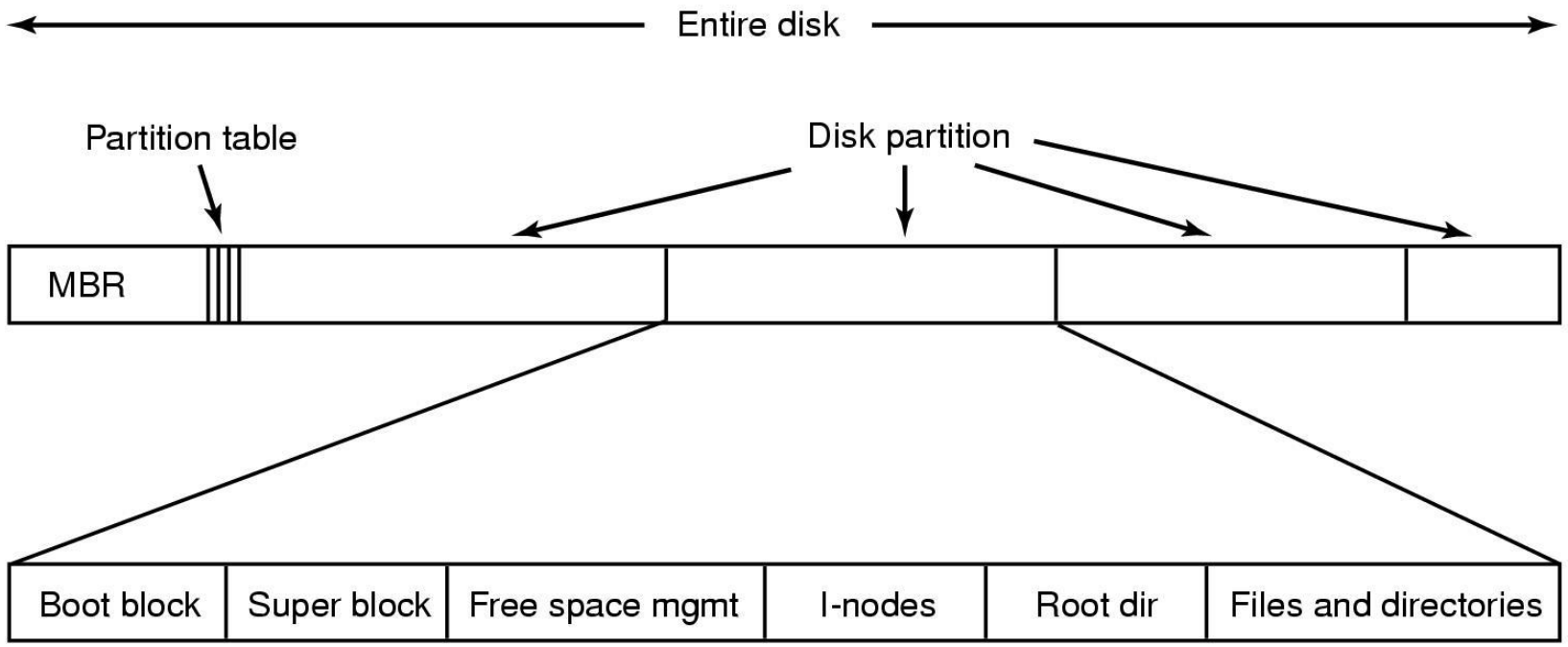
Directories
Directory Operations

1. Create
2. Delete
3. Opendir
4. Closedir
5. Readdir
6. Rename
7. Link
8. Unlink

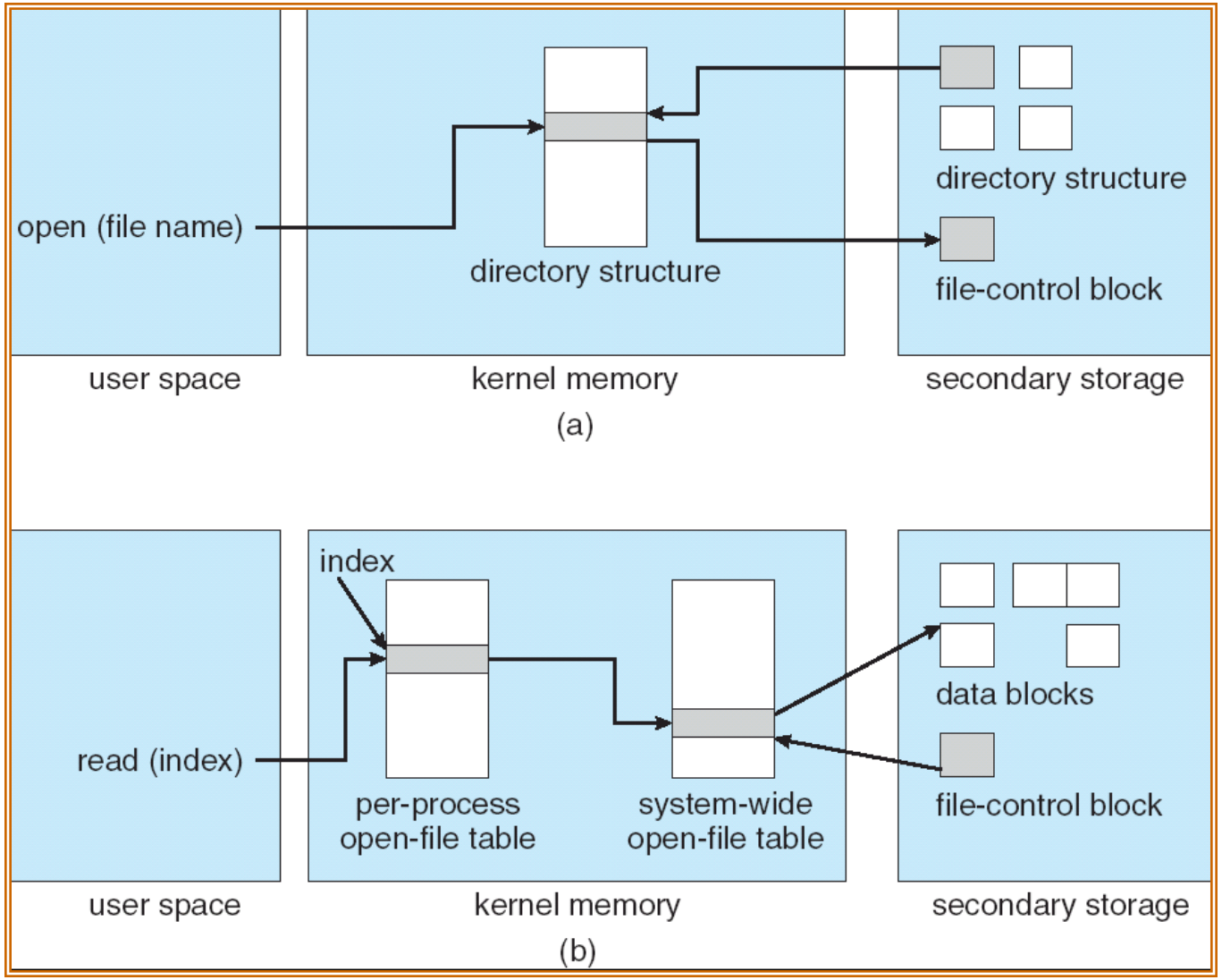
File System Implementation

File System Implementation

A possible file system layout



In-Memory File System Structures



File System Implementation Allocation Methods

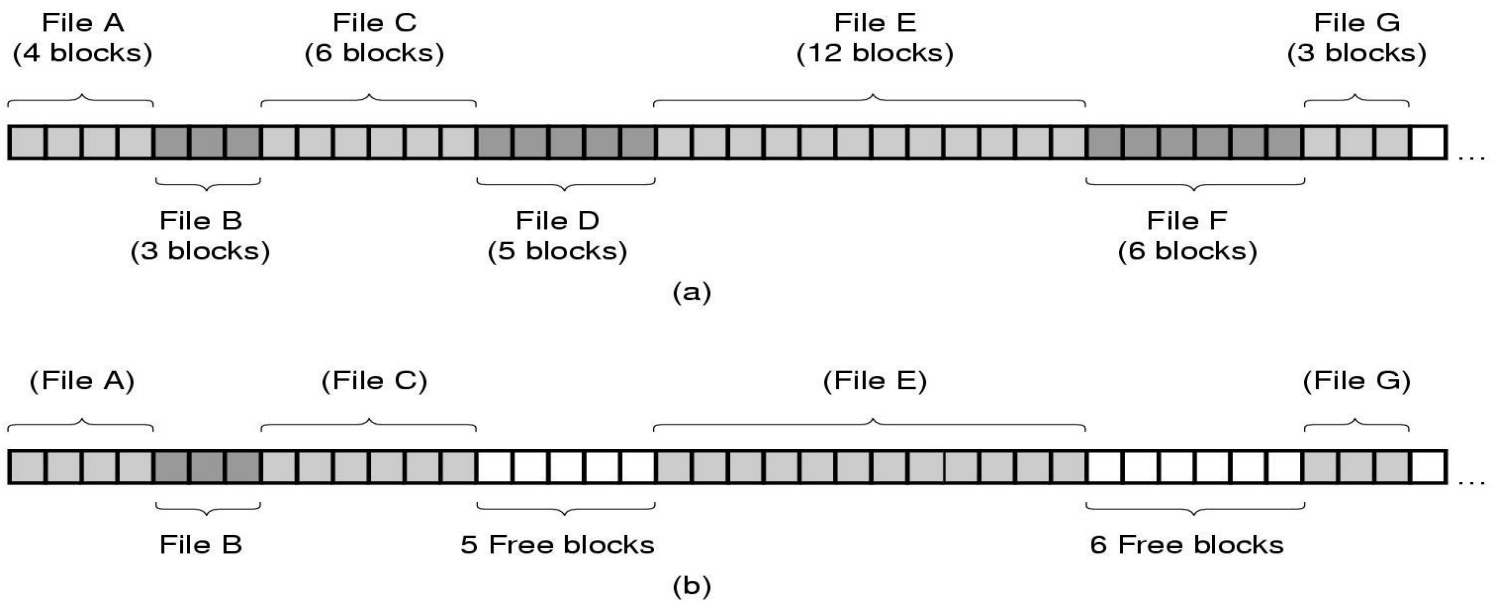
- An allocation method refers to how disk blocks are allocated for files:
- Contiguous allocation
- Linked allocation
- Indexed allocation

