File Structures

Sequential Files, Indexed Sequential Files

Introduction

File

- A file is an external collection of related data treated as a unit.
- Files are stored in auxiliary/secondary storage devices.
  - Disk
  - Tapes
- A file is a collection of data records with each record consisting of one or more fields.

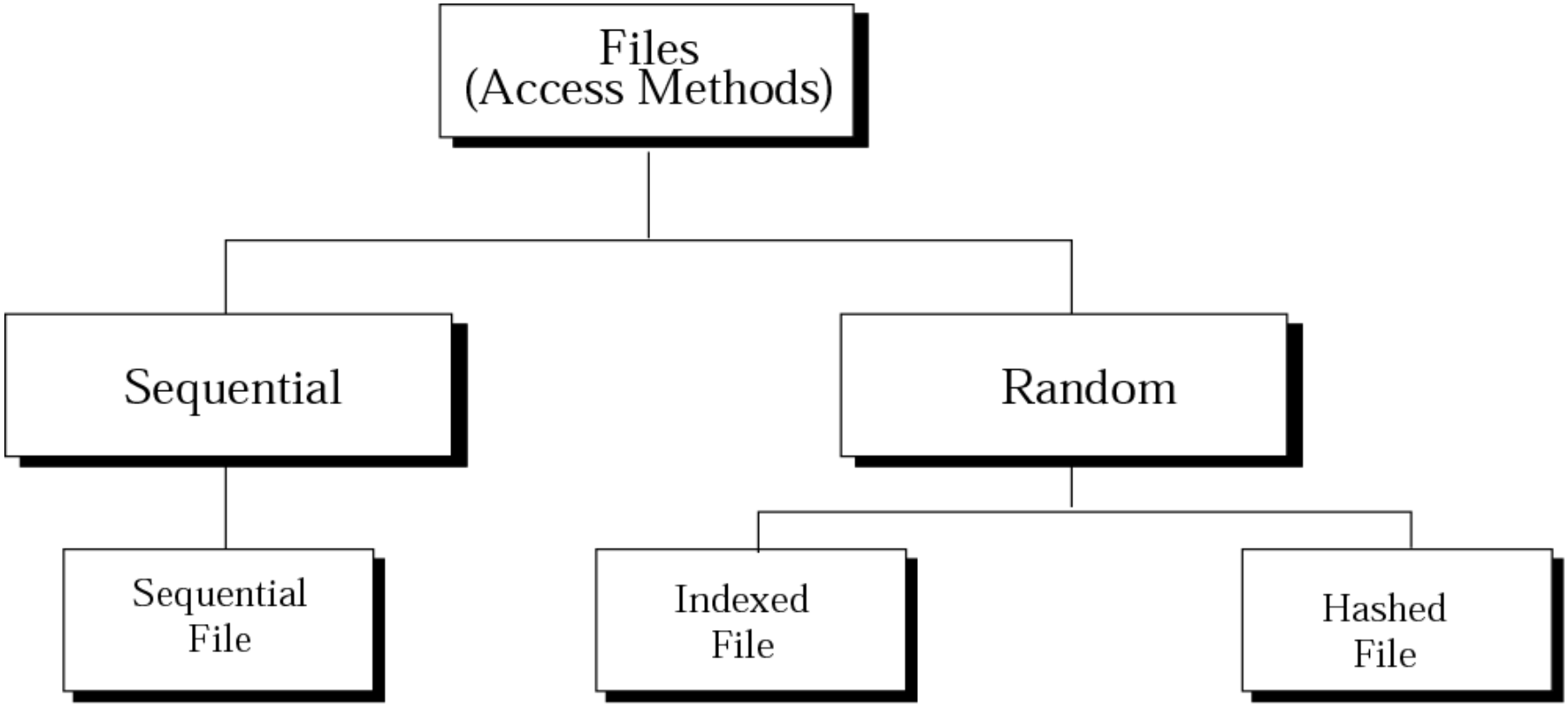
13.1

ACCESS METHODS

Figure 13-1

Taxonomy of file structures

- The access method determines how records can be retrieved: sequentially or randomly.



