File Management

Chapter 12

1

File Management

- File management system is considered part of the operating system
- Input to applications is by means of a file
- Output is saved in a file for long-term storage

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Terms Used with Files

- Field
  - Basic element of data
  - Contains a single value
  - Characterized by its length and data type
- Record
  - Collection of related fields
  - Treated as a unit
    - Example: employee record

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Terms Used with Files

- File
  - Collection of similar records
  - Treated as a single entity
  - Have unique file names
  - May restrict access
- Database
  - Collection of related data
  - Relationships exist among elements

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Typical Operations

- Retrieve_All
- Retrieve_One
- Retrieve_Next
- Retrieve_Previous
- Insert_One
- Delete_One
- Update_One
- Retrieve_Few

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File Management System

- The way a user of application may access files
- Programmer does not need to develop file management software

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Objectives for a File Management System

- Meet the data management needs and requirements of the user
- Guarantee that the data in the file are valid
- Optimize performance
- Provide I/O support for a variety of storage device types

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Objectives for a File Management System

- Minimize or eliminate the potential for lost or destroyed data
- Provide a standardized set of I/O interface routines
- Provide I/O support for multiple users

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Minimal Set of Requirements

- Each user should be able to create, delete, read, and change files
- Each user may have controlled access to other users' files
- Each user may control what type of accesses are allowed to the users' files
- Each user should be able to restructure the user's files in a form appropriate to the problem

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Minimal Set of Requirements

- Each user should be able to move data between files
- Each user should be able to back up and recover the user's files in case of damage
- Each user should be able to access the user's files by using symbolic names

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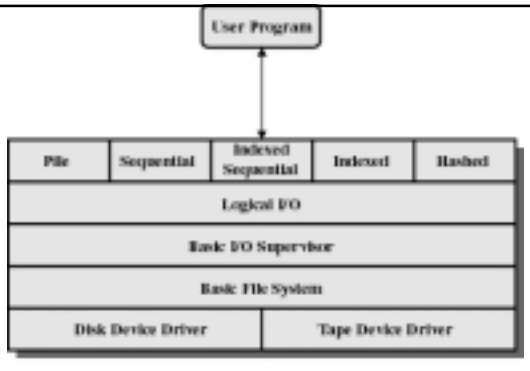

Figure 12.1 File System Software Architecture [GROS86]

Device Drivers

- Lowest level
- Communicates directly with peripheral devices
- Responsible for starting I/O operations on a device
- Processes the completion of an I/O request

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Basic File System

- Physical I/O
- Deals with exchanging blocks of data
- Concerned with the placement of blocks
- Concerned with buffering blocks in main memory

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Basic I/O Supervisor

- Responsible for file I/O initiation and termination
- Control structures are maintained
- Concerned with scheduling access to optimize performance
- Part of the operating system

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Logical I/O

- Enables users and applications to access records
- Provides general-purpose record I/O capability
- Maintains basic data about file

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Access Method

- Reflect different file structures
- Different ways to store and process data

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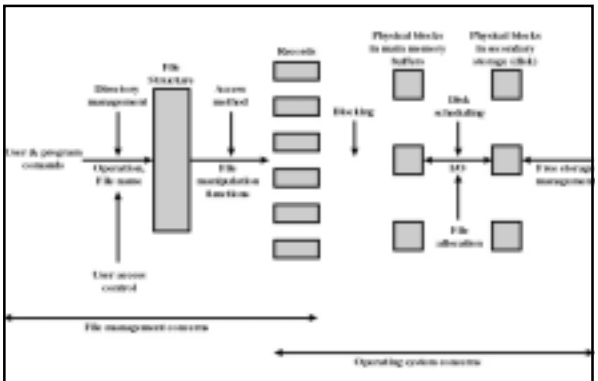

Figure 12.2 Elements of File Management

File Management Functions

- Identify and locate a selected file
- Use a directory to describe the location of all files plus their attributes
- On a shared system describe user access control
- Blocking for access to files
- Allocate files to free blocks
- Manage free storage for available blocks

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Criteria for File Organization

- Rapid access
  - Needed when accessing a single record
  - Not needed for batch mode
- Ease of update
  - File on CD-ROM will not be updated, so this is not a concern

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Criteria for File Organization

- Economy of storage
  - Should be minimum redundancy in the data
  - Redundancy can be used to speed access such as an index
- Simple maintenance
- Reliability

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File Organization

- The Pile
  - Data are collected in the order they arrive
  - Purpose is to accumulate a mass of data and save it
  - Records may have different fields
  - No structure
  - Record access is by exhaustive search

