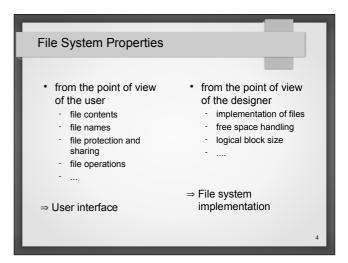
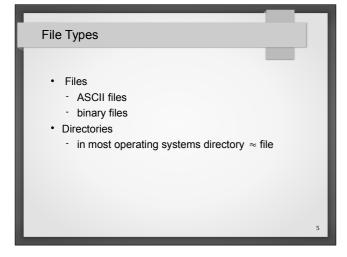
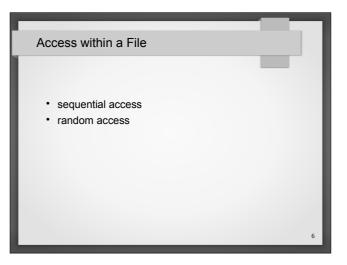


need to store very large amounts of data stored data should not be lost after process terminates processes should be able to share access to the stored data

File System Functions • file naming • file access • file use • protection and sharing • implementation







File Attributes

- information stored in directory structure (resides in secondary storage)
- directory entry: file name and unique id (used to locate file attributes)
 - · name: symbolic file name
 - identifier: unique tag used for identification in file system
 - type: for systems that support different types of files
 - location: pointer to device and location of file on device
 - size: current size of file (in bytes, words or blocks) and maximum allowed size
 - protection: access control information (who can read/write/execute, etc)
 - time, date and used identification: for creation, last modification, last

File Operations

- · create / delete
- rename
- open / close / truncate
- · read / write / append
- · position the file pointer
- · query/change file attributes
- ⇒ through system calls (open, creat, read, write, close,)

Operating System Tables

- operating system keeps open-file table
- operating system keeps open-tile table

 system-wide table: contains process independent info (e.g. location of file on disk, access
 dates, file size, open count, ...)

 per-process table: keeps track of all files opened by a process (info stored: current file po
 access rights, accounting info. ...)
 each entry in the per-process table, points to an entry in the system-wide open-file table

- when a process opens a file
 - an entry is added to the system-wide open-file table
 - open count is increment
 - an entry is added to the per-process open-file table, pointing to the entry in the system-wide open-file table
- upon each file close
 - open count is decremented

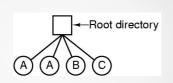
 - pointer in the per-process open-file table is removed if open count is zero, the entry is removed from the system-wide open-file table

Directories

- can be viewed as a symbol table that translates file names into their directory entries
- operations:
 - · searching for a file
 - create / delete a file
 - list a directory
 - · rename a file
 - · traverse the file system
- logical structure of a directory: single-level, two-level, tree structure, ...

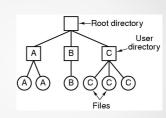
Single-Level Directory Systems

- Provides fast
- Not suitable for multi-user systems (problem if different users create files with same name)
- May be suitable for embedded systems (e.g. store driver profiles in a car)

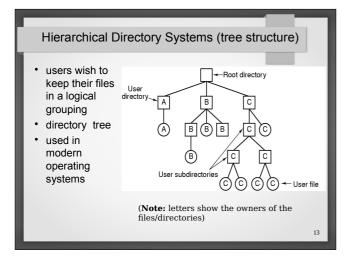


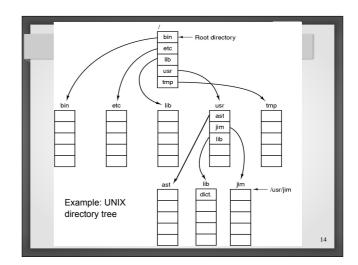
Two-Level Directory Systems

- A directory per user (hence users may have files with same name)
- May be suitable personal computers with multi-users
- System login with a user name and password may be possible



(Note: letters show the owners of the files/directories)





File System Implementation - Layered Structure

• file system has a layered structure:

application programs (top level)

logical file system

file-organization module

basic file system

I/O control (lowest level)

devices

- duplication of code minimized: I/O control and sometimes the basic file system can be used by multiple file systems
- introduces operating system overhead, decreasing performance

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I/O Control Level

- consists of device drivers and interrupt handlers
- device driver translates high-level commands into hardware-specific instructions used by hardware controller (interface of I/O device to system)