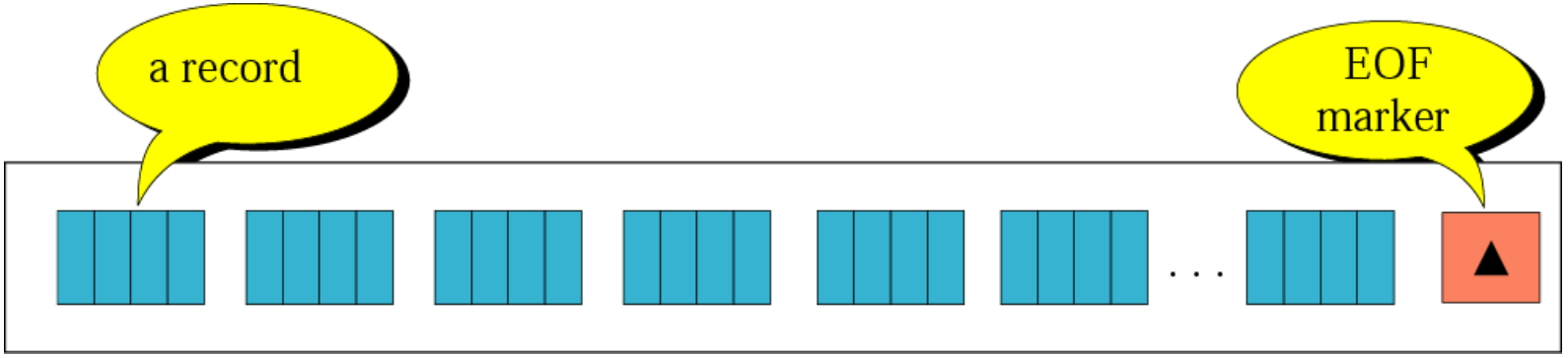
- One record after another, from beginning to end
- Access one specific record without having to retrieve all records before it

SEQUENTIAL FILES

Figure 13-2

Sequential file

- Sequential file –
  records can only be accessed sequentially,
  one after another, from beginning to end.



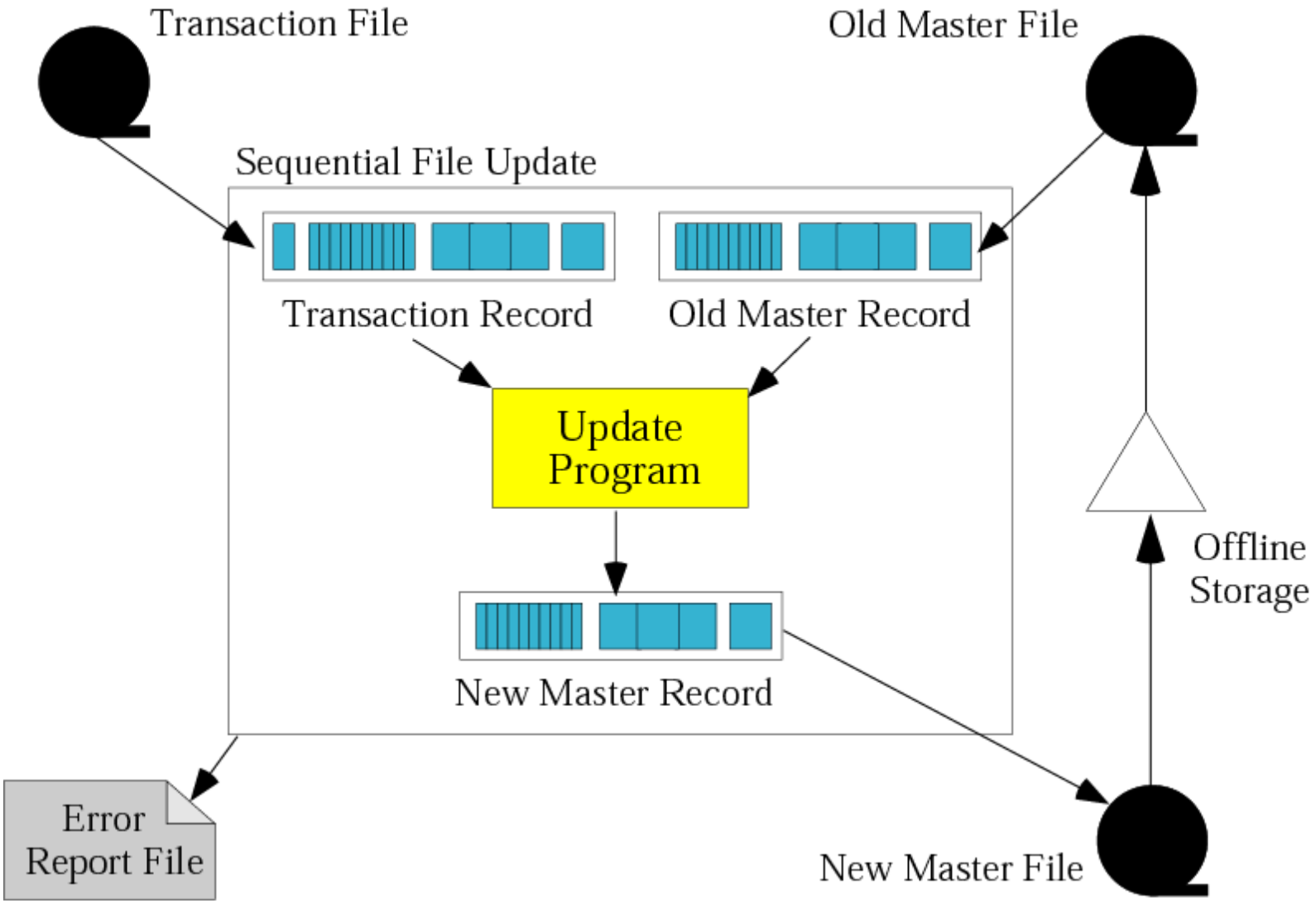
Program 13.1 *Processing records in a sequential file*

```
While Not EOF
{
    Read the next record
    Process the record
}
```