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Pile

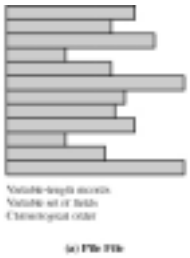

Figure 12.3 Common File Organizations

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File Organization

- The Sequential File
  - Fixed format used for records
  - Records are the same length
  - All fields the same (order and length)
  - Field names and lengths are attributes of the file
  - One field is the key filed
    - Uniquely identifies the record
    - Records are stored in key sequence

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File Organization

- The Sequential File
  - New records are placed in a log file or transaction file
  - Batch update is performed to merge the log file with the master file

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Sequential File

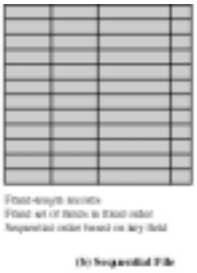

Figure 12.3 Common File Organizations

File Organization

- Indexed Sequential File
  - Index provides a lookup capability to quickly reach the vicinity of the desired record
    - Contains key field and a pointer to the main file
    - Indexed is searched to find highest key value that is equal or less than the desired key value
    - Search continues in the main file at the location indicated by the pointer

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File Organization

- Comparison of sequential and indexed sequential
  - Example: a file contains 1 million records
  - On average 500,00 accesses are required to find a record in a sequential file
  - If an index contains 1000 entries, it will take on average 500 accesses to find the key, followed by 500 accesses in the main file. Now on average it is 1000 accesses

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File Organization

- Indexed Sequential File
  - New records are added to an overflow file
  - Record in main file that precedes it is updated to contain a pointer to the new record
  - The overflow is merged with the main file during a batch update
  - Multiple indexes for the same key field can be set up to increase efficiency

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Indexed Sequential File

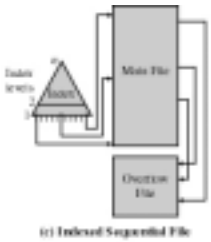

Figure 12.3 Common File Organizations

File Organization

- Indexed File
  - Uses multiple indexes for different key fields
  - May contain an exhaustive index that contains one entry for every record in the main file
  - May contain a partial index

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Indexed File

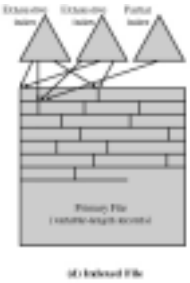

Figure 12.3 Common File Organizations

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File Organization

- The Direct, or Hashed File
  - Directly access a block at a known address
  - Key field required for each record

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File Directories

- Contains information about files
  - Attributes
  - Location
  - Ownership
- Directory itself is a file owned by the operating system
- Provides mapping between file names and the files themselves

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Simple Structure for a Directory

- List of entries, one for each file
- Sequential file with the name of the file serving as the key
- Provides no help in organizing the files
- Forces user to be careful not to use the same name for two different files

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Two-level Scheme for a Directory

- One directory for each user and a master directory
- Master directory contains entry for each user
  - Provides address and access control information
- Each user directory is a simple list of files for that user
- Still provides no help in structuring collections of files

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Hierarchical, or Tree-Structured Directory

- Master directory with user directories underneath it
- Each user directory may have subdirectories and files as entries

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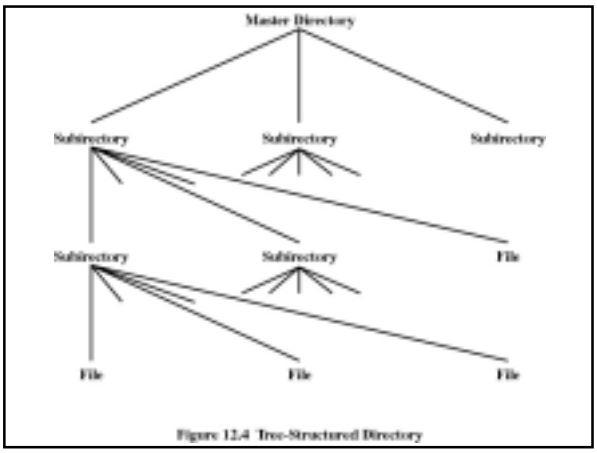
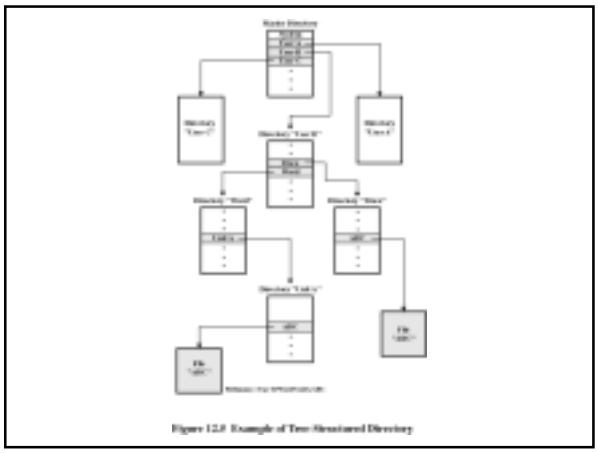


