File Management

File Management

- File management system consists of system utility programs that run as privileged applications
- Input to applications is by means of a file
- Output is saved in a file for long-term storage

File System Properties

- Long-term existence
- Sharable between processes
- Structure

File Operations

- Create
- Delete
- Open
- Close
- Read
- Write

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

Terms Used with Files

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

Typical Operations

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

File Management Systems

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

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

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

Minimal Set of Requirements

- Each user should be able to *create*, *delete*, *read*, *write* and *modify* 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

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*

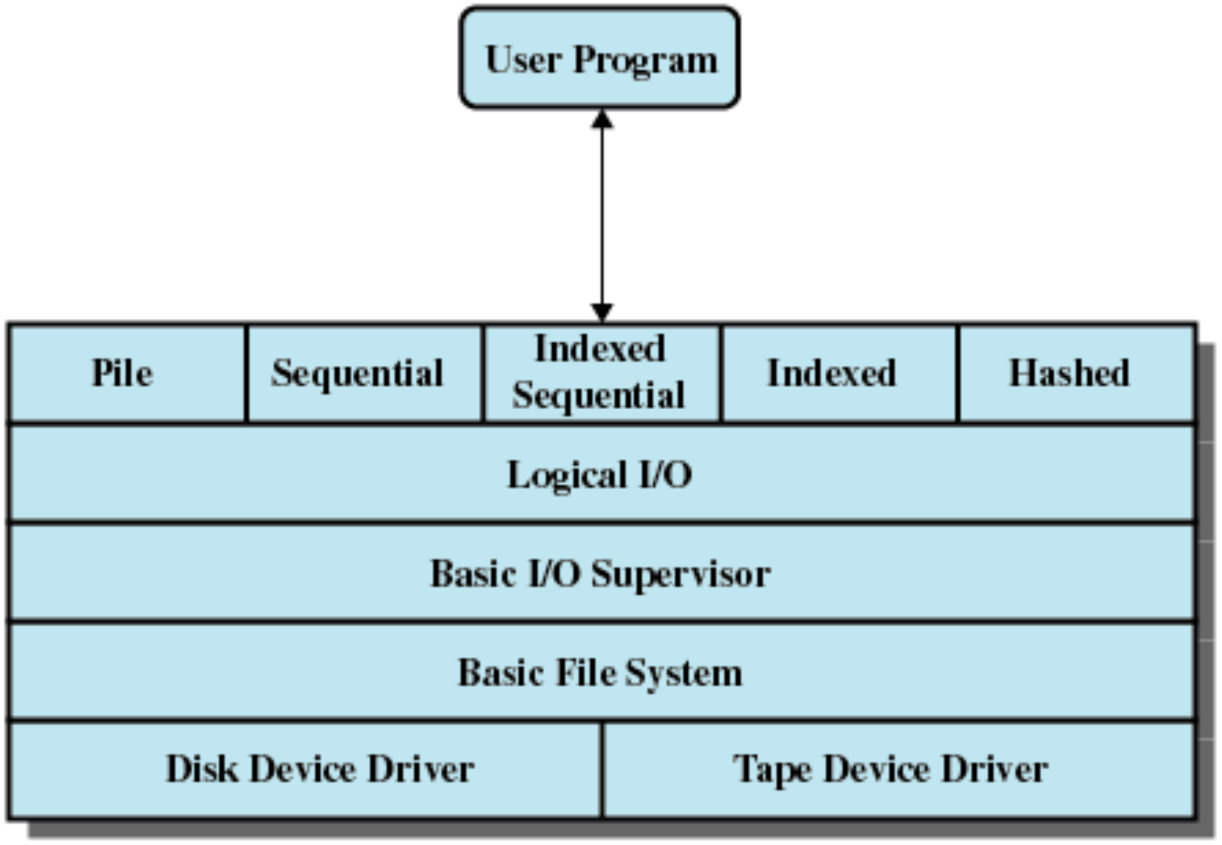
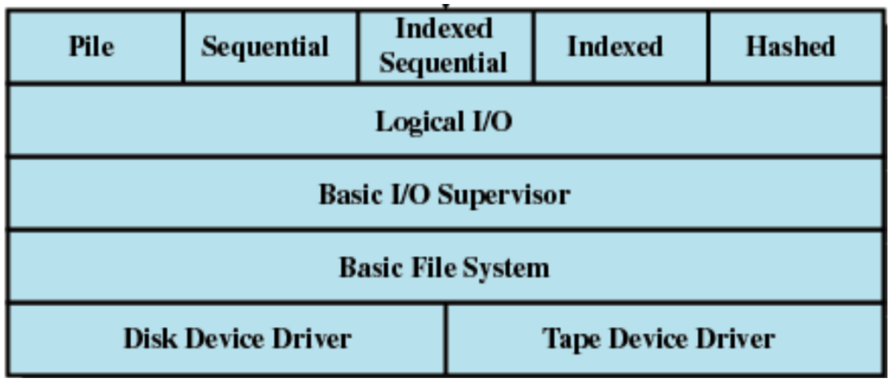


