Operating Systems

Chapter 12 File Management

Agenda

- 12.1 Overview
- 12.2 File Organization and Access
- 12.3 File Directories
- 12.4 File Sharing
- 12.5 Record Blocking
- 12.6 Secondary Storage Management
- 12.7 Summary

File Management

- File management system consists of system utility programs that run as privileged applications(特权程序)
- Provides a means of data I/O
  - Input to applications is by means of a file
  - Output is saved in a file for long-term storage

File System Properties(文件系统的特性)

- Long-term existence (长期存在)
- Sharable between processes (进程共享)
- Structure (结构化存储)
  - Have specific structure according to application

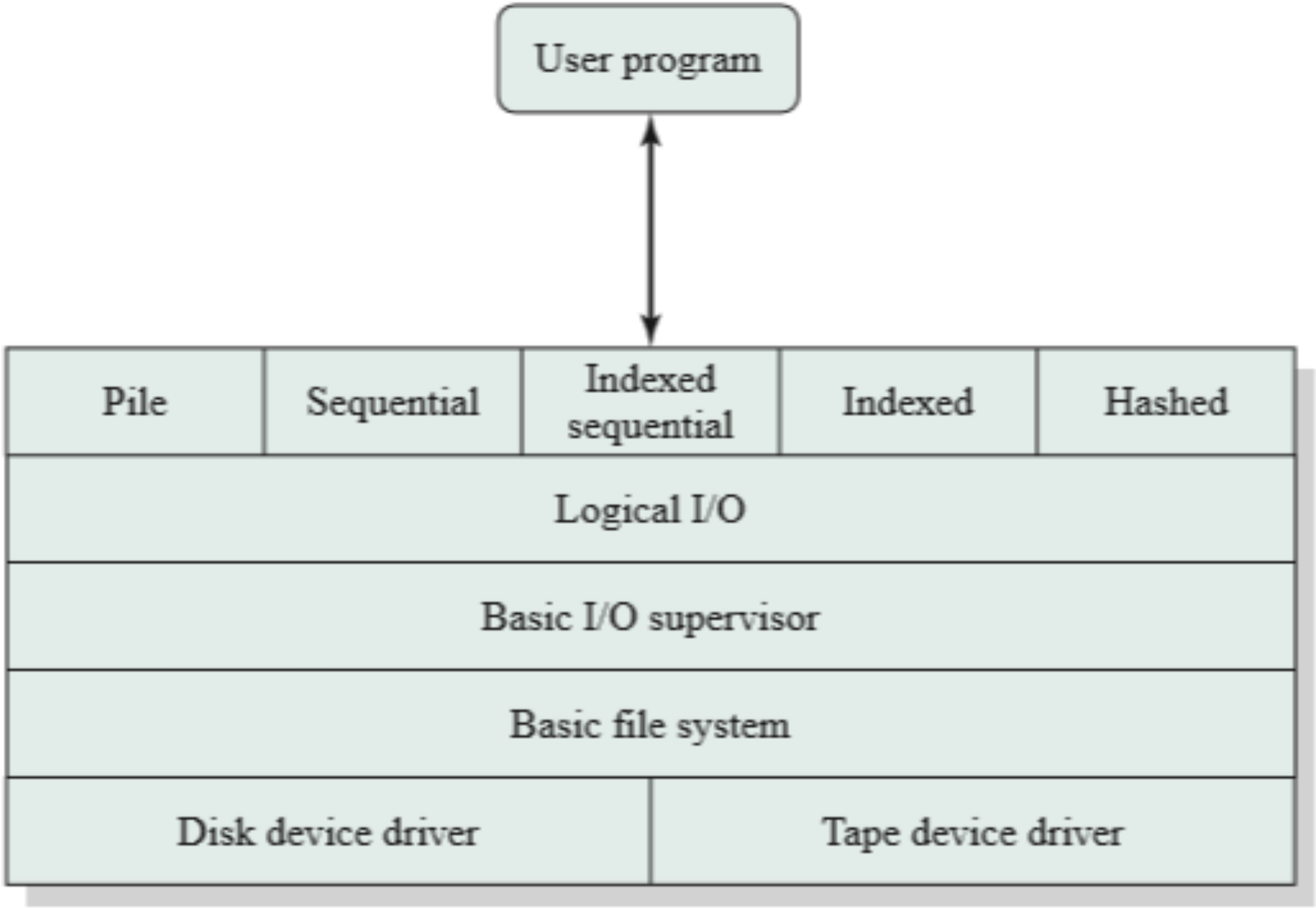

Figure 12.1 File System Software Architecture

单选题 1分

设置

The level of the file system architecture that enables users and applications to access file records is called the:

[✓ A] Logical I/O level

B Basic file system level

C Basic I/O supervisor level

D All of the above

提交

File Operations(文件操作)

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

Terms Used with Files (文件术语)

- Field (域)
  - Basic element of data(基本数据单元)
  - Contains a single value
  - Characterized by its length and data type
- Record (记录)
  - Collection of related fields(相关域的集合)
  - Treated as a unit
    - Example: employee record

Terms Used with Files

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

单选题 1分

设置

A file is generally defined to be:

[✓ A] A collection of similar records

B A collection of related fields

C A basic element of data

D All of the above

提交

File Management Systems (文件管理系统)

- The way a user of application may access files(用户和程序使用文件的唯一方式)
- Programmer does not need to develop file management software

File Management Functions

1. Identify (标识) and locate (定位) a selected file
   - Use file name to identify files
   - Use a directory (目录) to describe the location of all files plus their attributes (属性)
2. On a shared system describe user access control (存取控制)
3. Blocking (块化) for access to files
4. Manage free blocks
   - Allocate free blocks to files (空闲块分配)
   - Reclaim free blocks (空闲块回收)

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12.2 File Organization and Access

- 12.2.1 Criteria for File Organization
- 12.2.2 The Pile
- 12.2.3 The Sequential File
- 12.2.4 The Indexed Sequential File
- 12.2.5 The Indexed File
- 12.2.6 The Direct or Hashed File

Criteria for File Organization (文件管理的评价标准)

1. Short access time (短的存取时间)
2. Ease of update (易于修改)
3. Economy of storage (存储经济性)
4. Simple maintenance (维护简单)
5. Reliability (可靠性)

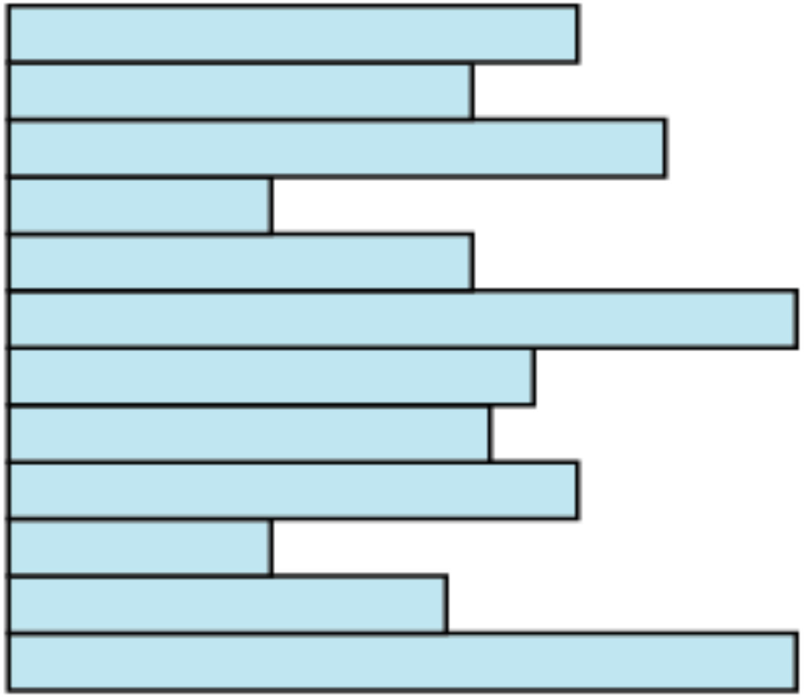
12.2 File Organization and Access

- 12.2.1 Criteria for File Organization
- 12.2.2 The Pile
- 12.2.3 The Sequential File
- 12.2.4 The Indexed Sequential File
- 12.2.5 The Indexed File
- 12.2.6 The Direct or Hashed File

