CS418—Operating Systems

Lecture 8

File Management

Textbook: Operating Systems
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1. Basic Concepts

- File Manager controls all the files in the system.
- Several factors determine the efficiency of a file manager
  - 1. How are the files organized: sequential, direct, indexed sequential.
  - 2. How are the files stored: contiguously, non-contiguously, indexed.
  - 3. How are each file's records structured: fixed-length, variable length.
- When you are creating, deleting, modifying and controlling access to a file, a file manager is functioning.
- Responsibilities of a file manager
  - 1.
  - 2.
  - 3.
  - 4.

- Some basic definitions
  - 1. A **field**
  - 2. A **record**
  - 3. A **file**

2. File Organization

- **Record Format:** Fixed-length records and variable-length records.
  - 1. **Fixed-length records**: easy to access, ideal for data files. If the size is too small some 'left-over' characters are truncated. If the size is too large then spaces are wasted.
  - 2. **Variable-length records**: do not leave empty space and do not truncate characters.
- **Physical File Organization**
  - 1. Physical file organization is decided by the way records are arranged.
  - 2. Physical file organization is also decided by what kind of medium are used to store the files.

- Physical File Organization is composed of
  - 1. Sequential record organization
  - 2. Direct record organization
  - 3. Indexed sequential record organization
- To decide which way you use to store the data, you need to look at the following parameters
  - 1. Volatility of the data: the frequency with which additions and deletions are made.
  - 2. Activity of the file: the percentage of records processed during a given run.
  - 3. Size of the file.
  - 4. Response time: the amount of time user is willing to wait.

- Sequential record organization
  - 1. Records are stored and retrieved sequentially
  - 2. An optimization version of it is to select a key and sort all the records by the key, of course, we have to pay for the overhead.
- Direct record organization
  - 1. Records are identified by relative addresses — their addresses relative to the beginning of the file.
  - 2. We can again identify a **key** — which uniquely identifies a record. Then we can use a hashing technique, say $h(i) = \lfloor m \times [(i \times A) mod 1] \rfloor, A = \frac{\sqrt{5}-1}{2}$.
  - 3. Although *collision* is not avoidable, hashing is widely used in practice.
- Indexed sequential record organization
  - 1. It is created and maintained through an Indexed Sequential Access Method. *This is very much like the contents in a textbook, if you want to search for a specific topic you look up the index and then go to the physical location indicated by that entry.*
  - 2. Again, overhead is the drawback.

3. Physical Storage Allocation

- Contiguous Storage: records are stored one by one.

- Advantage: simple to implement & manage. Disadvantage: file cannot be expanded.

- Noncontiguous Storage: allows files to use any storage space available on the disk.

- Indexed Storage: allows direct record access by bringing together into an index block the pointers linking every content of that file.

4. Data Compression

- Records with repeated characters can be abbreviated.

- Repeated terms can also be compressed.

- Front-end compression, which is usually used in database for index compression.

5. Access Methods

- Access methods are determined by a file's organization:
  - 1. Indexed sequential files are the most flexible.
  - 2. Sequential files are the least flexible.
- For sequential records, File Manager uses the **current byte address (CBA)** — address of the last byte read to access the next sequential record.
- Sequential access (of fixed-length records)
- Sequential access (of variable-length records)
- Direct access (with fixed-length records)

- Direct access (with variable-length records)

6. Access Control

- In 1950's a copy of FORTRAN compiler can only serve one user at one time. So at that time, we have no problem with access control.
- Five possible actions on a file
  - 1. Read only.
  - 2. Write only.
  - 3. Execute only.
  - 4. Delete only.
  - 5. Combinations.
- How to do access control?
  - 1. Access control matrix.
  - 2. Access control list.
  - 3. Capacity lists.
  - 4. Lockword.