File System Implementation

Allocation Methods: Contiguous allocation (1)

(a) Contiguous allocation of disk space for 7 files

(b) State of the disk after files *D* and *E* have been removed



File System Implementation

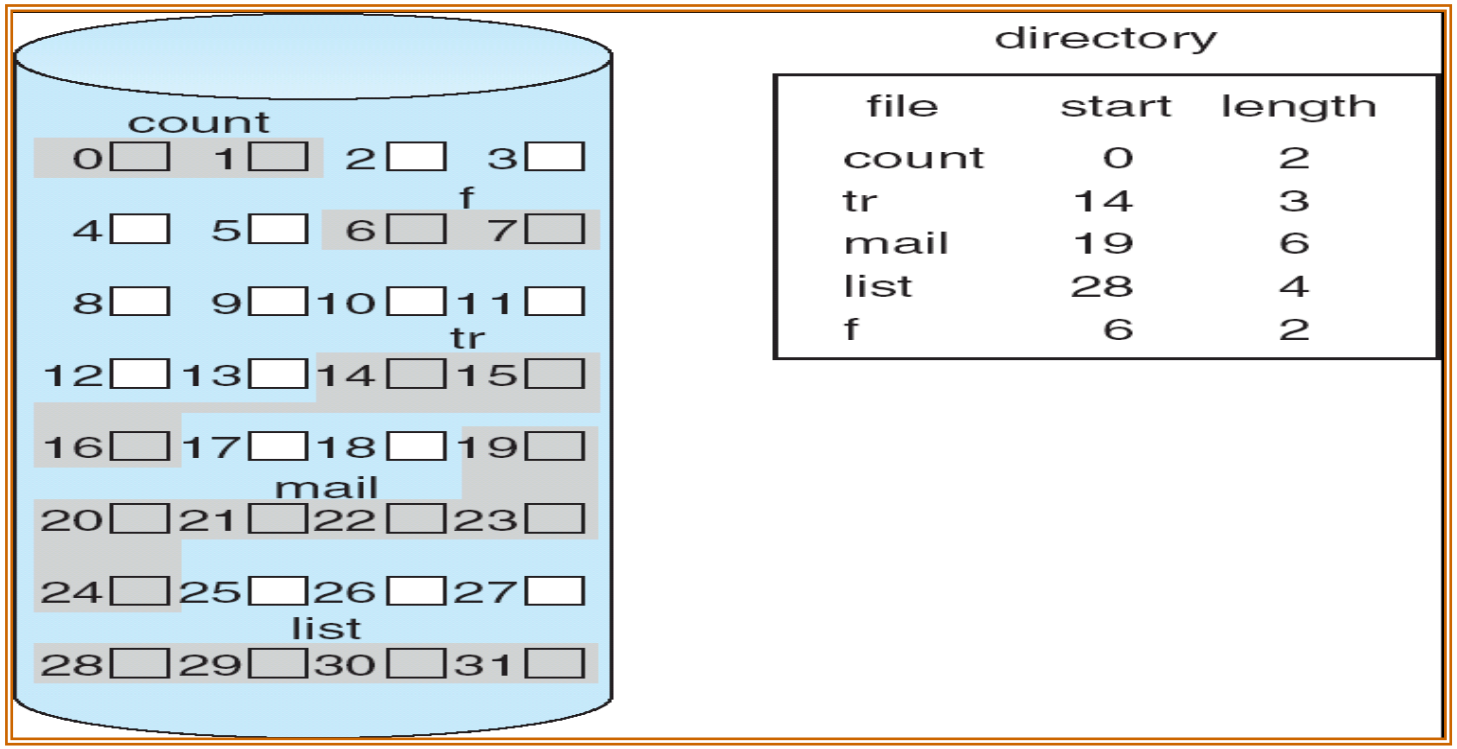
Allocation Methods: Contiguous allocation (2)

- Each file occupies a set of contiguous blocks on the disk
- Simple – only starting location (block #) and length (number of blocks) are required
- Random access
- Wasteful of space (dynamic storage-allocation problem)
- Files cannot grow
- Use for CD-ROM because the length of file are known in advance and no deletion

File System Implementation

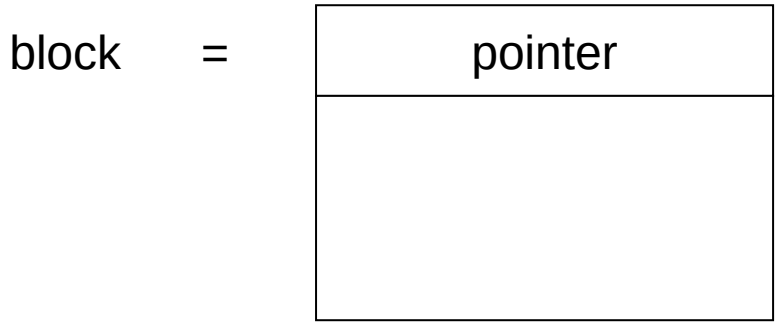
Allocation Methods: Contiguous allocation (3)

Contiguous Allocation of Disk Space

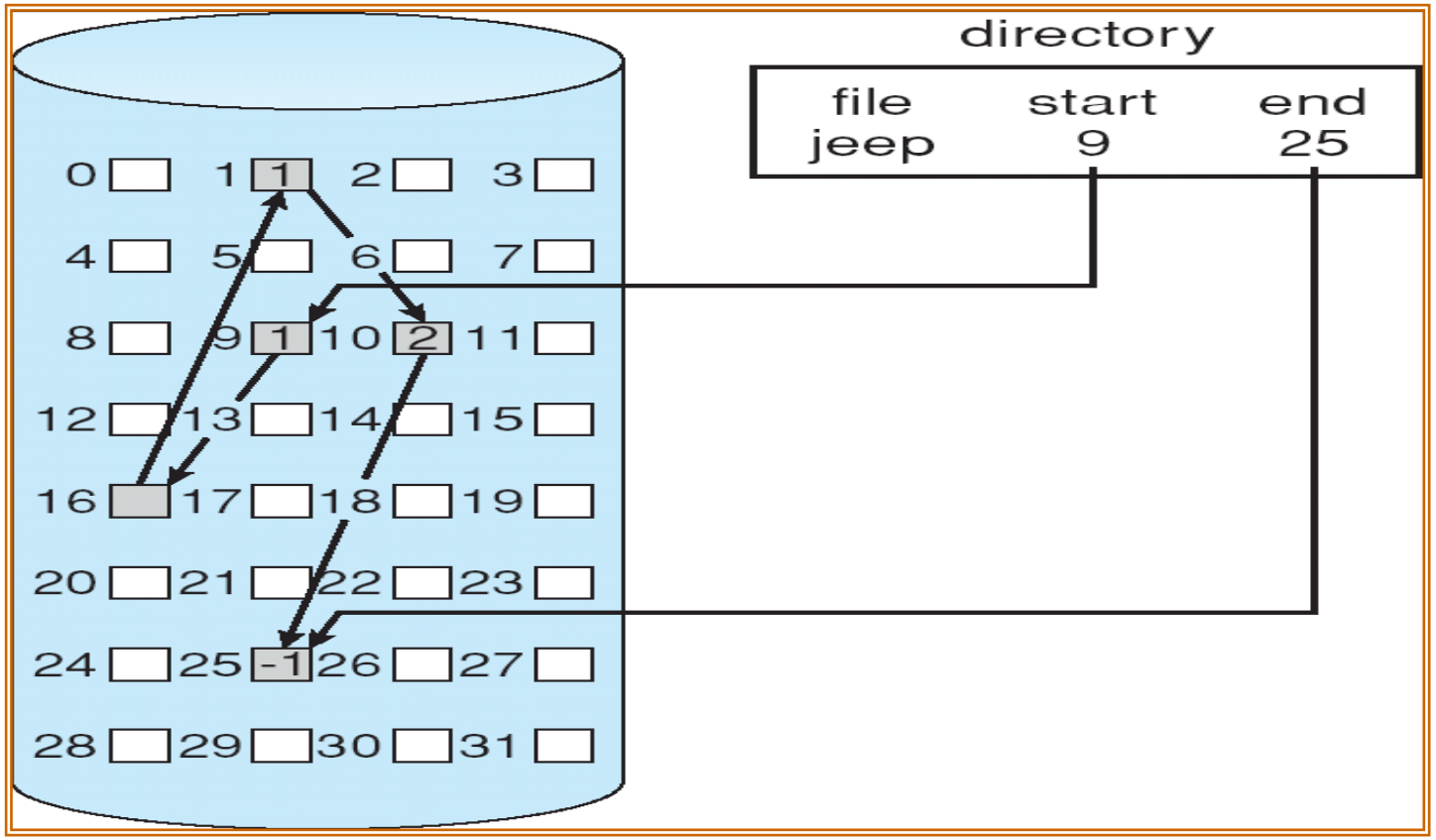


File System Implementation Allocation Methods: Linked allocation (1)

- Each file is a linked list of disk blocks: blocks may be scattered anywhere on the disk.
- Simple – need only starting address
- Free-space management system – no waste of space
- No random access