The Pile (堆文件)

- 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 (穷举搜索)

The Pile



Variable-length records
Variable set of fields
Chronological order 按时间的前后顺序排列

(a) Pile File

单选题 1分

设置

Record access in a pile file can be conducted by:

A Partial index

[✓ B] Exhaustive search

C Key field

D All of the above

提交

12.2 File Organization and Access

- 12.2.1 Criteria for File Organization
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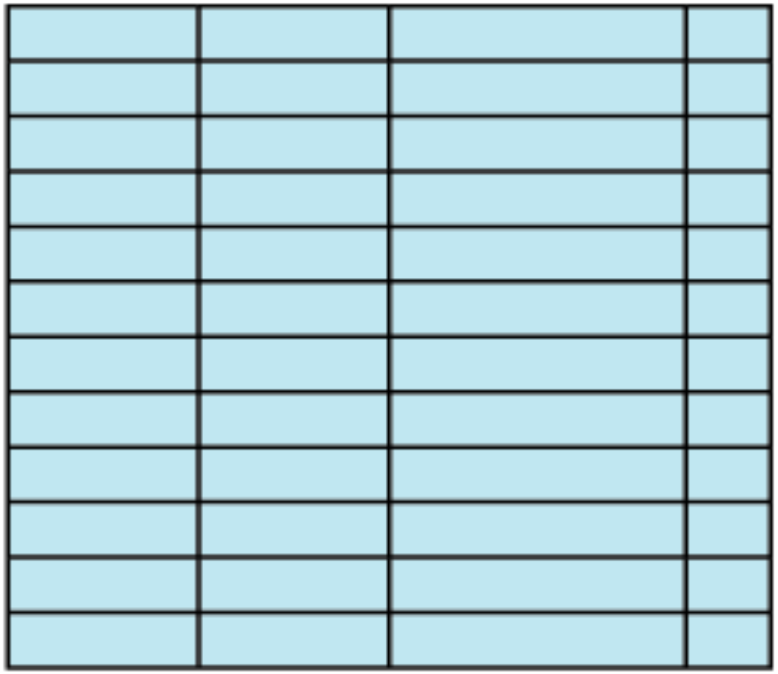
The Sequential File (顺序文件)

1. All fields the same (order and length)
   - Field names and lengths are attributes of the file
2. All records the same length
3. One field is the key filed (关键域，关键字)
   - Uniquely identifies the record
   - Records are stored in key sequence

The Sequential File

4. New records are placed in a log file(日志文件) or transaction file(事务文件)
5. Batch update (成批更新) is performed to merge(合并) the log file with the master file

The Sequential File



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

(b) Sequential File

12.2 File Organization and Access

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- 12.2.4 The Indexed Sequential File
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The Indexed Sequential File (索引顺序文件)

- Sequential file + index + overflow file
- Index provides a lookup capability to quickly reach the vicinity of the desired record (索引提供了快速接近目标记录的查询能力)
  - Index contains a key field and a pointer to the main file
  - Indexed is searched to find highest key value that is equal to or precedes the desired key value (索引查找关键字小于或者等于目标关键字的最大记录)

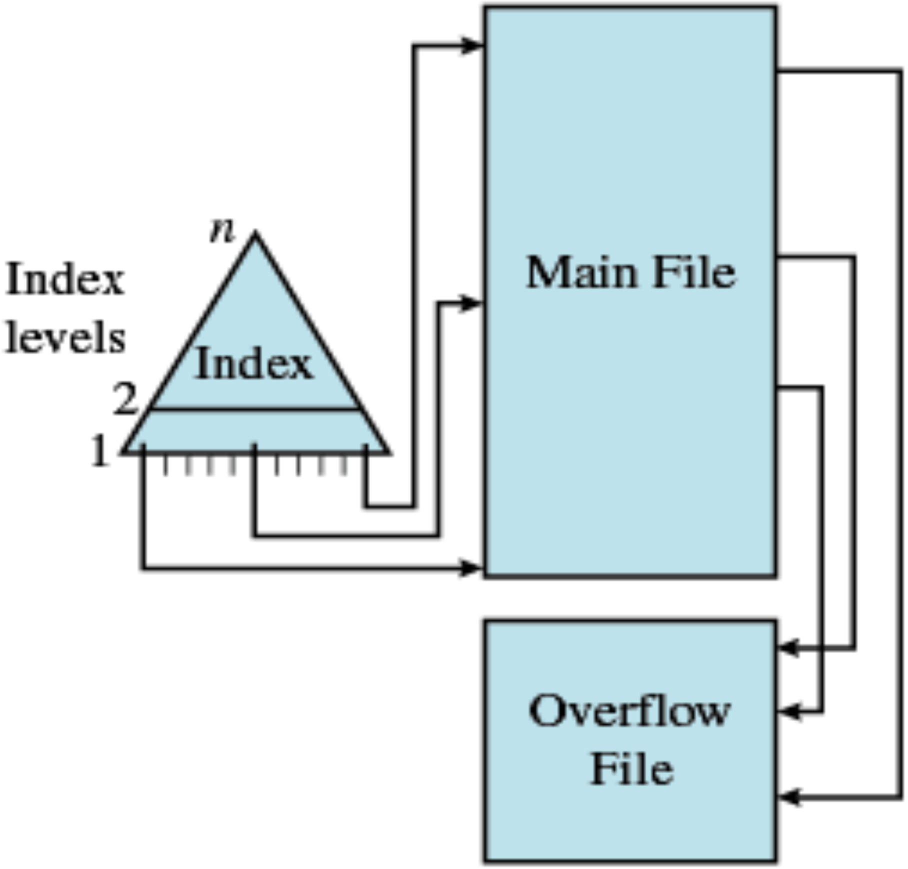
The Indexed Sequential File (索引顺序文件)

- Comparison of sequential and indexed sequential
  - Example: a file contains 1000000 records
  - On average 500000 accesses are required to find a record in a sequential file
  - If an index contains 1000 entries and each entries contains 1000 pointers to main file, 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

Overflow File of The Indexed Sequential File

- New records are added to an overflow file(溢出文件)
- Record in main file that precedes it is updated to contain a pointer to the new record
- The overflow is merged (合并) with the main file during a batch update
- Multiple level indexes (多级索引) for the same key field can be set up to increase efficiency

Indexed Sequential File



(c) Indexed Sequential File

单选题 1分

设置

Indexed sequential files similar to sequential files, but contain two added features:

A Hash function and an overflow file

B Hash function and file index

[✓ C] File index and overflow file

D All of the above

提交

12.2 File Organization and Access

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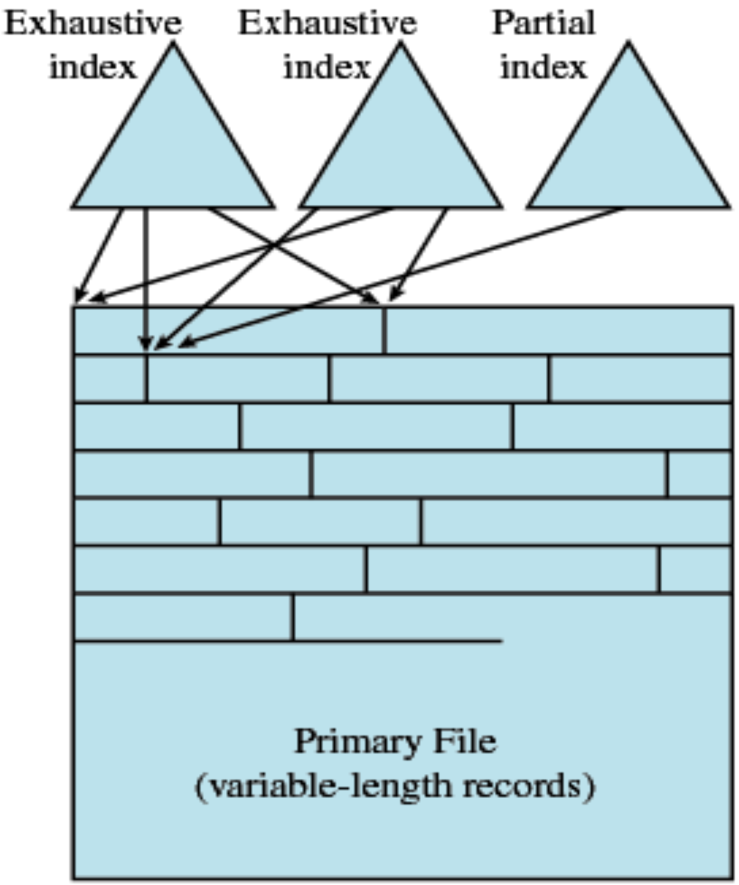
The Indexed File (索引文件)

- Uses multiple indexes for **different key fields**
- May contain an exhaustive index(完全索引) that contains one entry for every record in the main file
- May contain a partial index(部分索引)
- Index files itself are sequential file

The Indexed File



(d) Indexed File

12.2 File Organization and Access

- 12.2.1 Criteria for File Organization
- 12.2.2 The Pile
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- 12.2.6 The Direct or Hashed File

The Direct or Hashed File(直接文件或者散列文件)

- Directly access a block at a known address
- Key field required for each record
- Hash based on the key field

单选题 1分

设置

Direct or hashed files are often used where:

A Very rapid access is required

B Records are always accessed one at a time

C Fixed length records are used

[✓ D] All of the above

提交

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12.3 File Directories

- 12.3.1 Contents
- 12.3.2 Structure
- 12.3.3 Naming

File Directories

- Contains information about files
  - Attributes (属性)
  - Location (位置)
  - Ownership (所有者)
- Directory itself is a file owned by the operating system(一个目录本身是一个文件)
- Provides mapping between file names and the files themselves(提供文件名和文件之间的映射)

12.3 File Directories

- 12.3.1 Contents
- 12.3.2 Structure
- 12.3.3 Naming

Simple Structure for a Directory (简单目录结构)

- Represented by a simple sequential file with the name of the file serving as the key (用顺序文件代表目录，该目录下的文件名做该顺序文件的关键字)
- Forces user to be careful not to use the same name for two different files (文件不能重名)

Two-level Scheme for a Directory(两级目录方案)

- A master directory (主目录)
- One directory for each user (用户目录)
- 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 （不能建子目录）

Hierarchical, or Tree-Structured Directory (层次/树状结构目录)