Updating sequential files

- sequential files must be updated periodically to reflect changes in information.
- The updating process –
  all of the records need to be checked and updated (if necessary) sequentially.
  - New Master File
  - Old Master File
  - Transaction File –
    contains changes to be applied to the master file.
    - Add transaction
    - Delete transaction
    - Change transaction
    - A key is one or more fields that uniquely identify the data in the file.
  - Error Report File

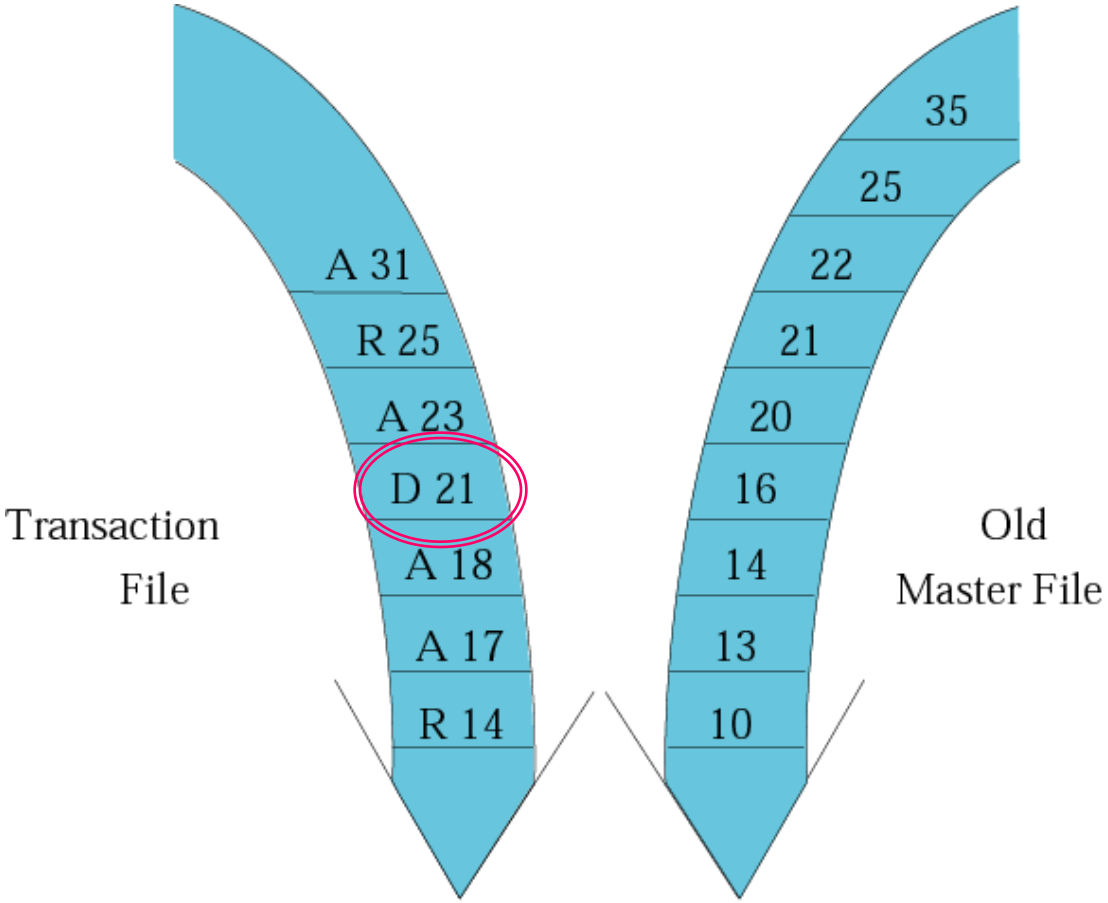
Updating a sequential file



Updating sequential files

- To make updating process efficient, all files are sorted on the same key.
- The update process requires that you compare : [transaction file key] vs. [old master file key]
  - < : add transaction to new master
  - = :
    - Change content of master file data (transaction code = R(revise))
    - Remove data from master file (transaction code = D(delete))
  - > : write old master file record to new master file (transaction code = A(add))