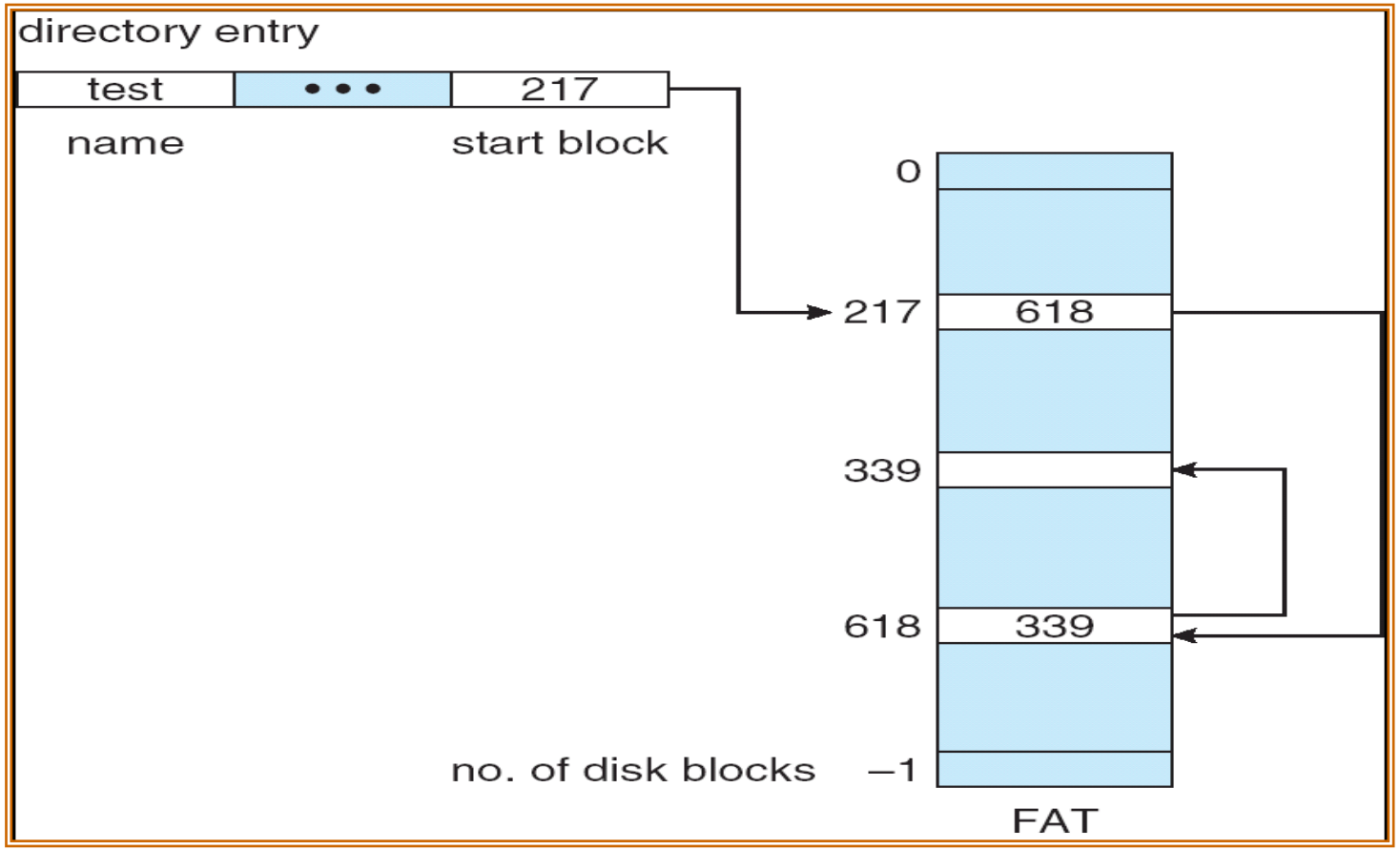


File System Implementation Allocation Methods: Linked allocation (2)



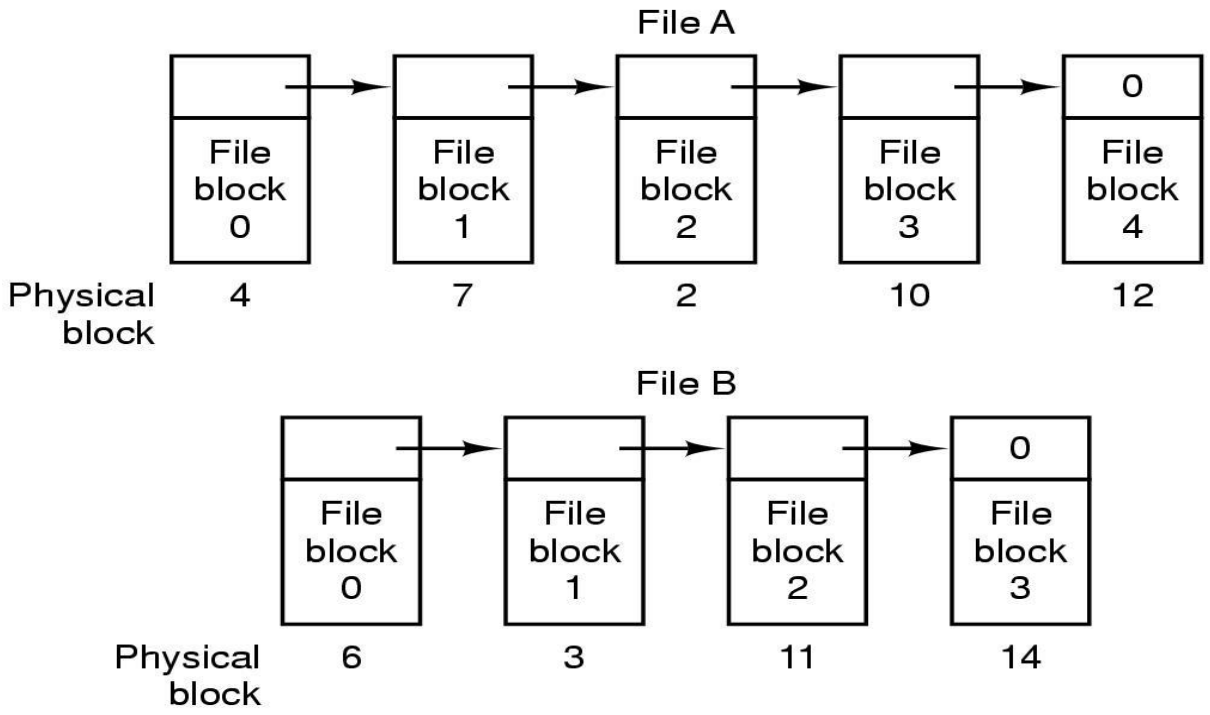
File System Implementation Allocation Methods: Linked allocation (3)

- File-Allocation Table



File System Implementation Allocation Methods: Linked allocation (4)

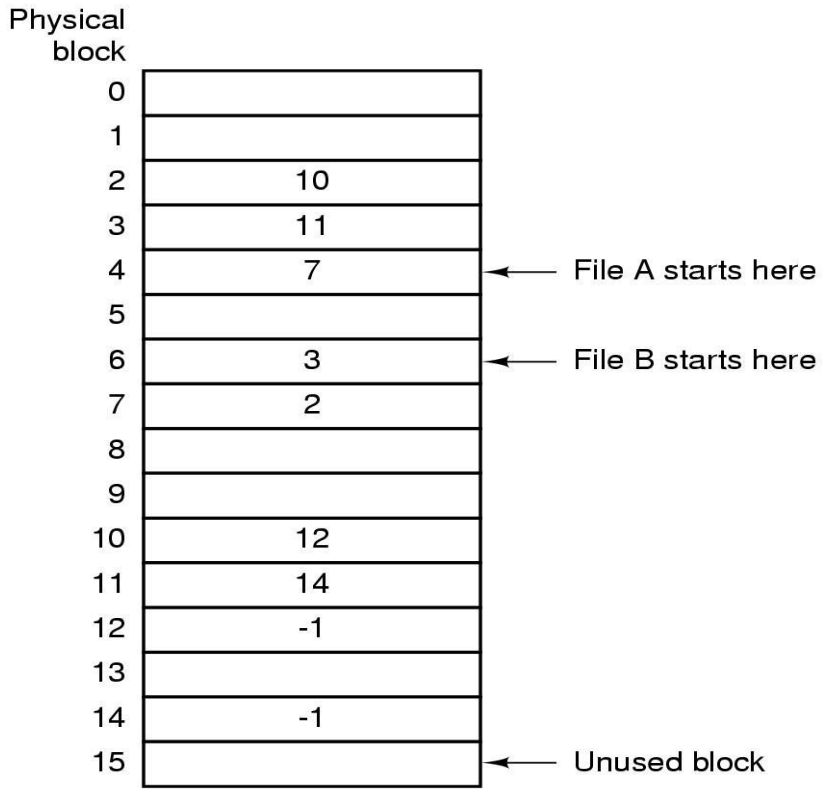
Storing a file as a linked list of disk blocks



File System Implementation Allocation Methods: Linked allocation (5)

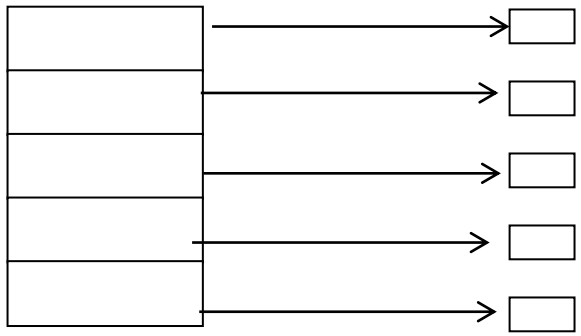
Linked list allocation using a file allocation table in RAM