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

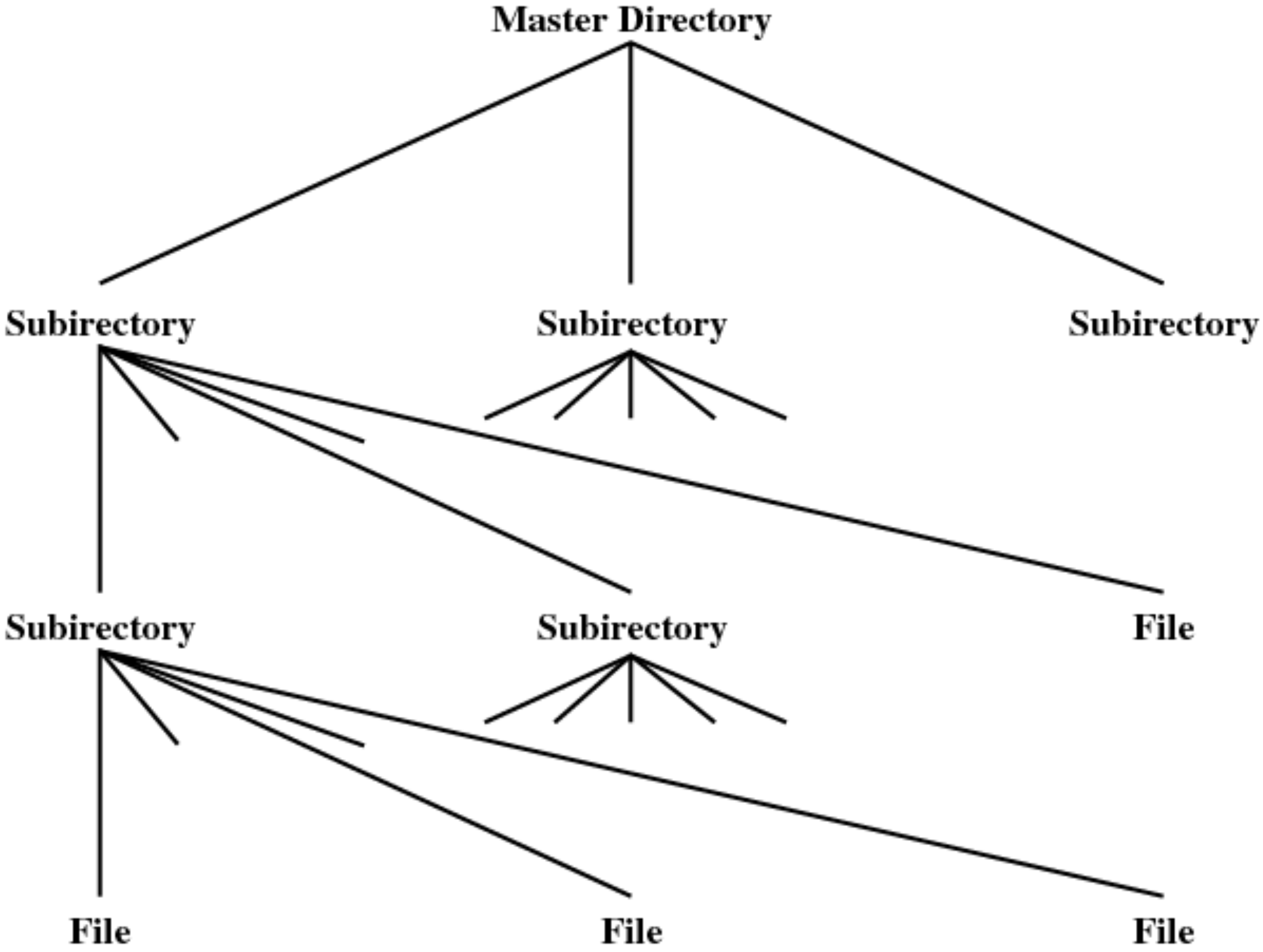


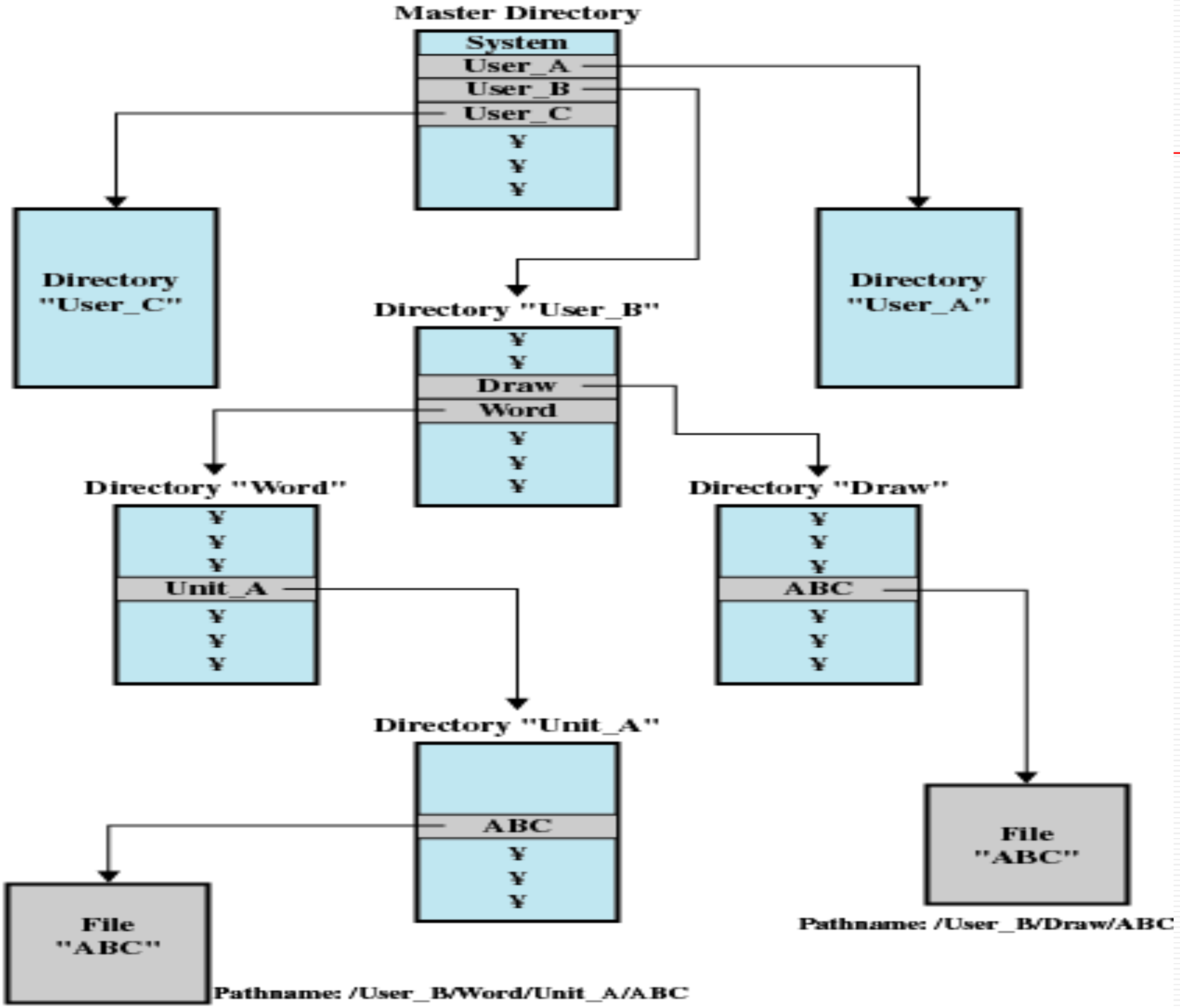
Figure 12.4 Tree-Structured Directory

12.3 File Directories

- 12.3.1 Contents
- 12.3.2 Structure
- 12.3.3 Naming

Hierarchical, or Tree-Structured Directory

- Files can be located (文件定位) 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 (文件同名) as long as they have unique path names



Pathname: /User_B/Draw/ABC

Pathname: /User_B/Word/Unit_A/ABC

Figure 12.5 Example of Tree-Structured Directory

Hierarchical, or Tree-Structured Directory

- Pathname(路径名)
- Current directory is the working directory (工作目录)
- Files are referenced relative to the working directory (相对路径)

单选题 1分

设置

In a tree-structured directory, the series of directory names that culminates in a file name is referred to as the:

A Symbolic name

[✓ B] Pathname

C Working directory

D None of the above

提交

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File Sharing

- In multiuser system, allow files to be shared among users
- Two issues
  - Access rights (存取权限)
  - Management of simultaneous access (同时存取控制)

Access Rights

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

Access Rights

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

Access Rights

- Updating(更新)
  - 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(更改保护)
  - User can change access rights granted to other users
- Deletion(删除)
  - User can delete the file

Access Rights

- Owners （所有者）
  - Has all rights previously listed
  - May grant rights to others using the following classes of users
    - Specific user(指定用户)
    - User groups(用户组)
    - All for public files(所有用户)

Simultaneous Access(同时访问)

- 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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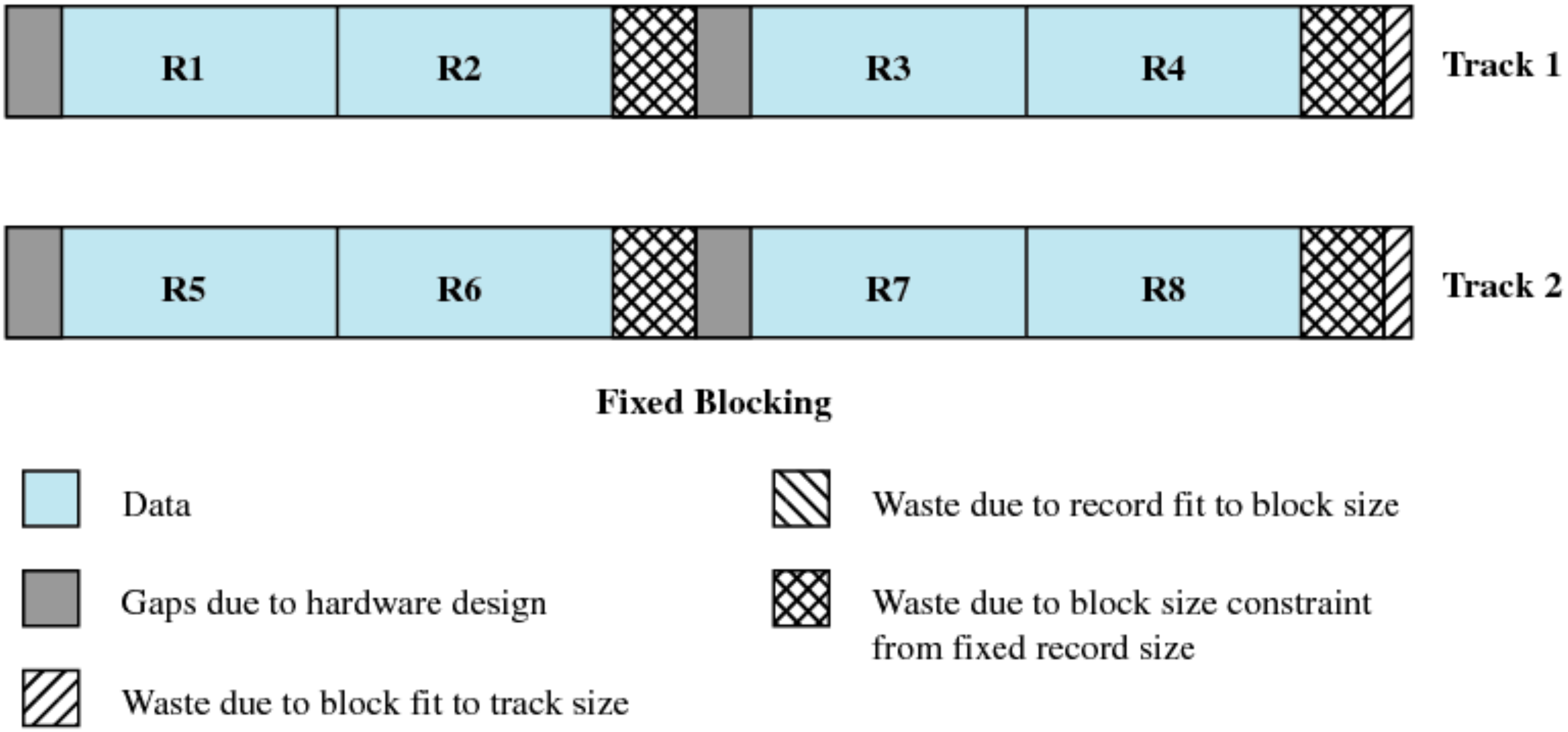
Fixed Blocking