Figure 12.1 File System Software Architecture

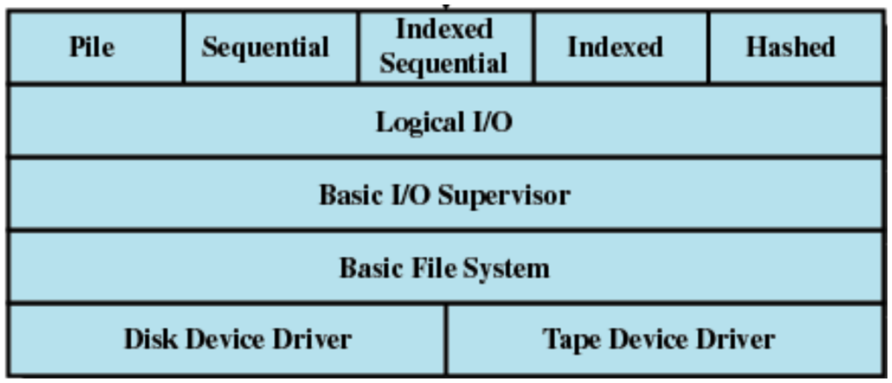
Device Drivers

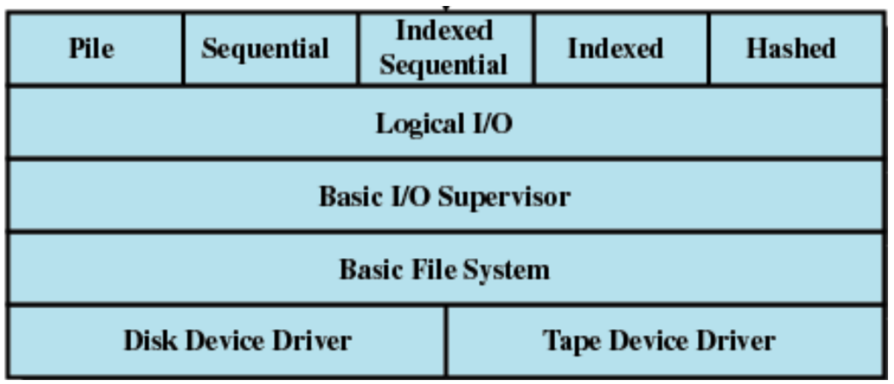
- Lowest level
- Communicates directly with peripheral devices
- Responsible for starting I/O operations on a device
- Processes the completion of an I/O request