Updating process



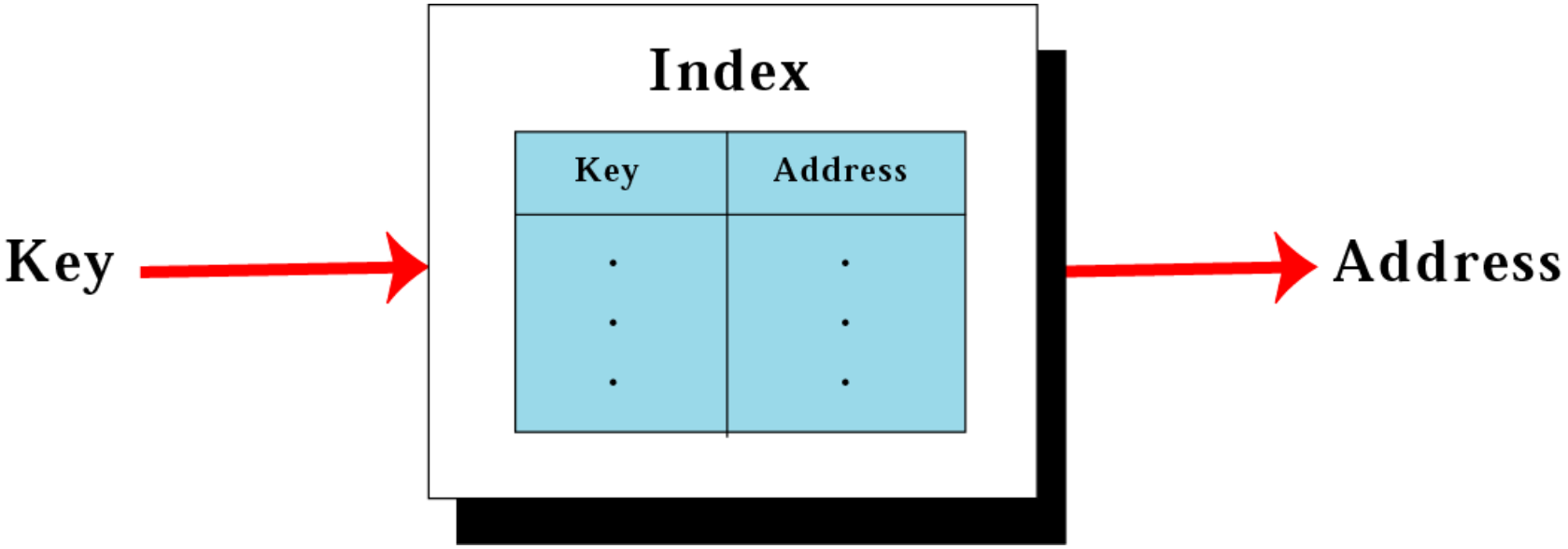
10	13	14	16	17	18	20	22	23	25	31	35

New Master File

INDEXED FILES

Mapping in an indexed file

- To access a record in a file randomly, you need to know the address of the record.
- An index file can relate the key to the record address.



Indexed files

- An index file is made of a data file, which is a sequential file, and an index.
- Index – a small file with only two fields:
  - The key of the sequential file
  - The address of the corresponding record on the disk.
- To access a record in the file :
  1. Load the entire index file into main memory.
  2. Search the index file to find the desired key.
  3. Retrieve the address the record.
  4. Retrieve the data record. (using the address)

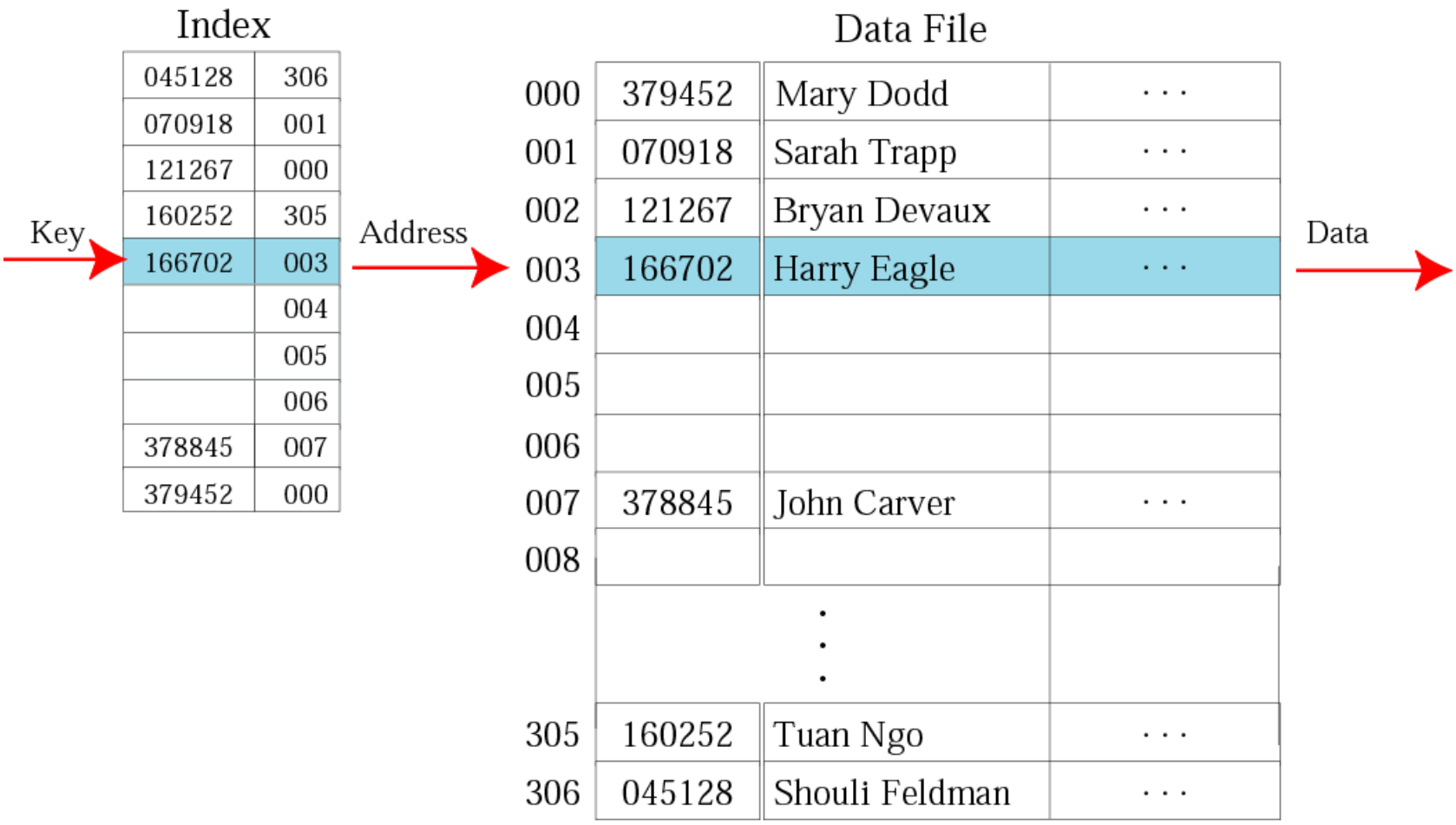
- Inverted file –
  you can have more than one index, each with a different key.