FAT File Allocation Table



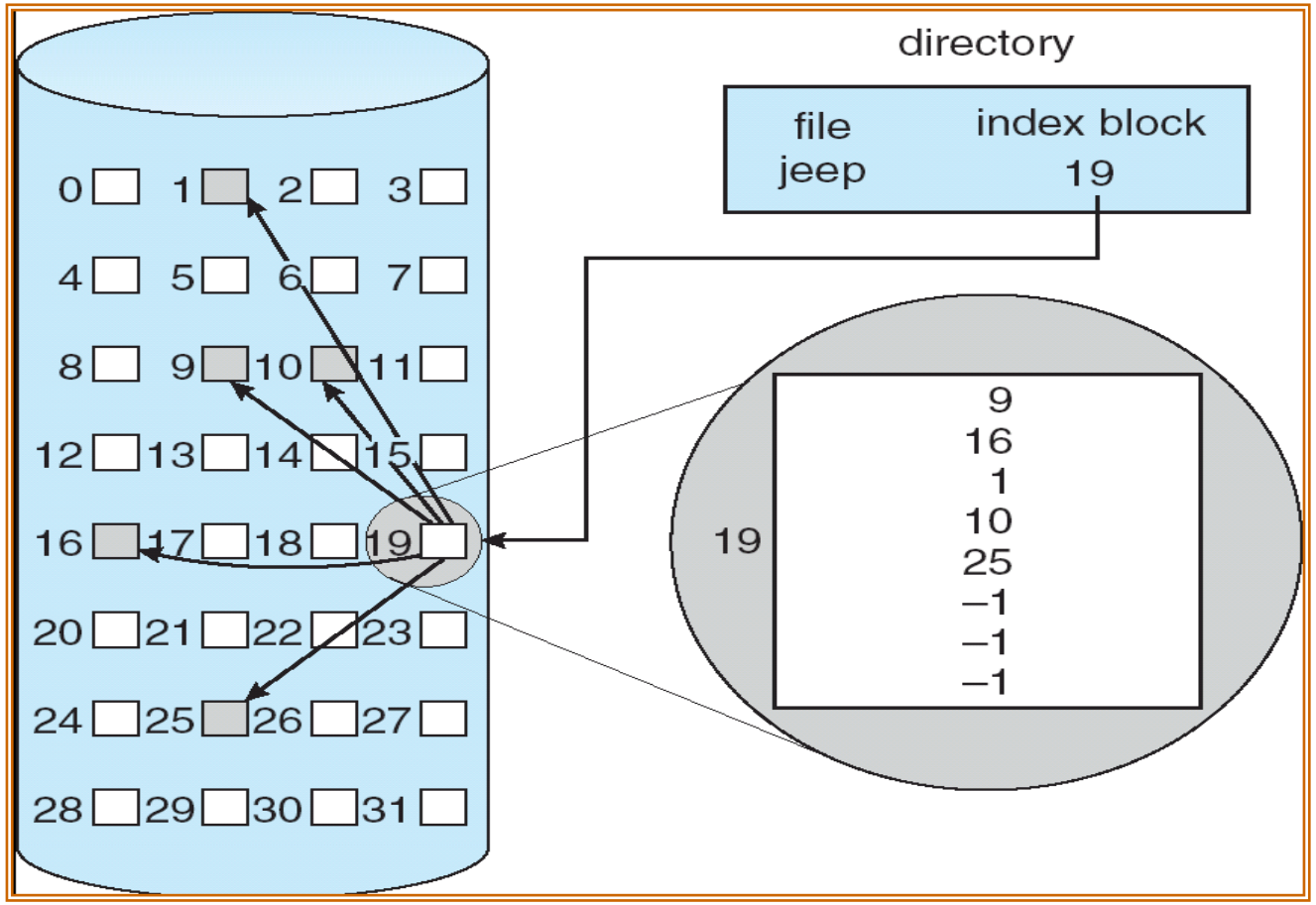
File System Implementation Allocation Methods: Indexed allocation (1)

- Brings all pointers together into the *index block.*
- Logical view.
- Need index table
- Random access
- Dynamic access without external fragmentation, but have overhead of index block.



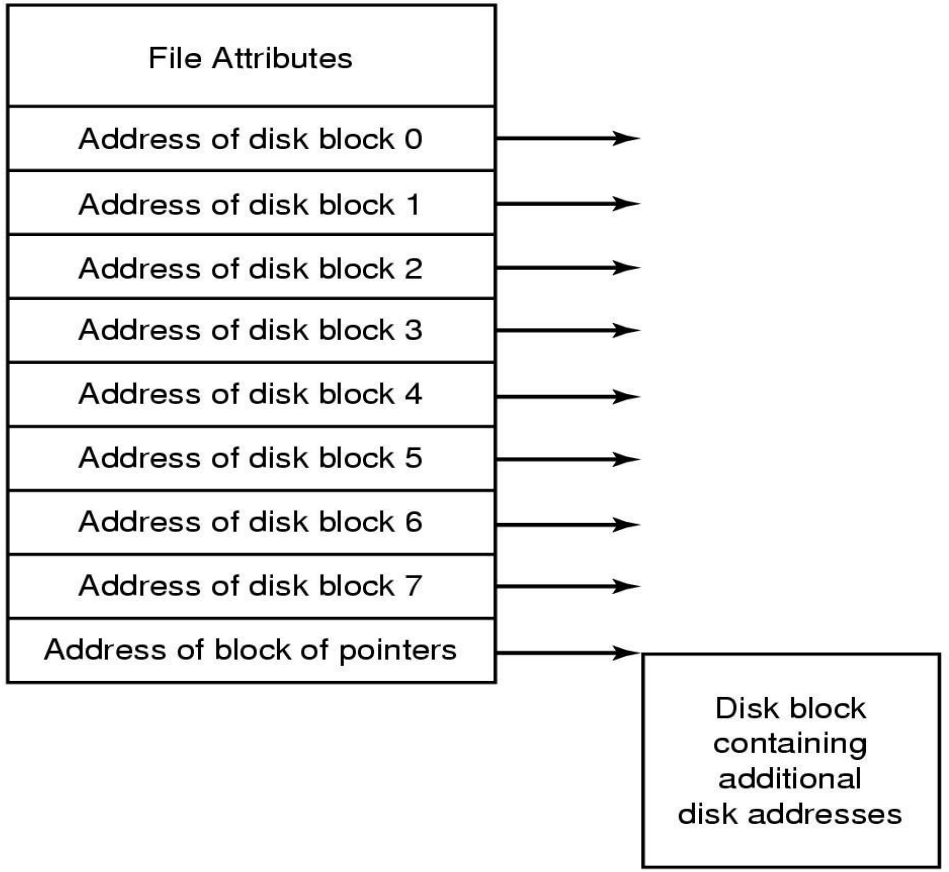
index table

File System Implementation Allocation Methods: Indexed allocation (2)



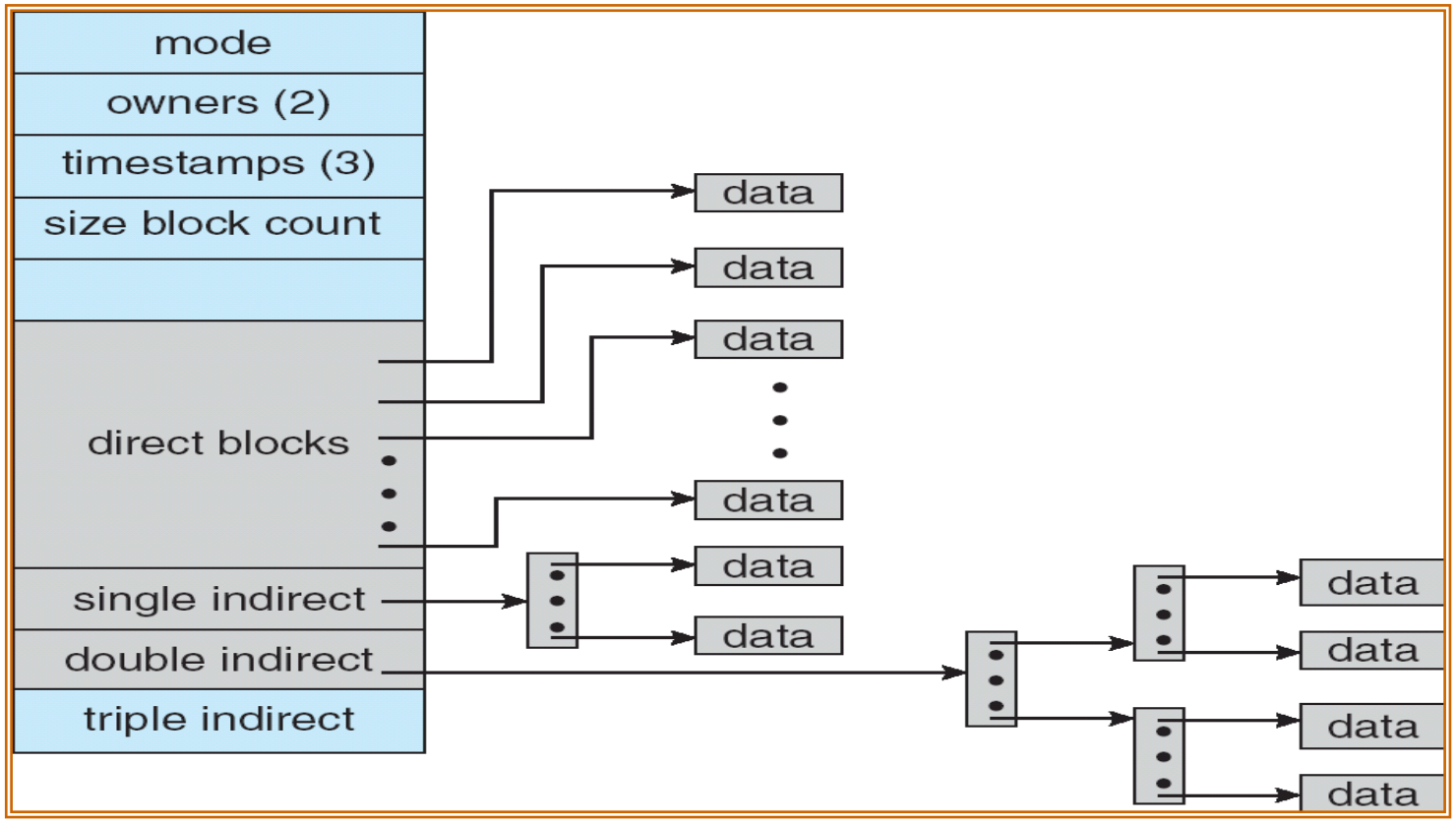
File System Implementation Allocation Methods: Indexed allocation (3)