R1
R2
R3
R4
Track 1
R5
R6
R7
R8
Track 2
Fixed Blocking
Data
Gaps due to hardware design
Waste due to block fit to track size
Waste due to record fit to block size
Waste due to block size constraint from fixed record size

单选题 1分

设置

Fixed file blocking experiences the following potential problem:

[✓ A] Internal fragmentation

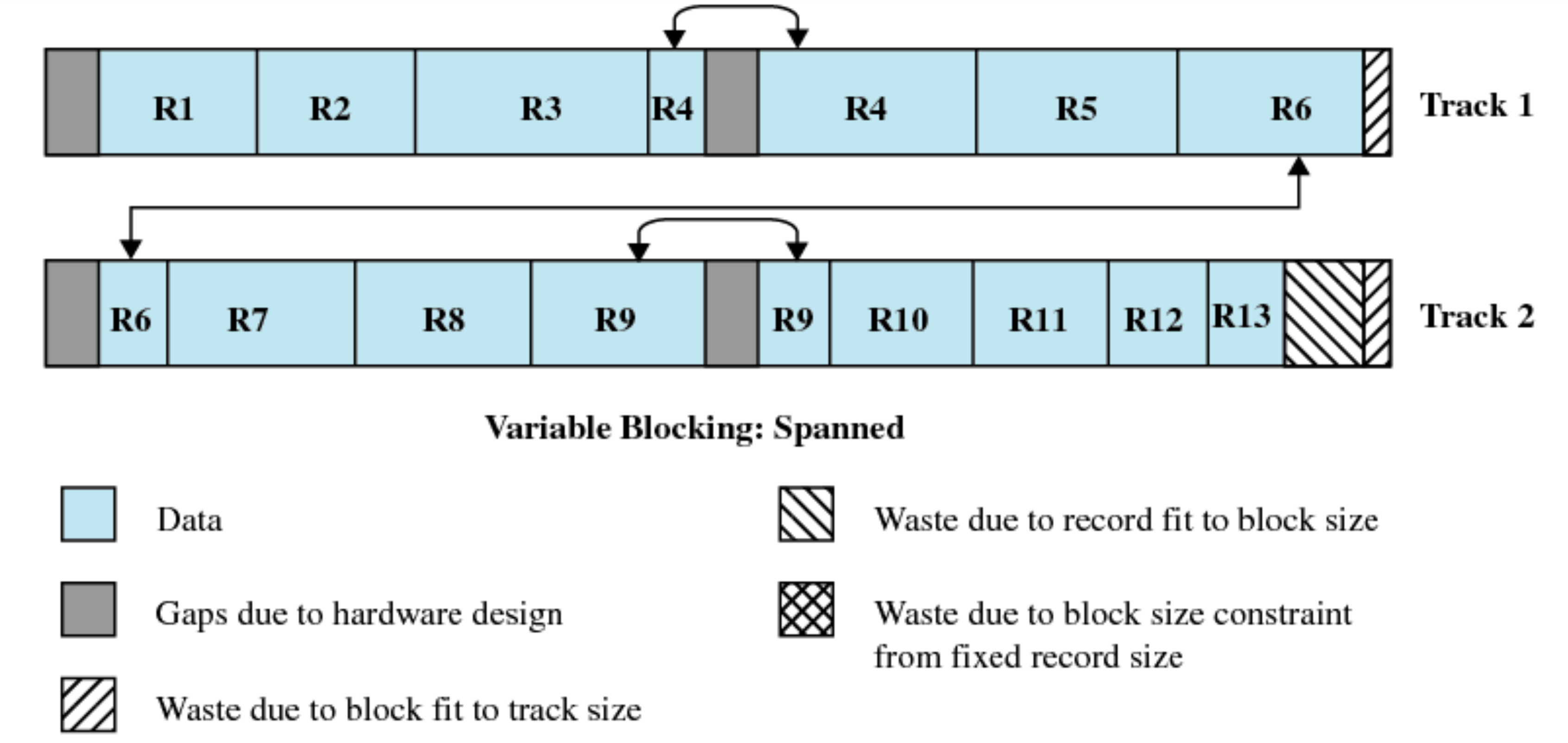
B Gaps due to hardware design

C External fragmentation

D None of the above

提交

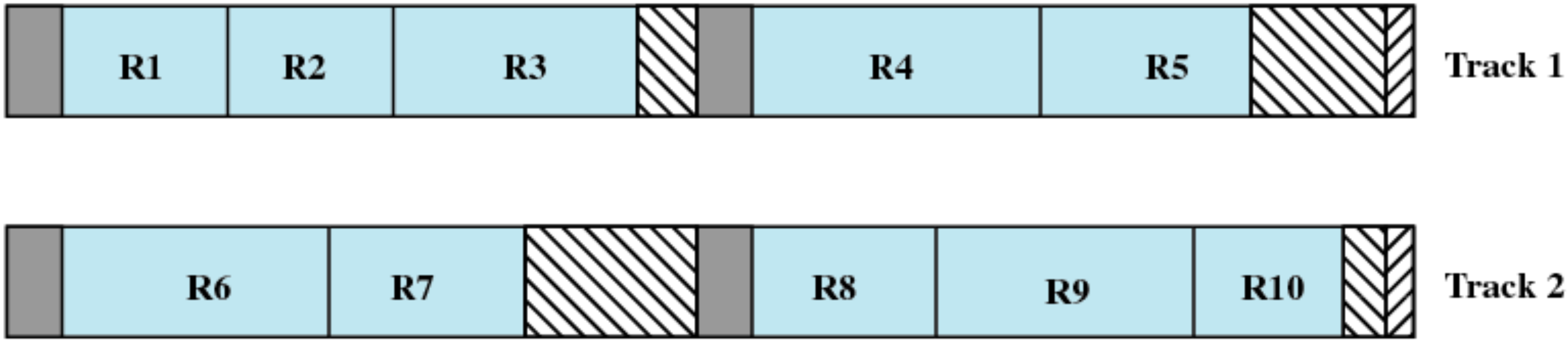
Variable-Length Spanned Blocking



Variable Blocking: Spanned

R1
R2
R3
R4
R4
R5
R6
Track 1
R6
R7
R8
R9
R9
R10
R11
R12
R13
Track 2
Data
Gaps due to hardware design
Waste due to block fit to track size
Waste due to record fit to block size
Waste due to block size constraint from fixed record size

Variable-Length Unspanned Blocking



Variable Blocking: Unspanned

- 🟦 Data
- ■ Gaps due to hardware design
- ▨ Waste due to block fit to track size
- ▧ Waste due to record fit to block size
- ▩ Waste due to block size constraint from fixed record size

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12.6 Secondary Storage Management(二级存储管理)

- 12.6.1 File Allocation
- 12.6.2 Free Space Management
- 12.6.3 Reliability

File Allocation Table(FAT)