inverted file

- A file that reorganizes the structure of an existing data file to enable a rapid search to be made for all records having one field falling within set limits.

- For example, a file used by an estate agent might store records on each house for sale, using a reference number as the key field for sorting. One field in each record would be the asking price of the house. To speed up the process of drawing up lists of houses falling within certain price ranges, an inverted file might be created in which the records are rearranged according to price. Each record would consist of an asking price, followed by the reference numbers of all the houses offered for sale at this approximate price.

Logical view of an indexed file



HASHED FILES

Mapping in a hashed file

- A hashed file uses a hash function to map the key to the address.
- Eliminates the need for an extra file (index).
- There is no need for an index and all of the overhead associated with it.

Hashing methods

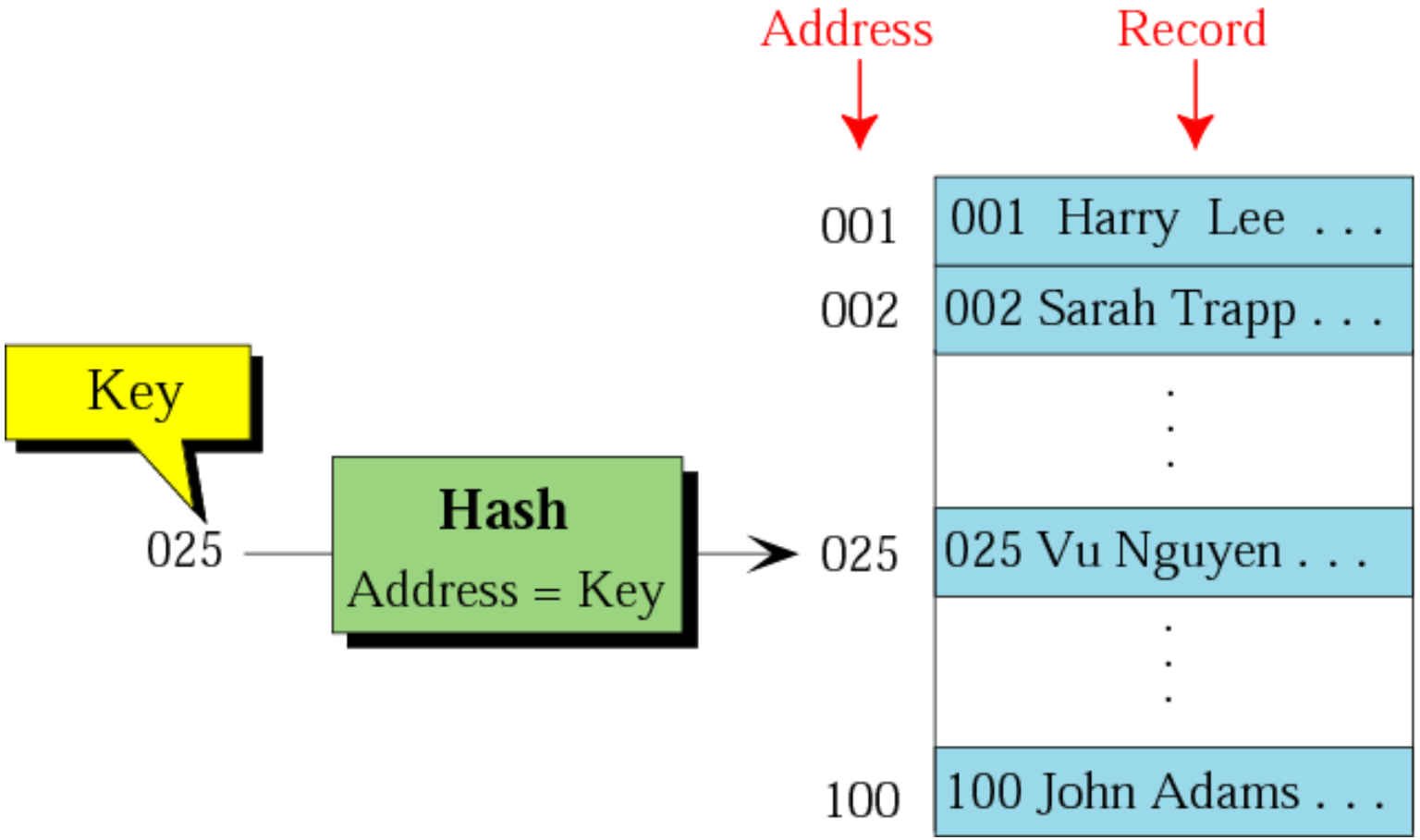
- Direct Hashing –
  the key is the address without any algorithmic manipulation.