An example i-node



File System Implementation Allocation Methods: Indexed allocation (4)

- Combined Scheme: UNIX (4K bytes per block)



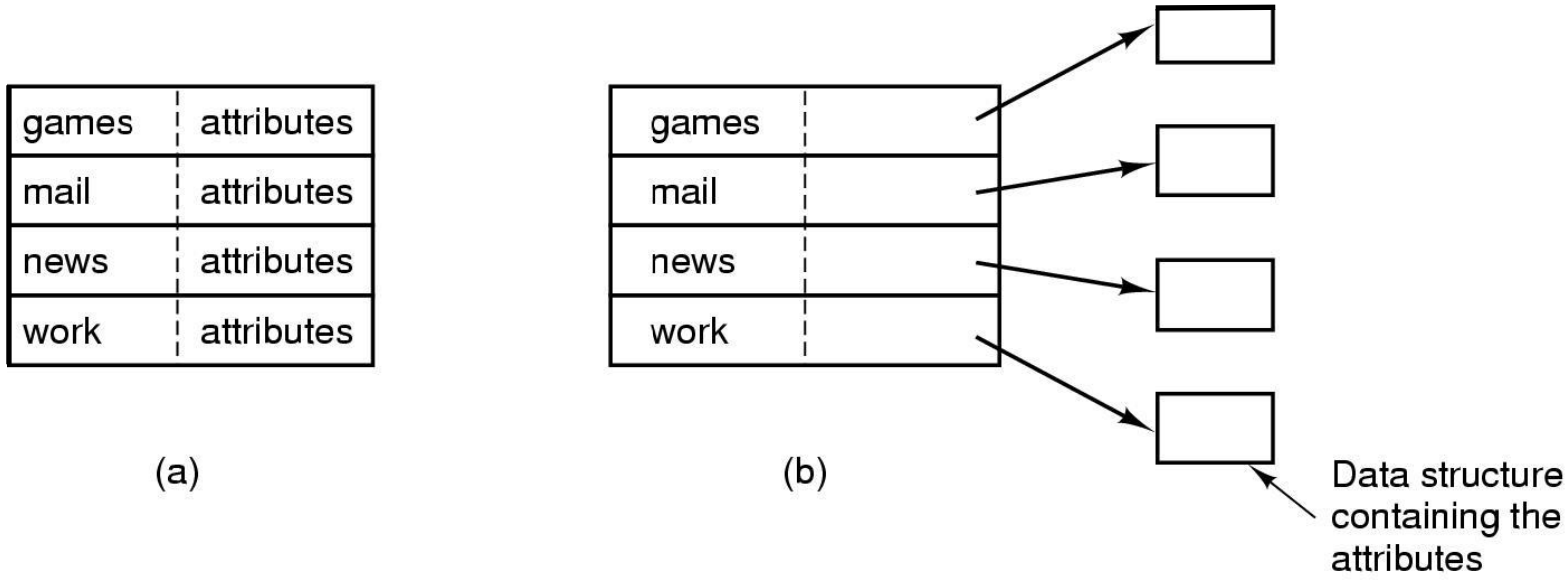
Implementing Directories (1)

(a) A simple directory

fixed size entries

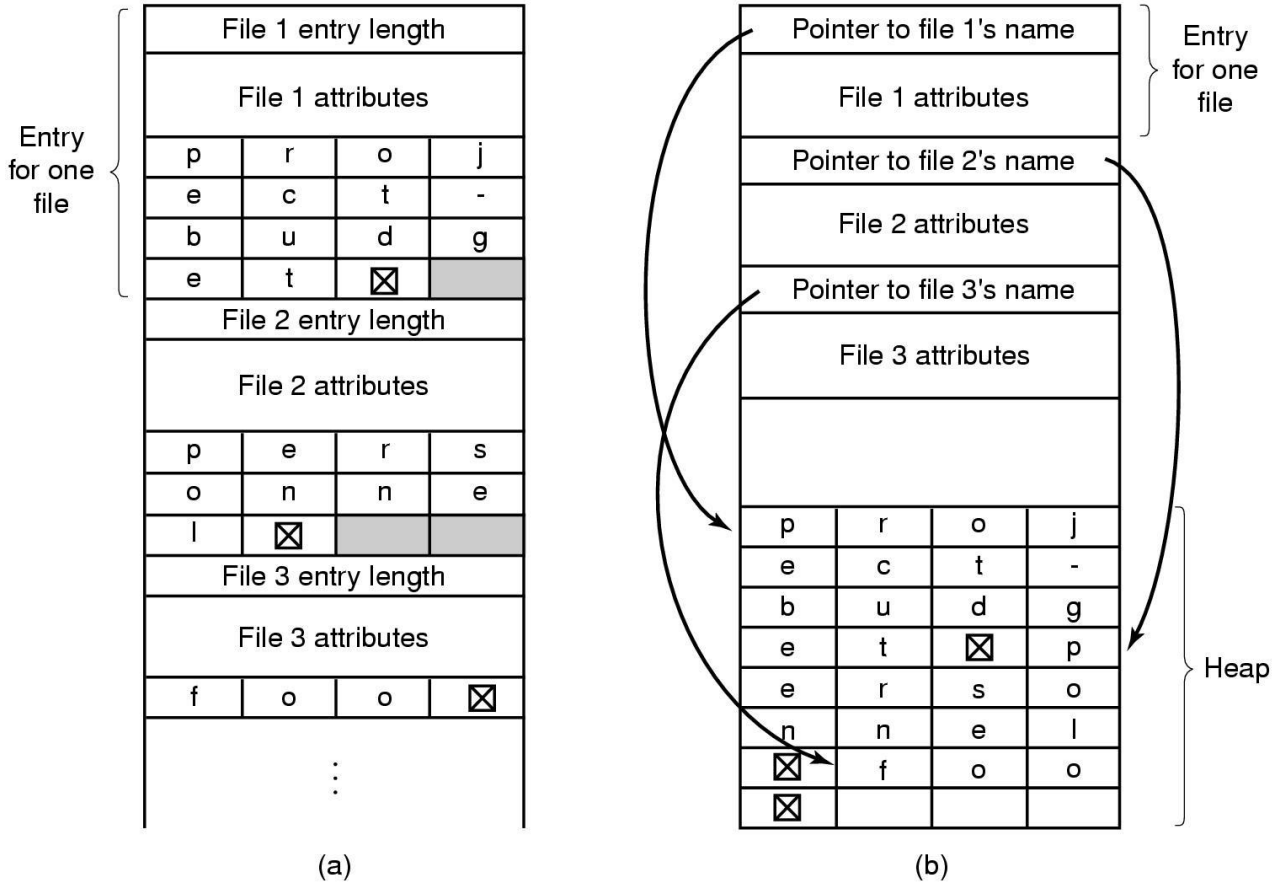
disk addresses and attributes in directory entry

(b) Directory in which each entry just refers to an i-node



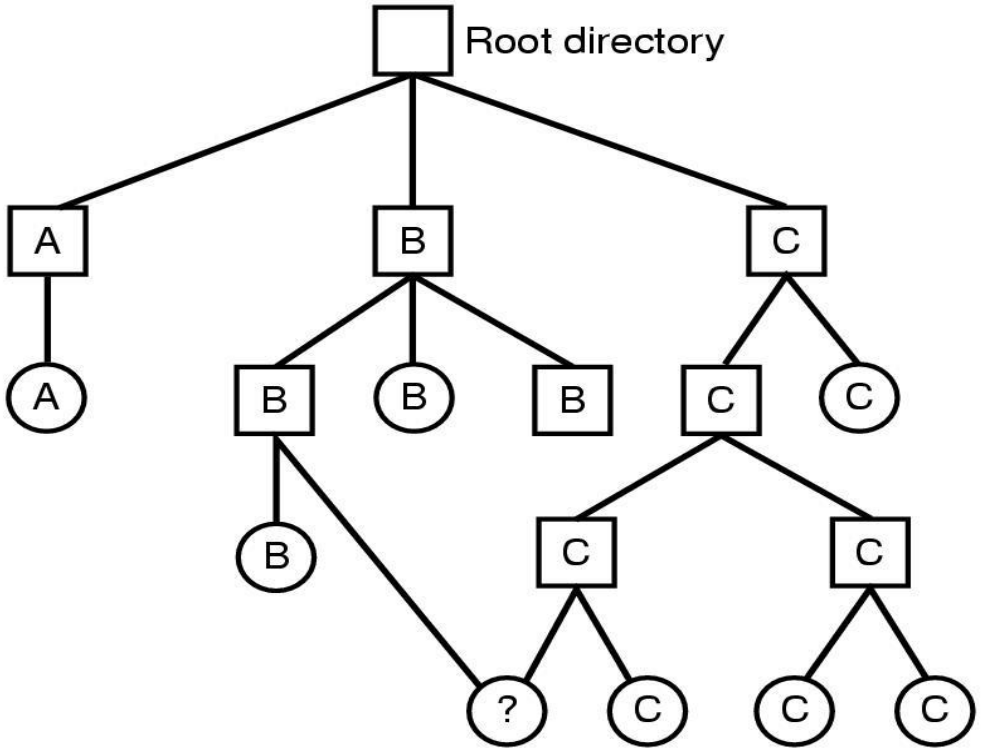
Implementing Directories (2)

- Two ways of handling long file names in directory
  - (a) In-line
  - (b) In a heap



Shared Files (1)