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



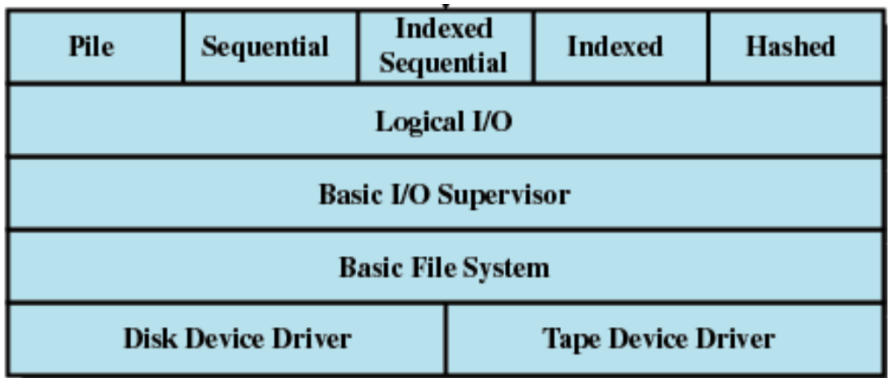


Basic I/O Supervisor

- Responsible for file I/O initiation and termination
- Control structures are maintained
- Concerned with selection of the device on which file I/O is to be performed
- Concerned with scheduling access to optimize performance
- Part of the operating system