- Modulo Division Hashing – (Division remainder hashing)
  divides the key by the file size and
  use the remainder plus 1 for the address.

- Digit Extraction Hashing –
  selected digits are extracted from the key and used as the address.

Direct hashing

- Direct Hashing –
  the key is the address without any algorithmic manipulation.



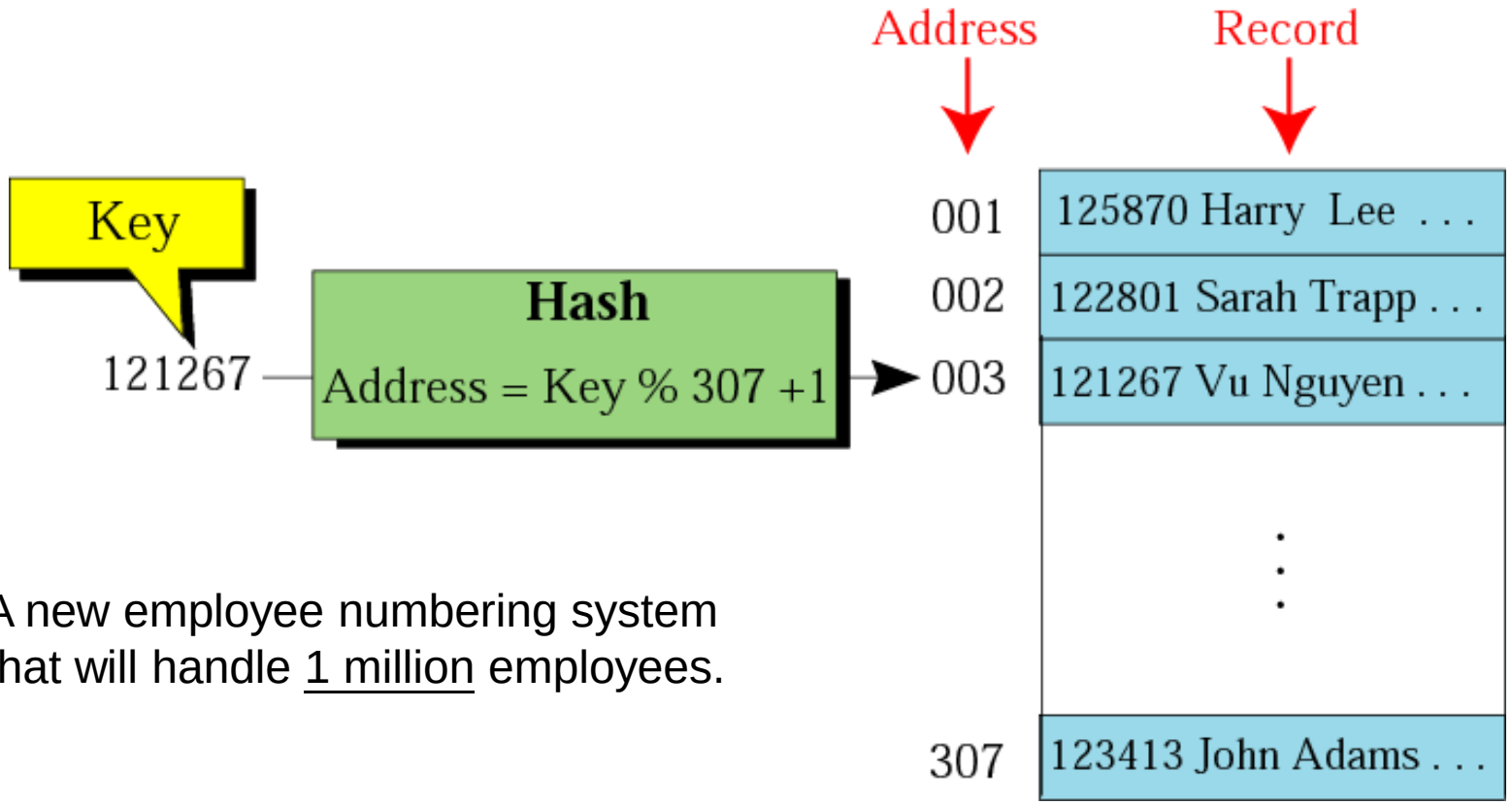
Direct Hashing

- the file must contain a record for every possible key.
- Adv. – no collision.
- Disadv. – space is wasted.