1.0

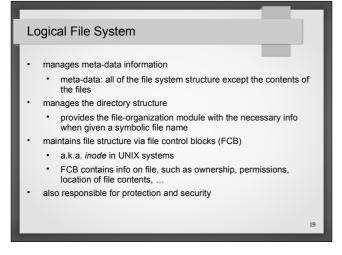
Basic File System

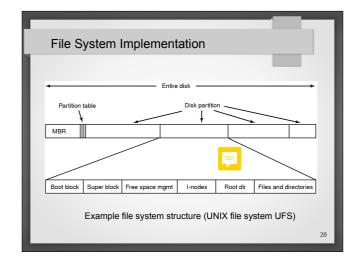
- issues generic commands to appropriate device driver
- manages memory buffers and caches holding filesystem, directory and data blocks
- a block in the buffer is allocated before a disk block transfer can occur

File-Organization Module

- knows about files' logical and physical blocks
- translates logical block addresses to physical block addresses
- also manages free space: keeps track of unallocated blocks

1





File System Implementation

- Boot control block (per volume)
 - info needed by system to boot an operating system from that volume
 - if no operating system on volume, block is empty (raw disk, e.g. swap space in UNIX can use a raw partition)
 - · typically is the first block of a volume
 - in UFS: boot block

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File System Implementation

- Volume control block (per volume)
 - contains volume (or partition) details (e.g. no of blocks in partition,
 - size of blocks, free block count, free block pointers, free FCB count and free FCB pointers, ...
 - in UFS: superblock

2.

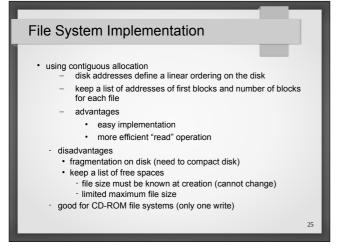
File System Implementation

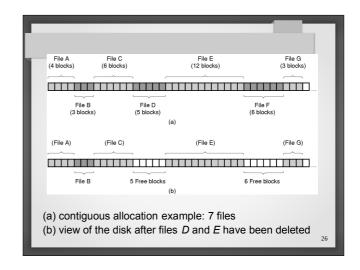
- Directory structure (per file system)
 - for organizing files
 - in UFS: includes file names and associated inode numbers

File System Implementation

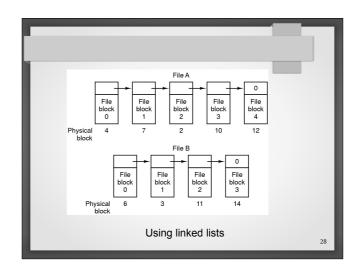
- per-file FCB
 - · contains details about file
 - has a unique id to associate with a directory entry
 - inodes in UFS

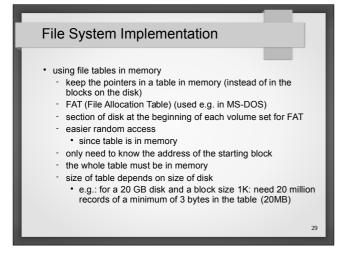
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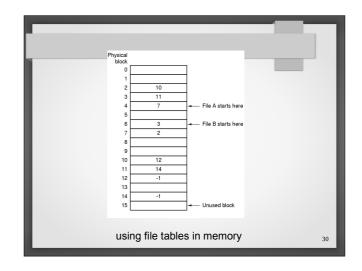




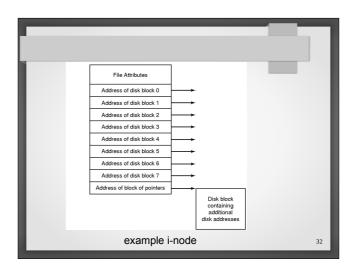
File System Implementation • using linked lists - first word of each block is a pointer to the next block - no fragmentation (internal fragmentation only in the last block) - only the address of the first block of a file is kept - access to data in a file: easy sequential access; random access is harder - data size in blocks are no longer a power of 2: few bytes taken up by pointer - most reads performed in sizes as powers of 2 (need to read two blocks to achieve the required amount of data)







File System Implementation • keep an i-node (index-node) for each file - contains file attributes - contains disk addresses of blocks • keep only the i-nodes of open files in memory - total memory size needed is proportional to the number of maximum files allowed to be open at the same time • in the simplest implementation, the maximum number of blocks for a file is limited - solution: reserve the last entry of the i-node for a pointer to a block containing more block addresses



Poisk Space Management In files split up into blocks of fixed size which do not need to be adjacent on disk In what should the block size be (unit of allocation)? In same as sector, track, cylinder size? In device dependent In selection of the size of blocks is crucial In performance and efficient disk space usage are contradictory objectives In better to choose depending on average file size In size is usually predetermined for each system UNIX systems: usually 1K