Figure 12.4 Tree-Structured Directory



Hierarchical, or Tree-Structured Directory

- Files can be located by following a path from the root, or master, directory down various branches
  - This is the pathname for the file
- Can have several files with the same file name as long as they have unique path names

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Hierarchical, or Tree-Structured Directory

- Current directory is the working directory
- Files are referenced relative to the working directory

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File Sharing

- In multiuser system, allow files to be shared among users
- Two issues
  - Access rights
  - Management of simultaneous access

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Access Rights

- None
  - User may not know of the existence of the file
  - User is not allowed to read the user directory that includes the file
- Knowledge
  - User can only determine that the file exists and who its owner is

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Access Rights

- Execution
  - The user can load and execute a program but cannot copy it
- Reading
  - The user can read the file for any purpose, including copying and execution
- Appending
  - The user can add data to the file but cannot modify or delete any of the file's contents

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Access Rights

- Updating
  - The user can modify, deleted, and add to the file's data. This includes creating the file, rewriting it, and removing all or part of the data
- Changing protection
  - User can change access rights granted to other users
- Deletion
  - User can delete the file

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Access Rights

- Owners
  - Has all rights previously listed
  - May grant rights to others using the following classes of users
    - Specific user
    - User groups
    - All for public files

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Simultaneous Access

- User may lock entire file when it is to be updated
- User may lock the individual records during the update
- Mutual exclusion and deadlock are issues for shared access

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Fixed Blocking

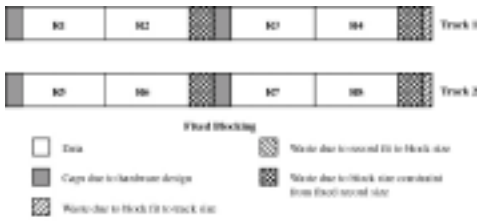

Figure 12.6 Record Blocking Methods [WIED87]

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Variable Blocking: Spanned

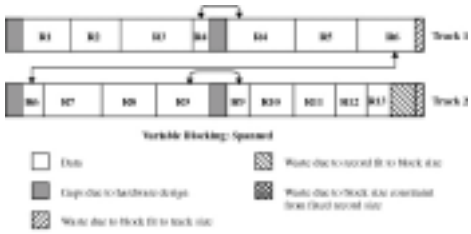

Figure 12.6 Record Blocking Methods [WIED87]

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Variable Blocking Unspanned

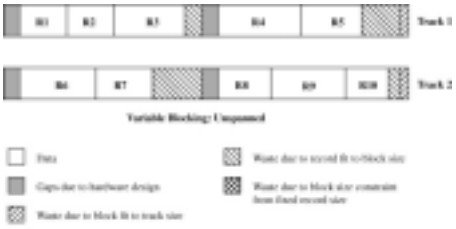

Figure 12.6 Record Blocking Methods [WIED87]

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Secondary Storage Management

- Space must be allocated to files
- Must keep track of the space available for allocation

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Preallocation

- Need the maximum size for the file at the time of creation
- Difficult to reliably estimate the maximum potential size of the file
- Tend to overestimated file size so as not to run out of space

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Methods of File Allocation

- Contiguous allocation
  - Single set of blocks is allocated to a file at the time of creation
  - Only a single entry in the file allocation table
    - Starting block and length of the file
- External fragmentation will occur

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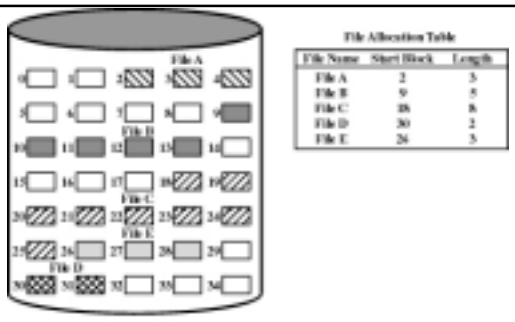