- Hashing techniques –
  map a large population of possible keys into
  a small address space.

Modulo division

- address = key % list_size + 1
- list_size : a prime number produces fewer collisions



A new employee numbering system that will handle 1 million employees.

Digit Extraction Hashing

- selected digits are extracted from the key and used as the address.

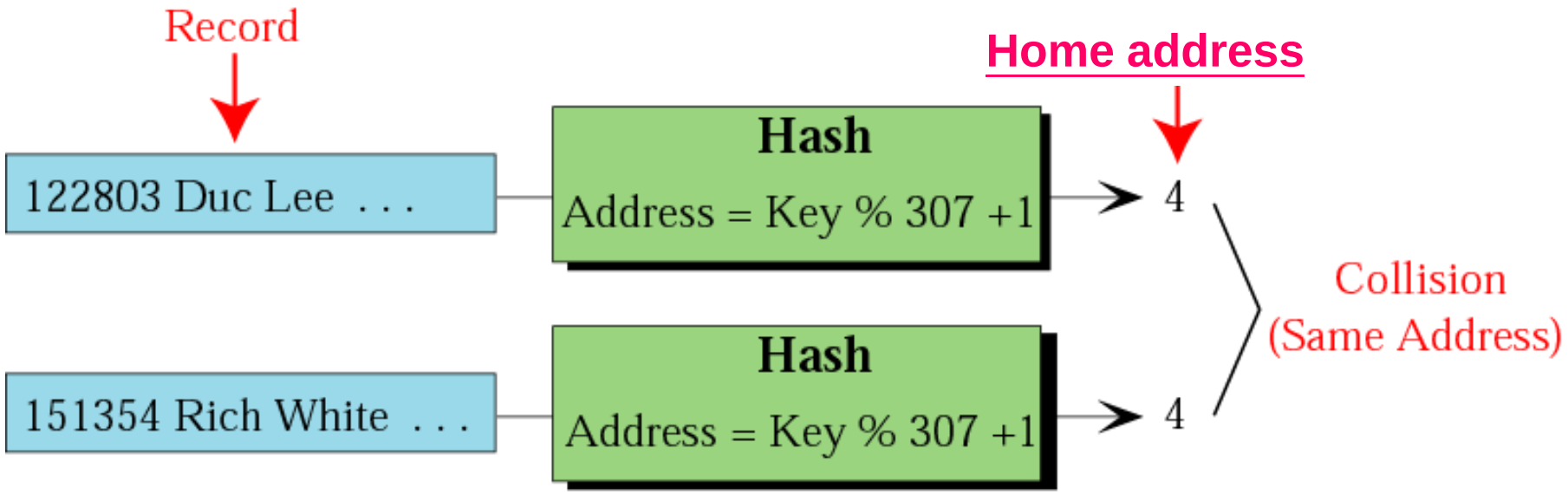
- For example : *1*,*3*,*4*

  6-digit employee number ⟶ ⟶ ⟶ 3-digit address

  - 125870 ⟶ 158
  - 122801 ⟶ 128
  - 121267 ⟶ 112
  - …
  - 123413 ⟶ 134

Collision

- Because there are many keys for each address in the file, there is a possibility that more than one key will hash to the same address in the file.
- Synonyms – the set of keys that hash to the same address.
- Collision – a hashing algorithm produces an address for an insertion key, and that address is already occupied.
- Prime area – the part of the file that contains all of the home addresses.