Logical I/O

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



Access Method

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

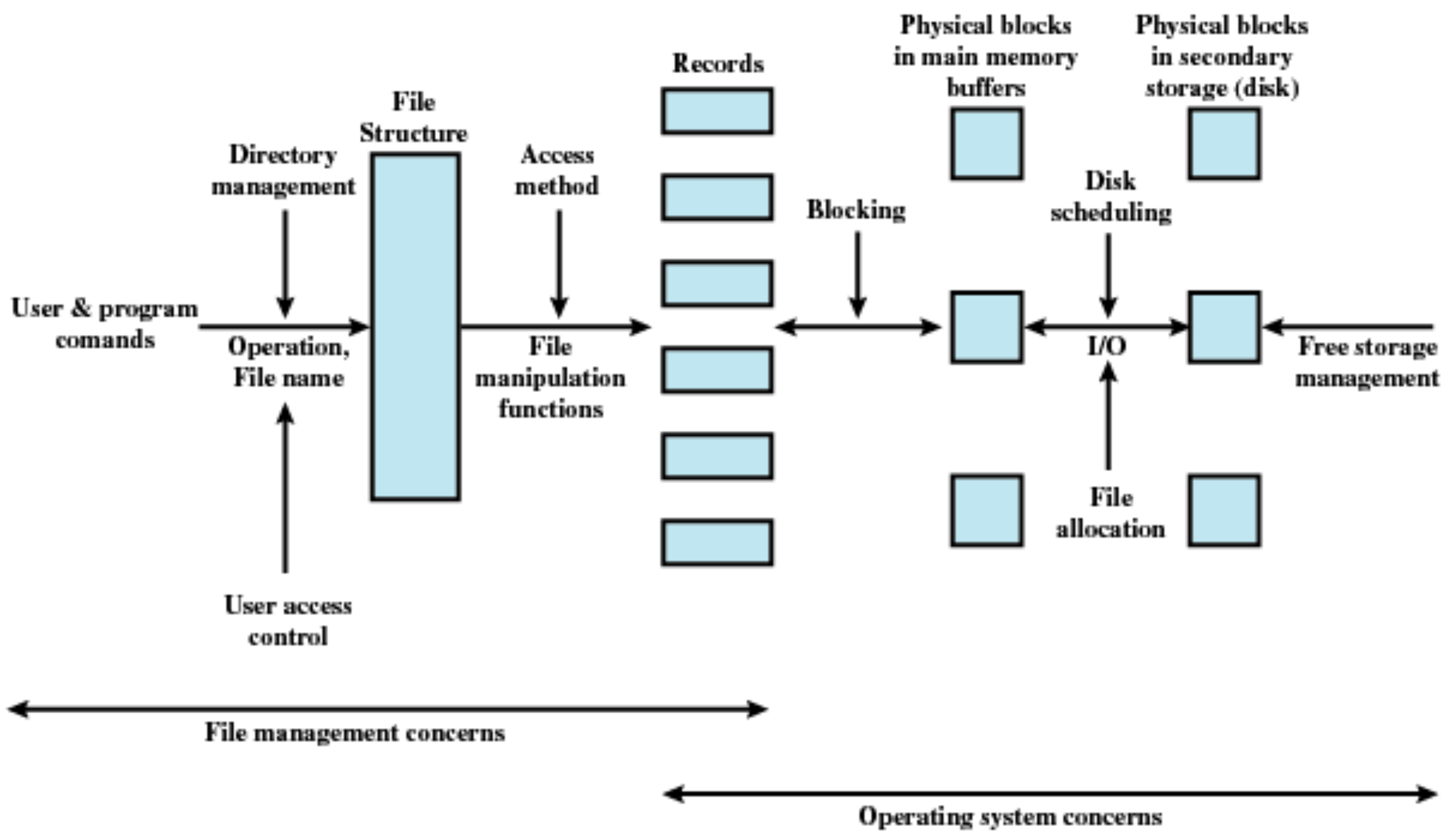


Figure 12.2 Elements of File Management

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

Criteria for File Organization

- Short access time
  - 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

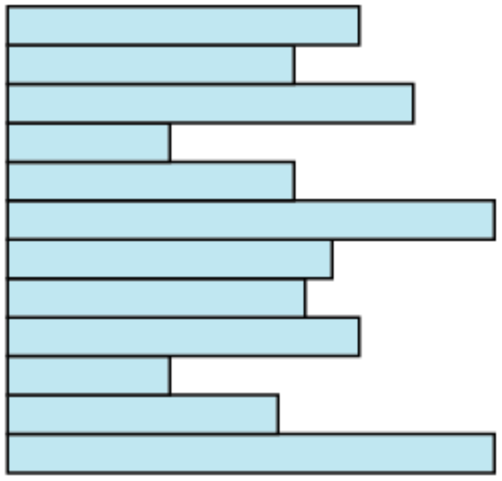
Criteria for File Organization

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

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

Pile



Variable-length records
Variable set of fields
Chronological order

(a) Pile File

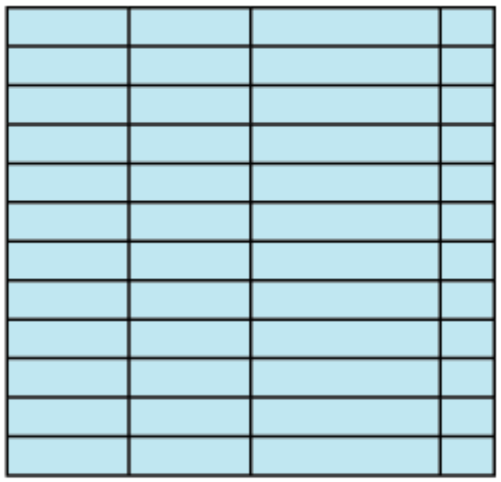
File Organization

- 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

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
- Problems accessing records
  - need to “scan” though file
  - sequential storage proves limited
    - organize sequential file physically as linked list

Sequential File



Fixed-length records
Fixed set of fields in fixed order
Sequential order based on key field

(b) Sequential File

File Organization

- Indexed Sequential File
  - Maintain key characteristics of sequential file
    - records organized in sequence base on key field
  - Two new features are added
    - index to file to support random access
    - overflow file

File Organization

- Index
  - allows to quickly reach the vicinity of the desired record
    - Contains key field and a pointer to the main file
    - Index is searched to find highest key value that is equal to or precedes the desired key value
    - Search continues in the main file at the location indicated by the pointer