Figure 12.7 Contiguous File Allocation

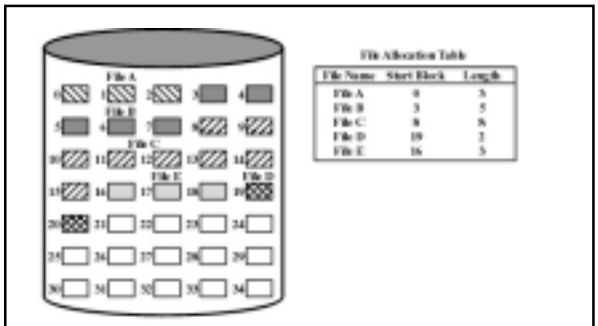

Figure 12.8 Contiguous File Allocation (After Compaction

Methods of File Allocation

- Chained allocation
  - Allocation on basis of individual block
  - Each block contains a pointer to the next block in the chain
  - Only single entry in the file allocation table
    - Starting block and length of file
- No external fragmentation
- Best for sequential files
- No accommodation of the principle of locality

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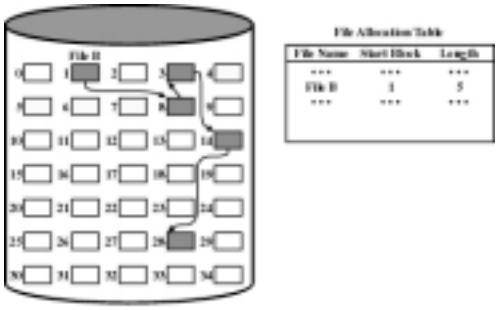

Figure 12.9 Chained Allocation

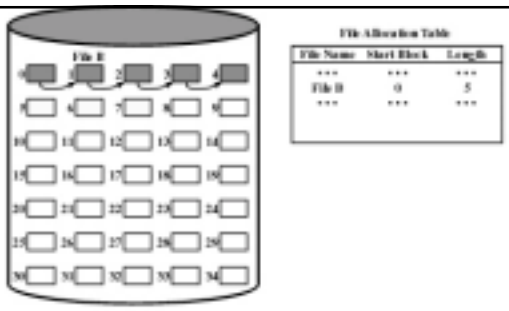

Figure 12.10 Chained Allocation (after consolidation)

Methods of File Allocation

- Indexed allocation
  - File allocation table contains a separate one-level index for each file
  - The index has one entry for each portion allocated to the file
  - The file allocation table contains block number for the index

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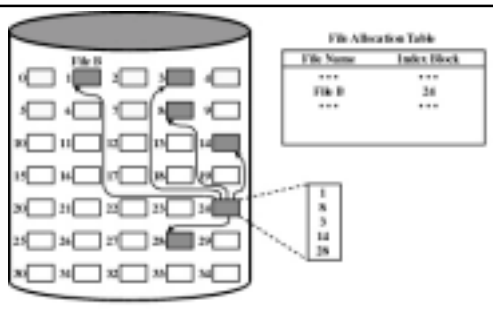

Figure 12.11 Indexed Allocation with Block Portions

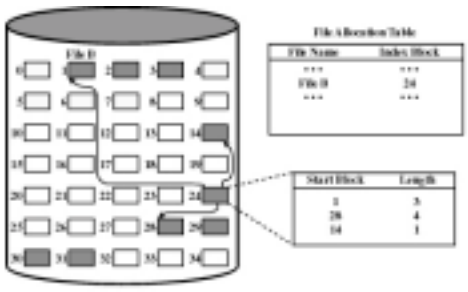

Figure 12.12 Indexed Allocation with Variable-Length Portions

UNIX File Management

- Types of files
  - Ordinary
  - Directory
  - Special
  - Named

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Figure 12.13 UNIX Block Addressing Scheme

Windows 2000 File System

- Key features of NTFS
  - Recoverability
  - Security
  - Large disks and large files
  - Multiple data streams
  - General indexing facility

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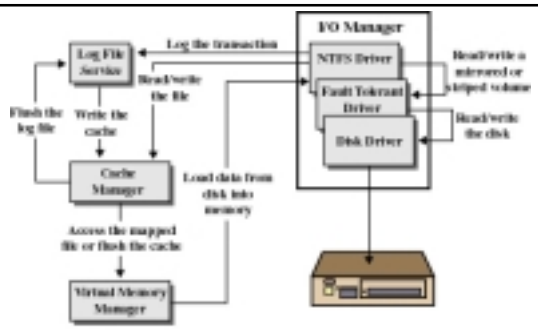

Figure 12.15 Windows NTFS Components [CUST94]