- FAT is used to track portions allocated to files

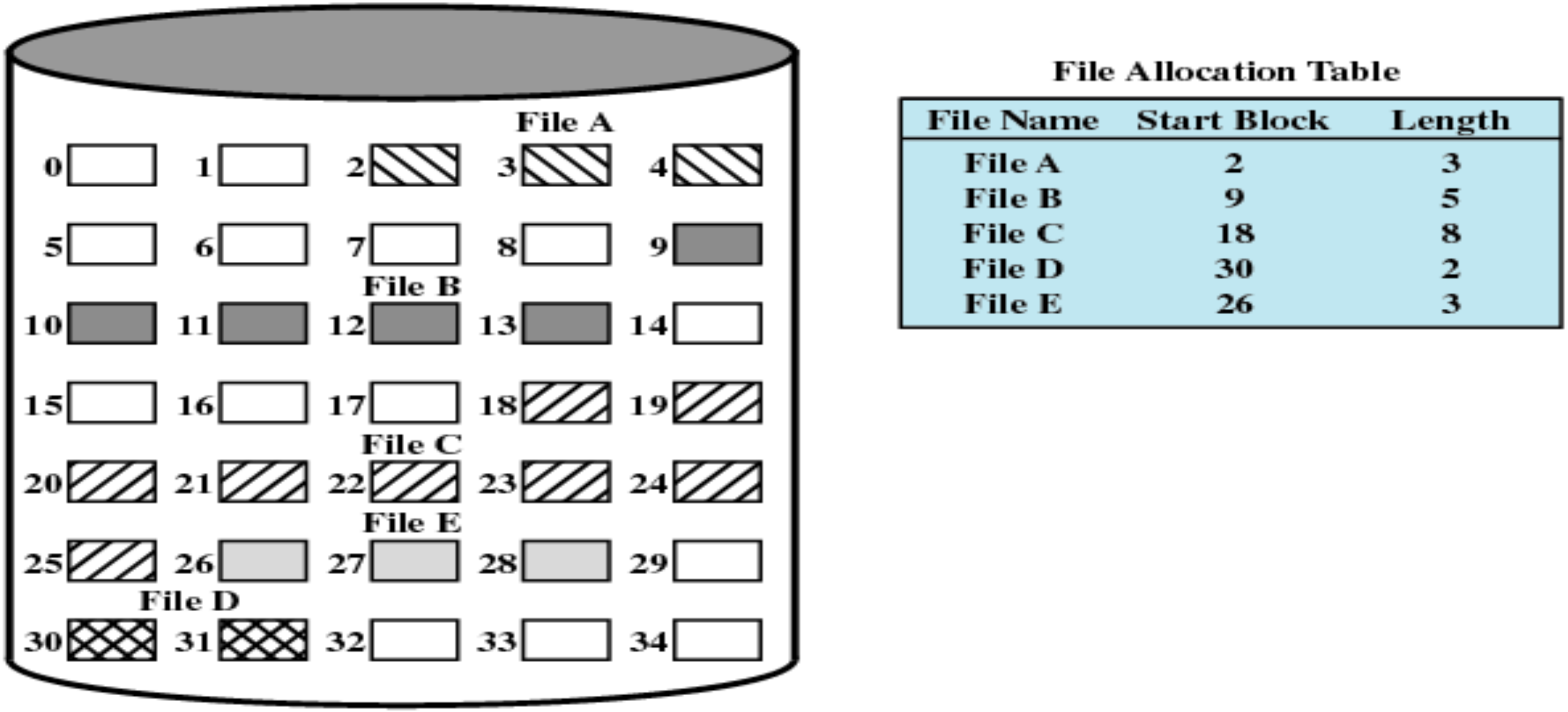
Preallocation (预分配) VS Dynamic allocation (动态分配)

- Preallocation
  - Need the maximum size for the file at the time of creation
  - Difficult to reliably estimate the maximum potential size of the file
- Dynamic allocation
  - Allocates space to a file in portions as needed.

Contiguous allocation (连续分配)

- Single set of blocks is allocated to a file at the time of creation (文件创建时分配一组连续的块)
- Only a single entry in the file allocation table
  - Starting block and length of the file
- External fragmentation will occur
  - Need to perform compaction

Contiguous allocation

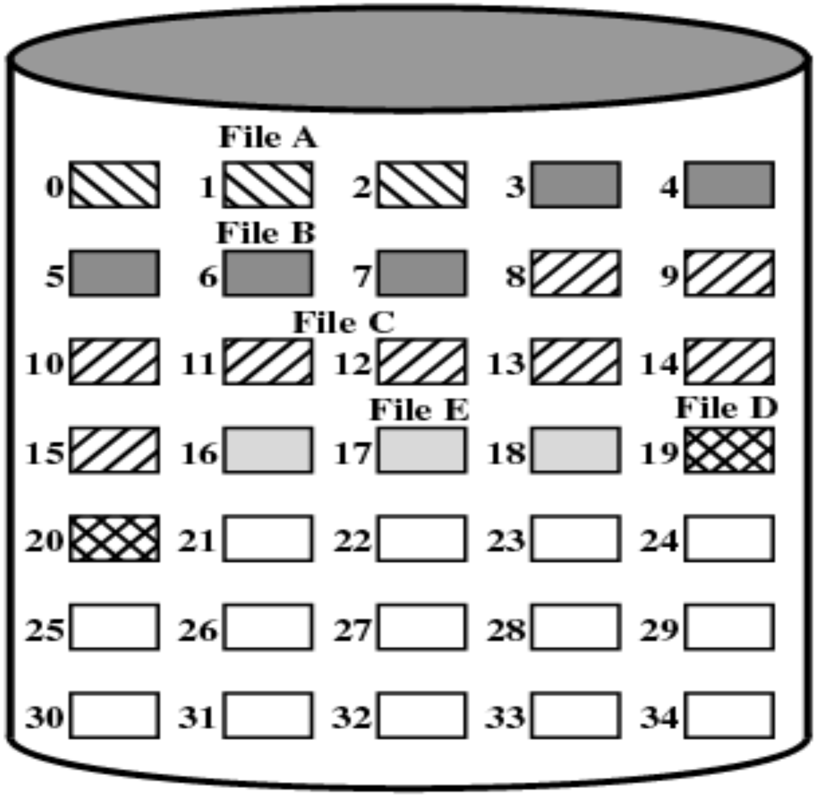


File Allocation Table

File Name	Start Block	Length
File A	2	3
File B	9	5
File C	18	8
File D	30	2
File E	26	3

Figure 12.7 Contiguous File Allocation

Contiguous allocation



File Allocation Table

File Name	Start Block	Length
File A	0	3
File B	3	5
File C	8	8
File D	19	2
File E	16	3

Figure 12.8 Contiguous File Allocation (After Compaction)

单选题 1分

设置

In which of the following file allocation methods is preallocation required:

[✓ A] Contiguous

B Chained

C Indexed

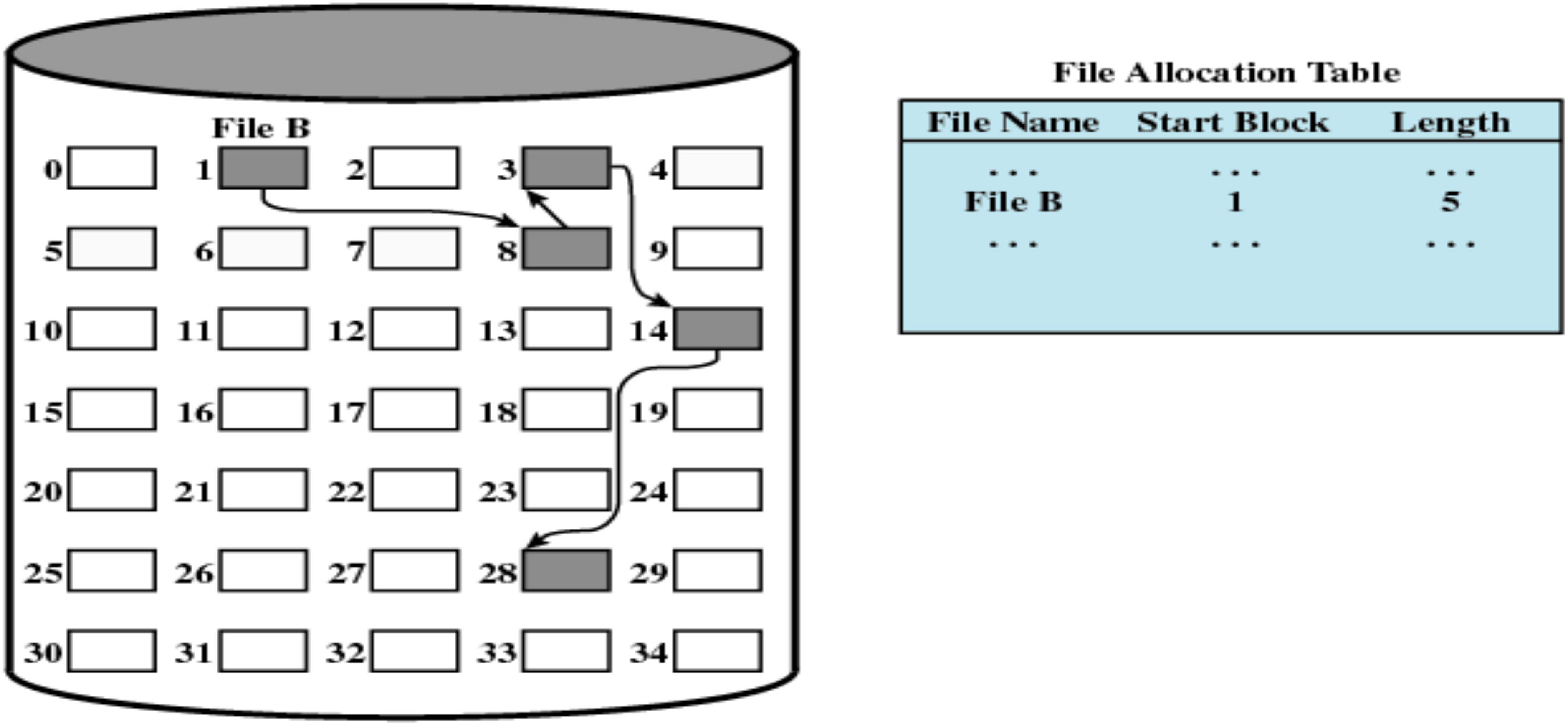
D None of the above

提交

Chained allocation (链式分配)

- Allocation on basis of individual block(基于单个块进行分配)
- 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 (适合顺序文件)
- No accommodation of the principle of locality (局部性原理不再适用)， so consolidation(迁移、集结) is need to move blocks adjacent each other

Chained allocation

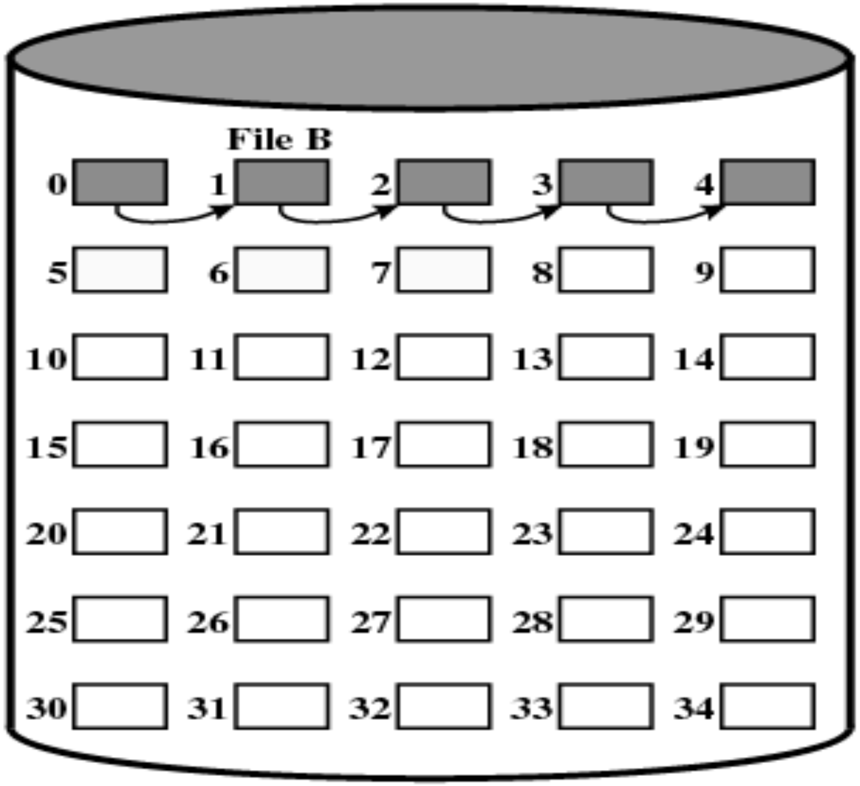


File Allocation Table

File Name	Start Block	Length
...	...	...
File B	1	5
...	...	...

Figure 12.9 Chained Allocation

Chained allocation



File Allocation Table

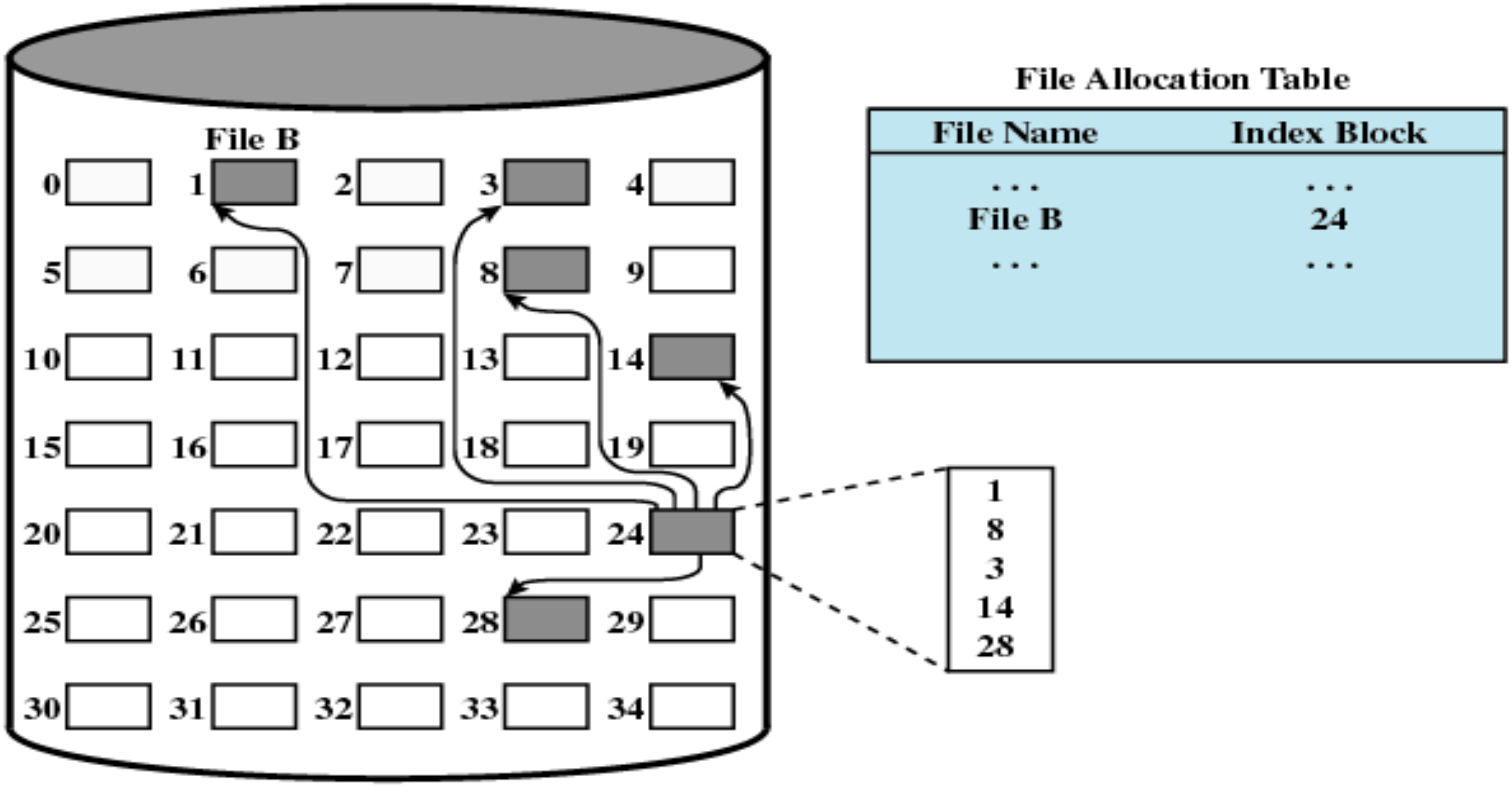
File Name	Start Block	Length
. . .	. . .	. . .
File B	0	5
. . .	. . .	. . .