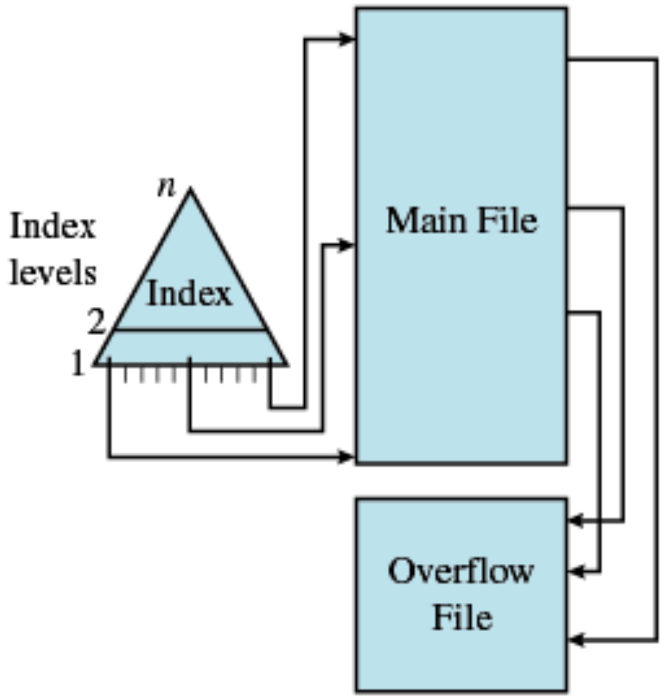
File Organization

- Comparison of sequential and indexed sequential
  - Example: a file contains 1 million records
  - sequential file: on average 500,000 accesses are required to find a record
  - indexed sequential:
    - if index contains 1000 entries, it will take on average 500 accesses to find the key
    - now the search continues in main file at the location indicated
      - on the average 500,000/1000 = 500 accesses

File Organization

- Overflow
  - 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

Indexed Sequential File

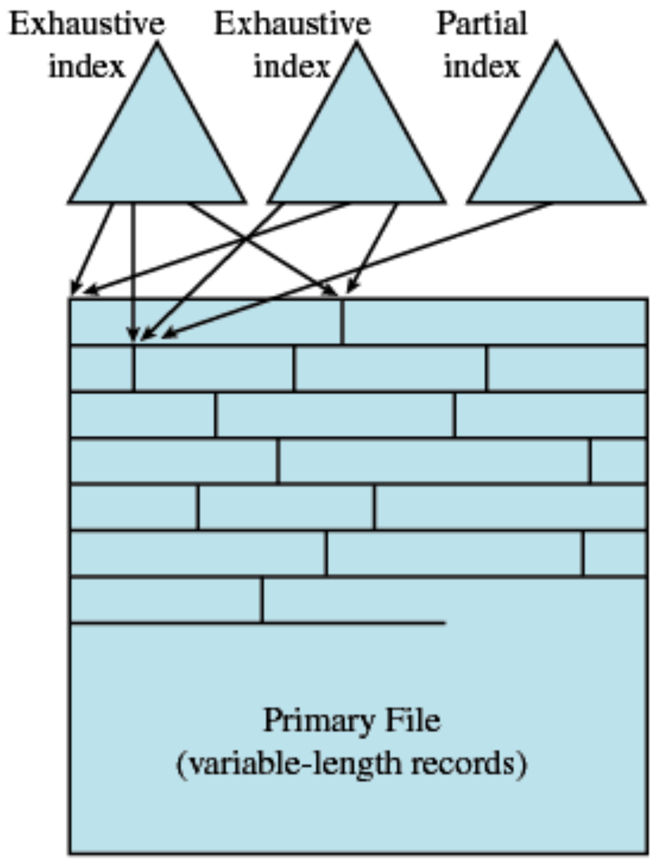


(c) Indexed Sequential File

File Organization

- Indexed File
  - Indexed sequential is limited to the use of a single key (based on single field of the 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

Indexed File



(d) Indexed File

File Organization

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

Table 12.1 Grades of Performance for Five Basic File Organizations [WIED87]

	Space		Update		Retrieval		
	Attributes		Record Size				
File Method	Variable	Fixed	Equal	Greater	Single record	Subset	Exhaustive
Pile	A	B	A	E	E	D	B
Sequential	F	A	D	F	F	D	A
Indexed sequential	F	B	B	D	B	D	B
Indexed	B	C	C	C	A	B	D
Hashed	F	B	B	F	B	F	E

A	=	Excellent, well suited to this purpose	$\approx O(r)$
B	=	Good	$\approx O(o \times r)$
C	=	Adequate	$\approx O(r \log n)$
D	=	Requires some extra effort	$\approx O(n)$
E	=	Possible with extreme effort	$\approx O(r \times n)$
F	=	Not reasonable for this purpose	$\approx O(n^{>1})$

where

r = size of the result
o = number of records that overflow
n = number of records in file