File system containing a shared file



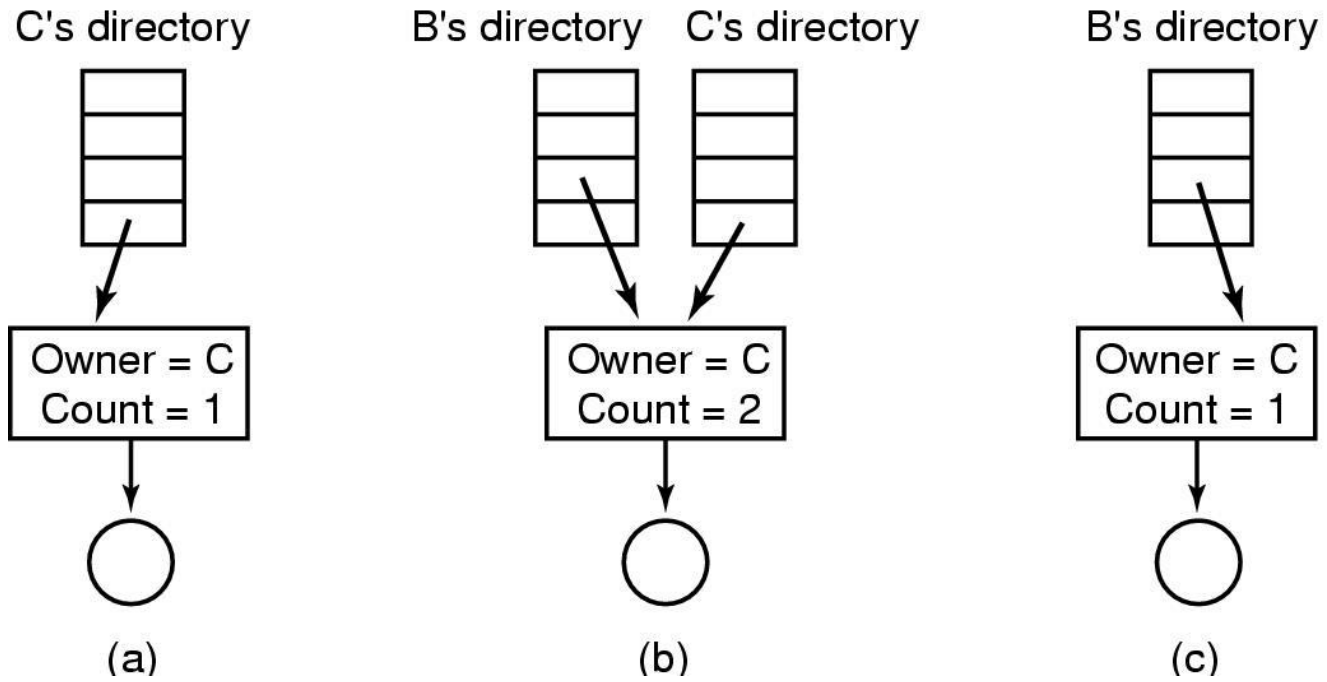
Shared file

Shared Files (2)

(a) Situation prior to linking

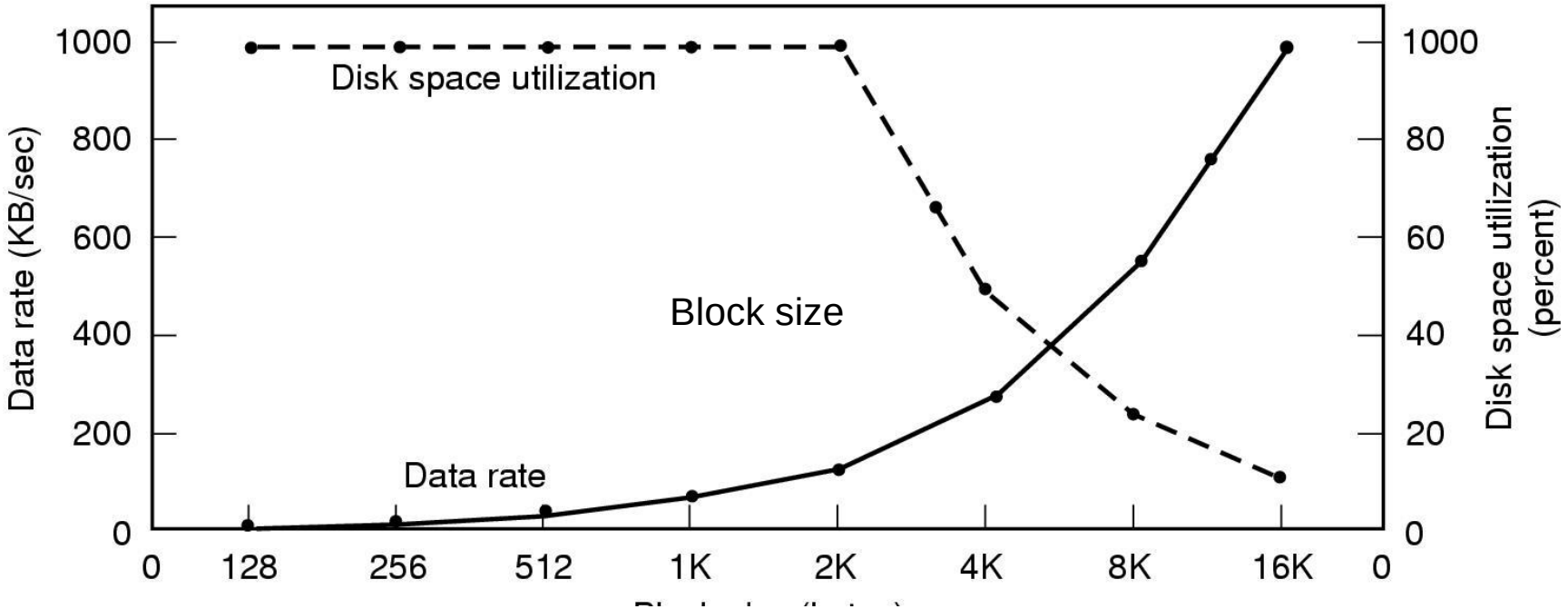
(b) After the link is created

(c)After the original owner removes the file



Disk Space Management (1)

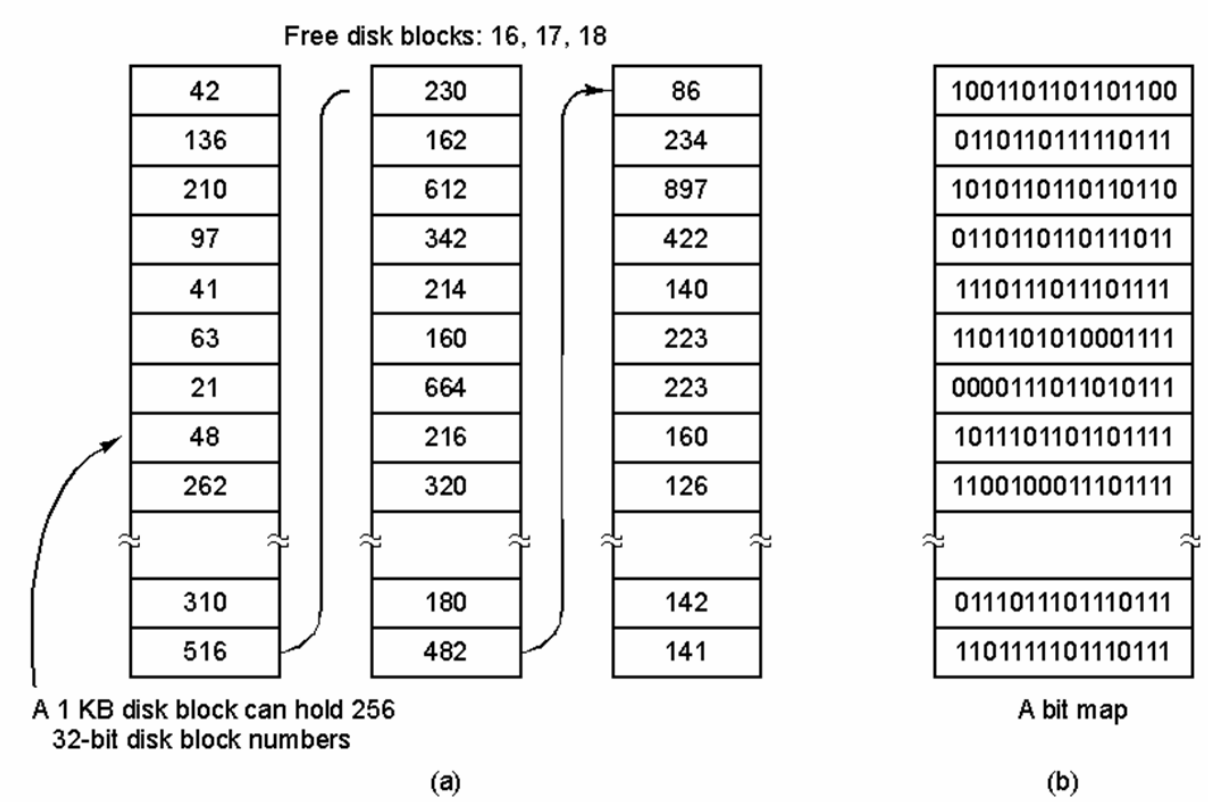
- Dark line (left hand scale) gives data rate of a disk
- Dotted line (right hand scale) gives disk space efficiency
- All files 2KB



Disk Space Management (2)