Figure 12.10 Chained Allocation (After Consolidation)

Indexed allocation (索引分配)

- File allocation table contains a separate one-level index for each file (每个文件在文件分配表中有一个一级索引)
- The file allocation table contains block number for the index (文件分配表指向该文件在磁盘上的索引块)
- The index has one entry for each portion allocated to the file (分配给文件的每个分区都在索引中都有一个表项)
- Indexed allocation supports both sequential and direct access to the file and thus is the most popular form of file allocation.

Indexed allocation

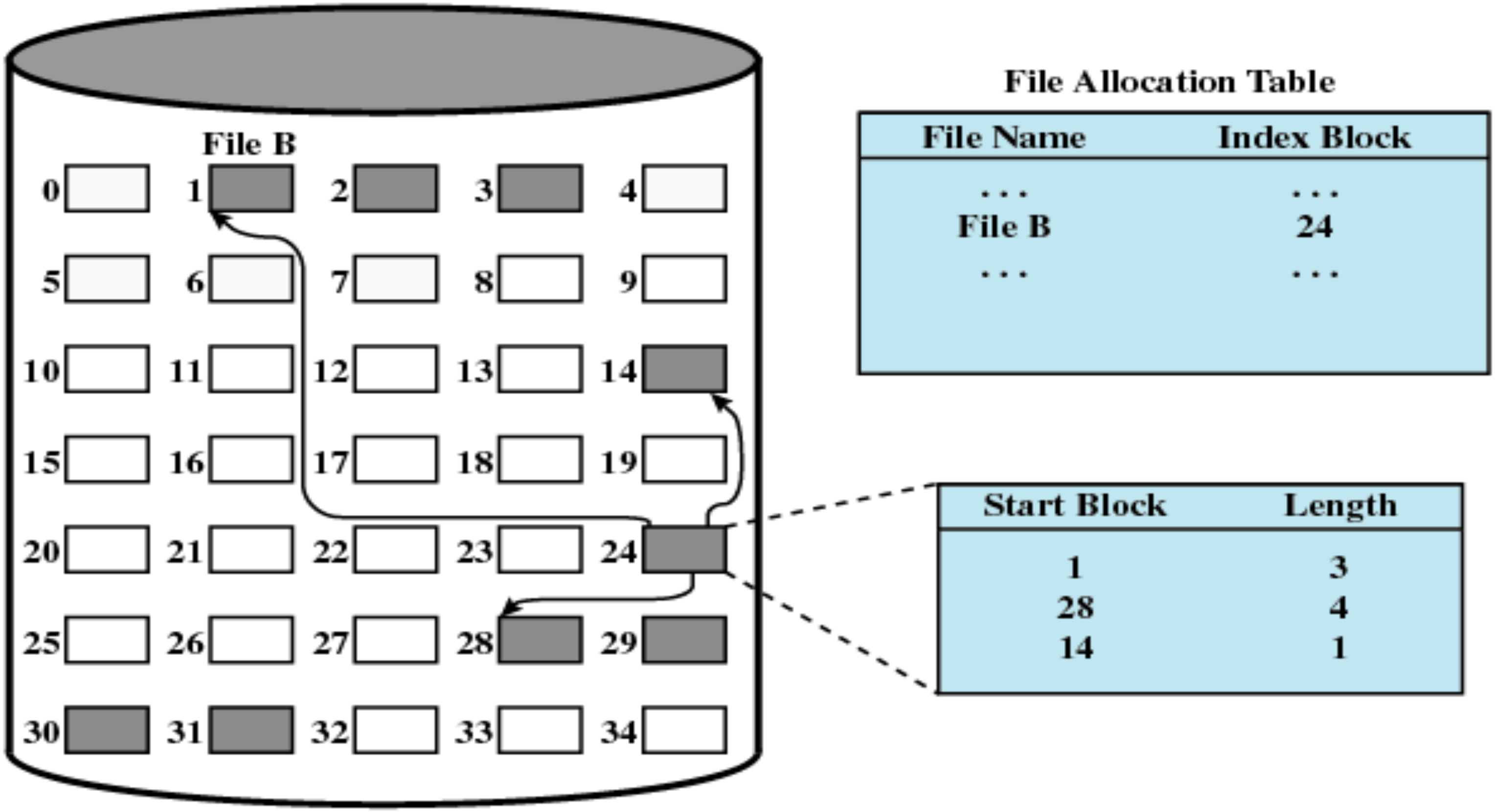


File Allocation Table

File Name	Index Block
• • •	• • •
File B	24
• • •	• • •

Figure 12.11 Indexed Allocation with Block Portions

Indexed allocation



File Allocation Table

File Name	Index Block
• • •	• • •
File B	24
• • •	• • •

Start Block	Length
1	3
28	4
14	1

Figure 12.12 Indexed Allocation with Variable-Length Portions

12.6 Secondary Storage Management

- 12.6.1 File Allocation
- 12.6.2 Free Space Management
- 12.6.3 Reliability

Free Space Management

- Bit tables (位表)
  - Use a vector containing one bit for each block on the disk. Each entry of a 0 corresponds to a free block, and each 1 corresponds to a block in use.
- Chained free portions (链式空闲区)
  - The free portions may be chained together by using a pointer and length value in each free portion
- Indexing (空闲索引表)
- Free block list (空闲列表)

单选题 1分

设置

The technique of free disk space management that employs a pointer and length value of each free portion is the:

A Indexing

B Free block list

C Bit tables

[✓ D] None of the above

提交

12.6 Secondary Storage Management

- 12.6.1 File Allocation
- 12.6.2 Free Space Management
- 12.6.3 Reliability

单选题 1分

设置

The data structure that maintains information on available disk space is called the

[✓ A] Disk Allocation Table

B Bit Table

C File Allocation Table (FAT)

D None of the above

提交

12.6.3 Reliability

- Use a lock to prevent interfere among processes and make sure of consistent of space allocation

在磁盘中对磁盘分配表加锁，这可以防止在分配完成以前另一个用户修改这个表.