(a) Storing the free list on a linked list

(b) A bit map

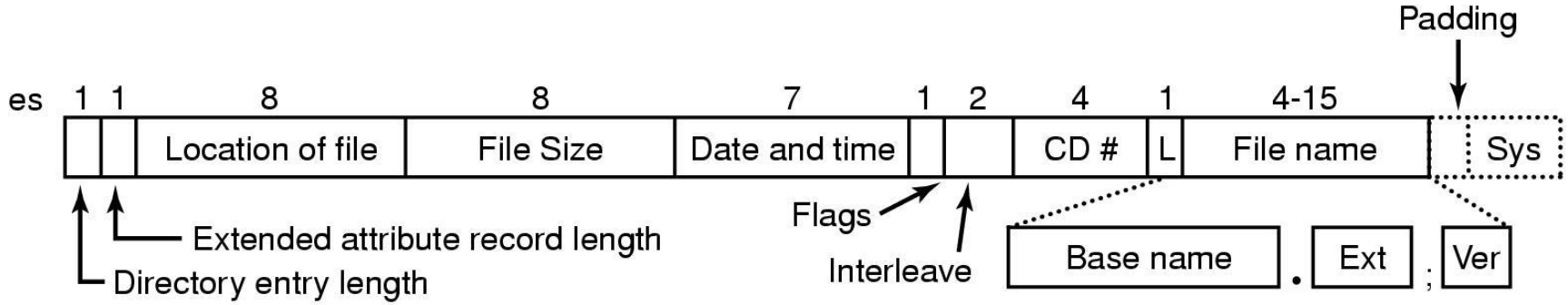


Example File Systems

Example File Systems

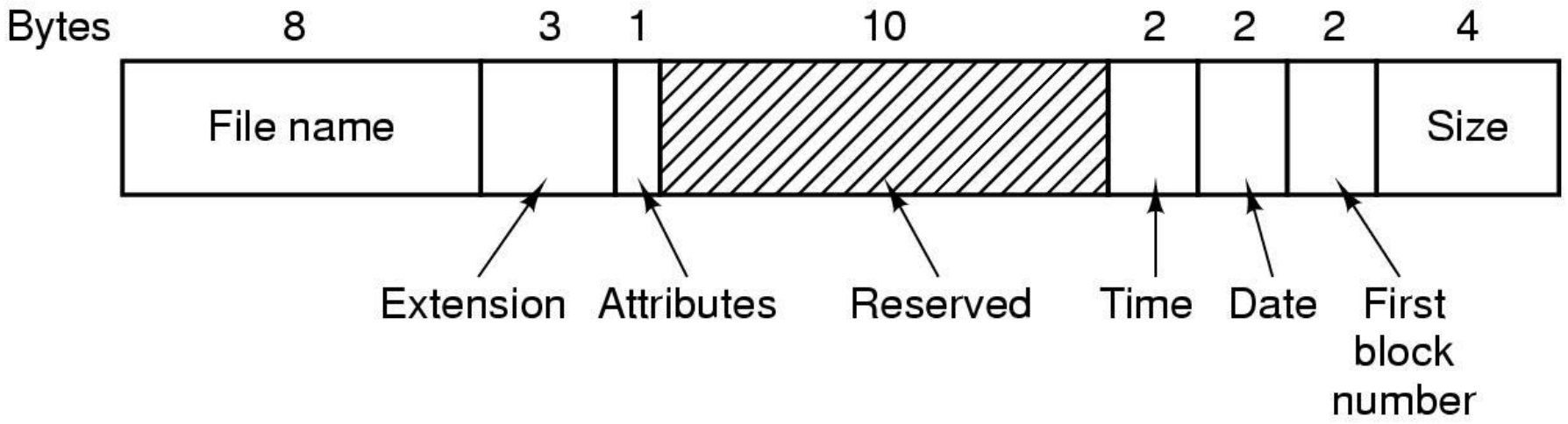
CD-ROM File Systems

The ISO 9660 directory entry



The MS-DOS File System (1)

The MS-DOS directory entry



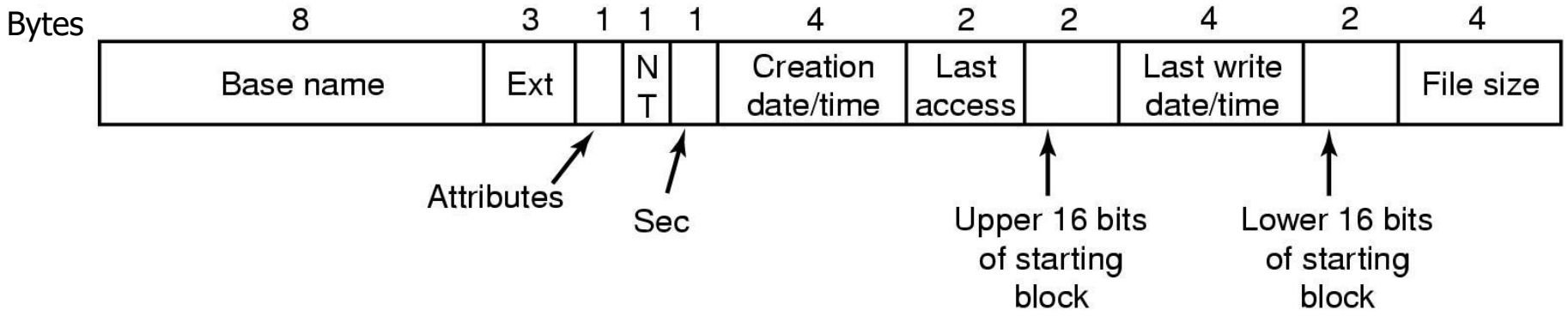
The MS-DOS File System (2)

- Maximum partition for different block sizes
- The empty boxes represent forbidden combinations

Block size	FAT-12	FAT-16	FAT-32
0.5 KB	2 MB		
1 KB	4 MB		
2 KB	8 MB	128 MB	
4 KB	16 MB	256 MB	1 TB
8 KB		512 MB	2 TB
16 KB		1024 MB	2 TB
32 KB		2048 MB	2 TB

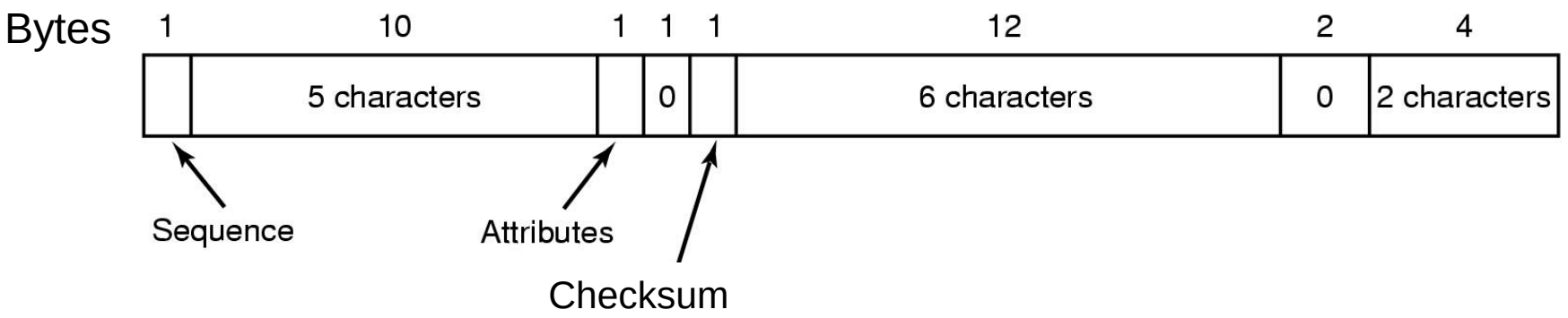
The Windows 98 File System (1)

The extended MOS-DOS directory entry used in Windows 98



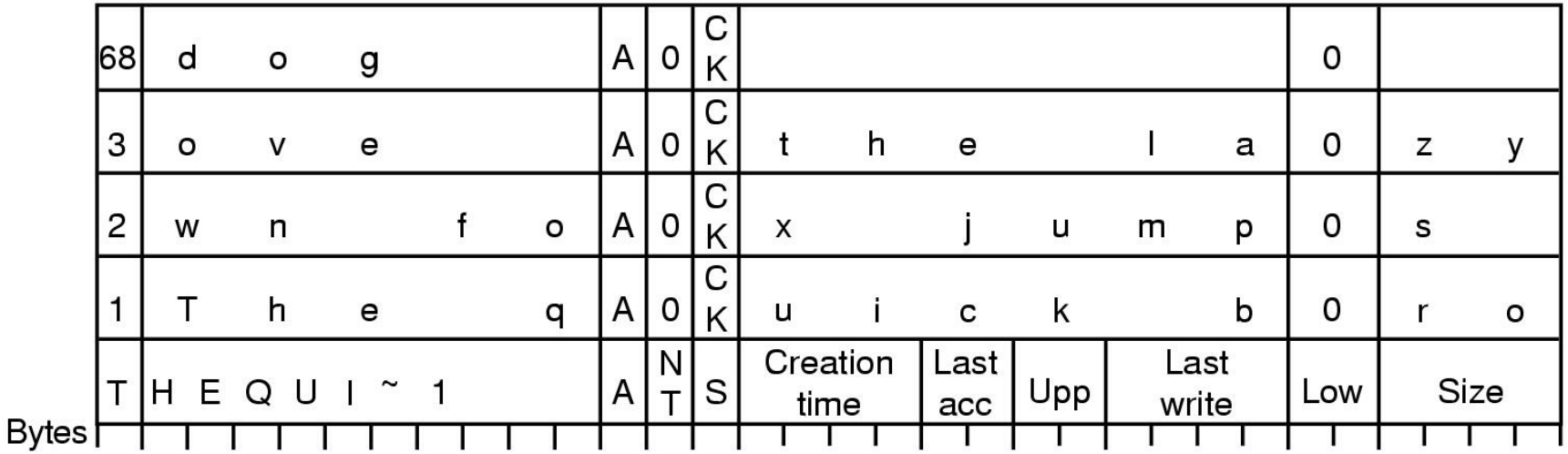
The Windows 98 File System (2)

An entry for (part of) a long file name in Windows 98



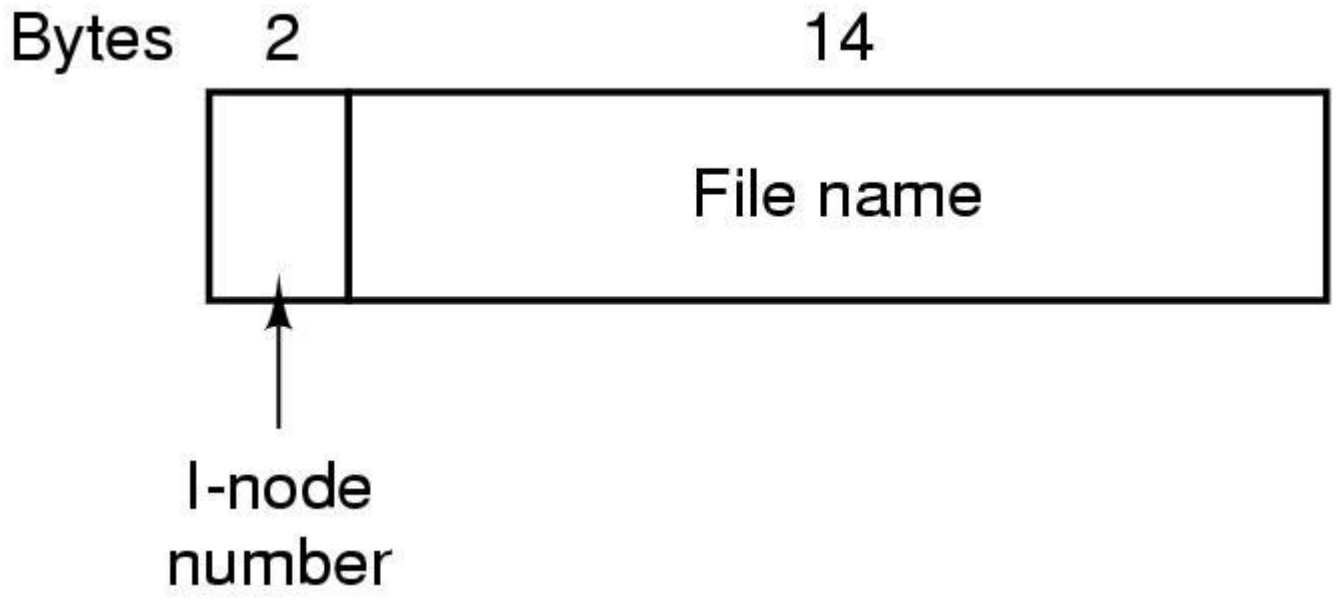
The Windows 98 File System (3)

An example of how a long name is stored in Windows 98



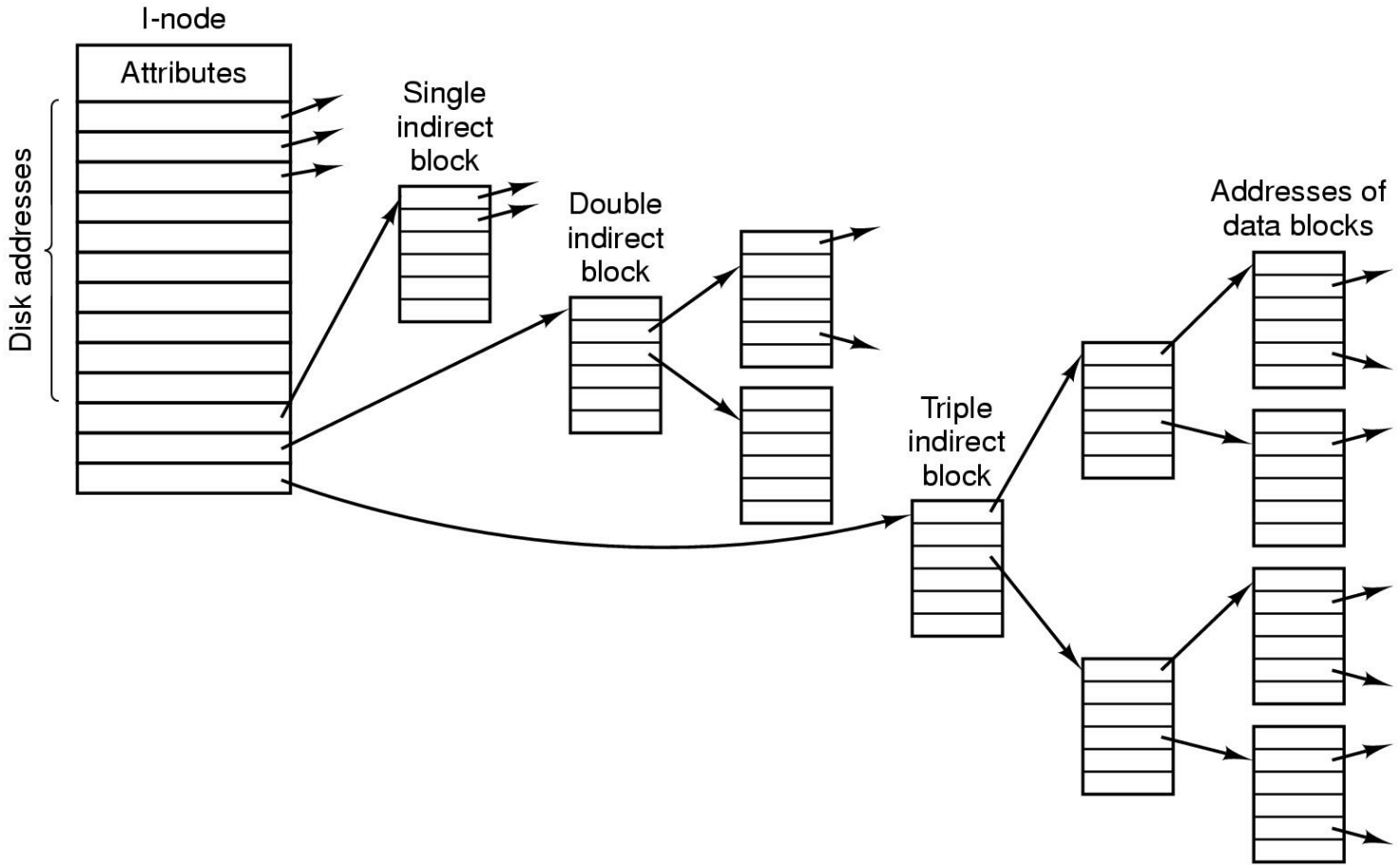
The UNIX V7 File System (1)

A UNIX V7 directory entry



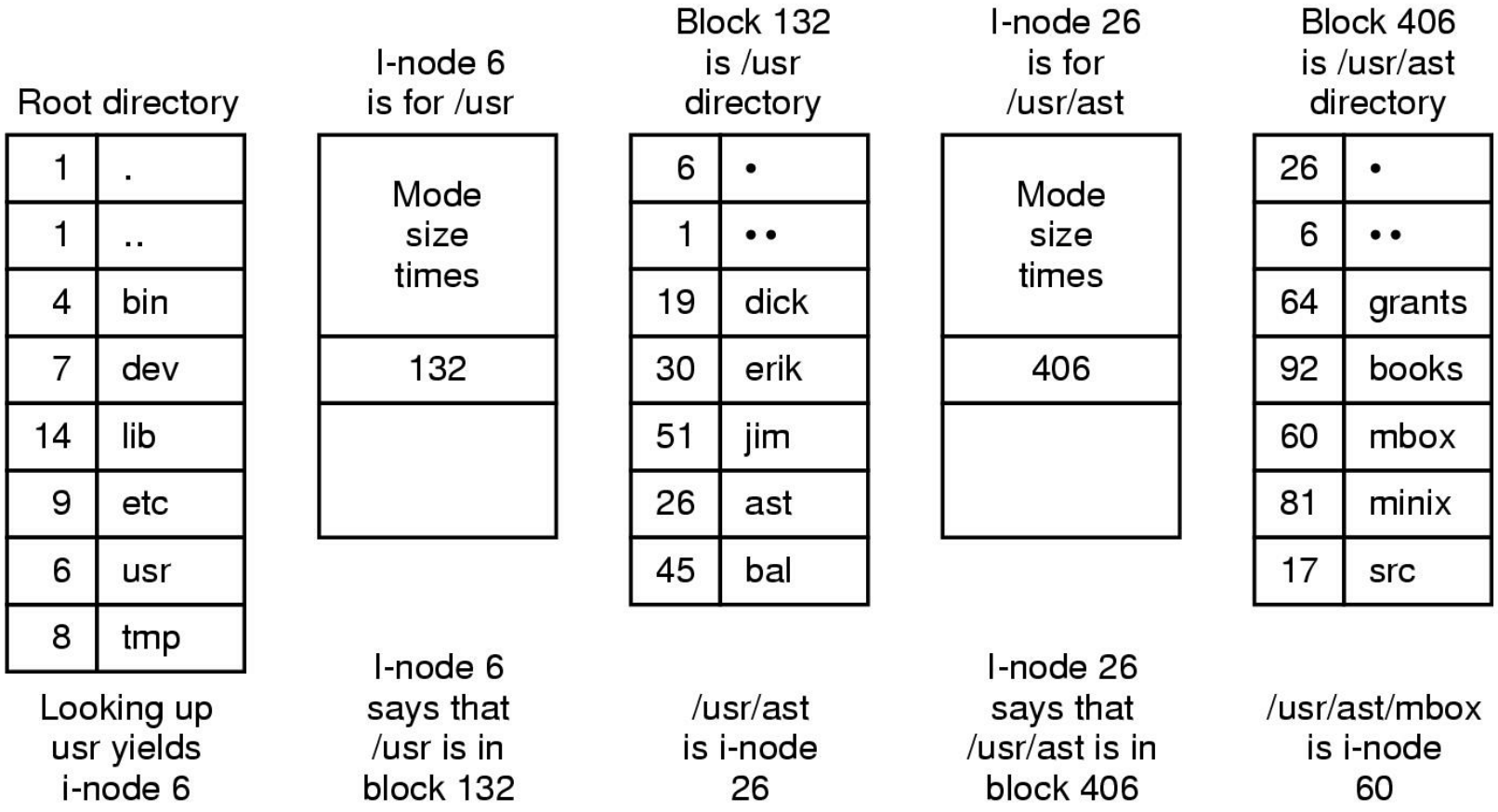
The UNIX V7 File System (2)

A UNIX i-node



The UNIX V7 File System (3)

The steps in looking up */usr/ast/mbox*



SUMMARY

- Files
- Directories
- File system implementation
- Example file systems