Collision Resolution

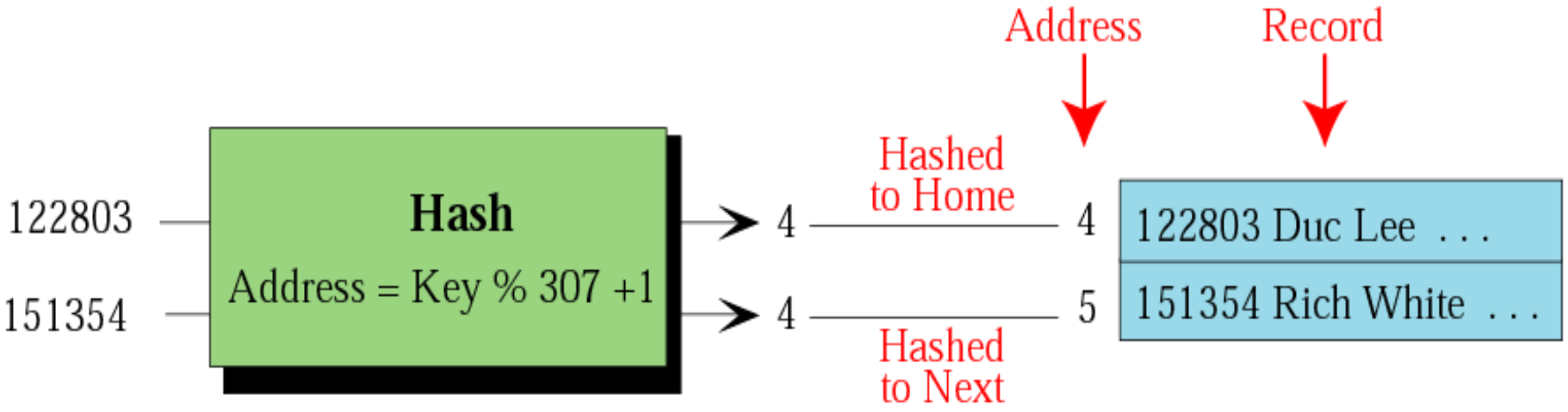
- With the exception of the directed hashing, none of the methods we discussed creates one-to-one mapping.

- Several collision resolution methods :
  - Open addressing resolution
  - Linked list resolution
  - Bucket hashing resolution

Figure 13-11

Open addressing resolution

- Resolve collisions in the prime area.
- The prime area addresses are searched for an open or unoccupied record where the new data can be placed.
- One simplest strategy –
  the next address (home address + 1)
- Disadv. –
  each collision resolution increases the possibility of future collisions.



Linked list resolution

- The first record is stored in the home address (prime area), but it contains a pointer to the second record. (overflow area)

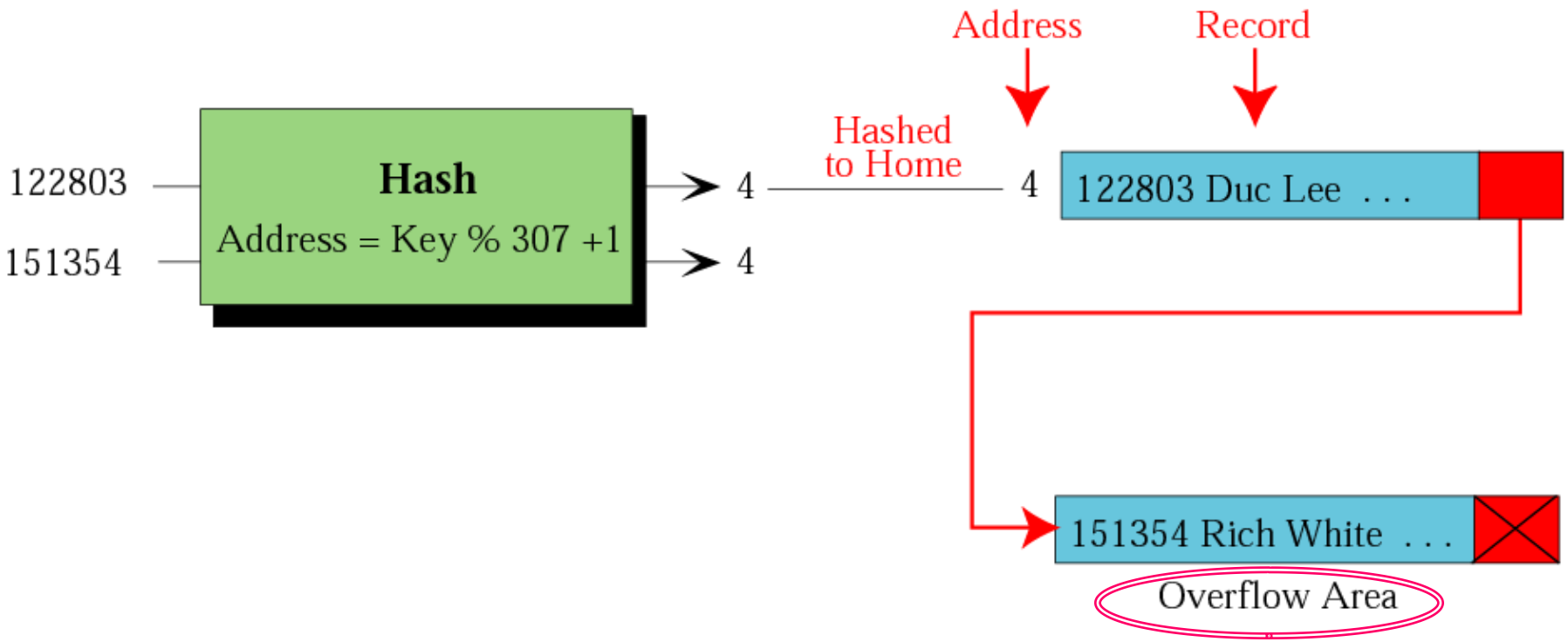
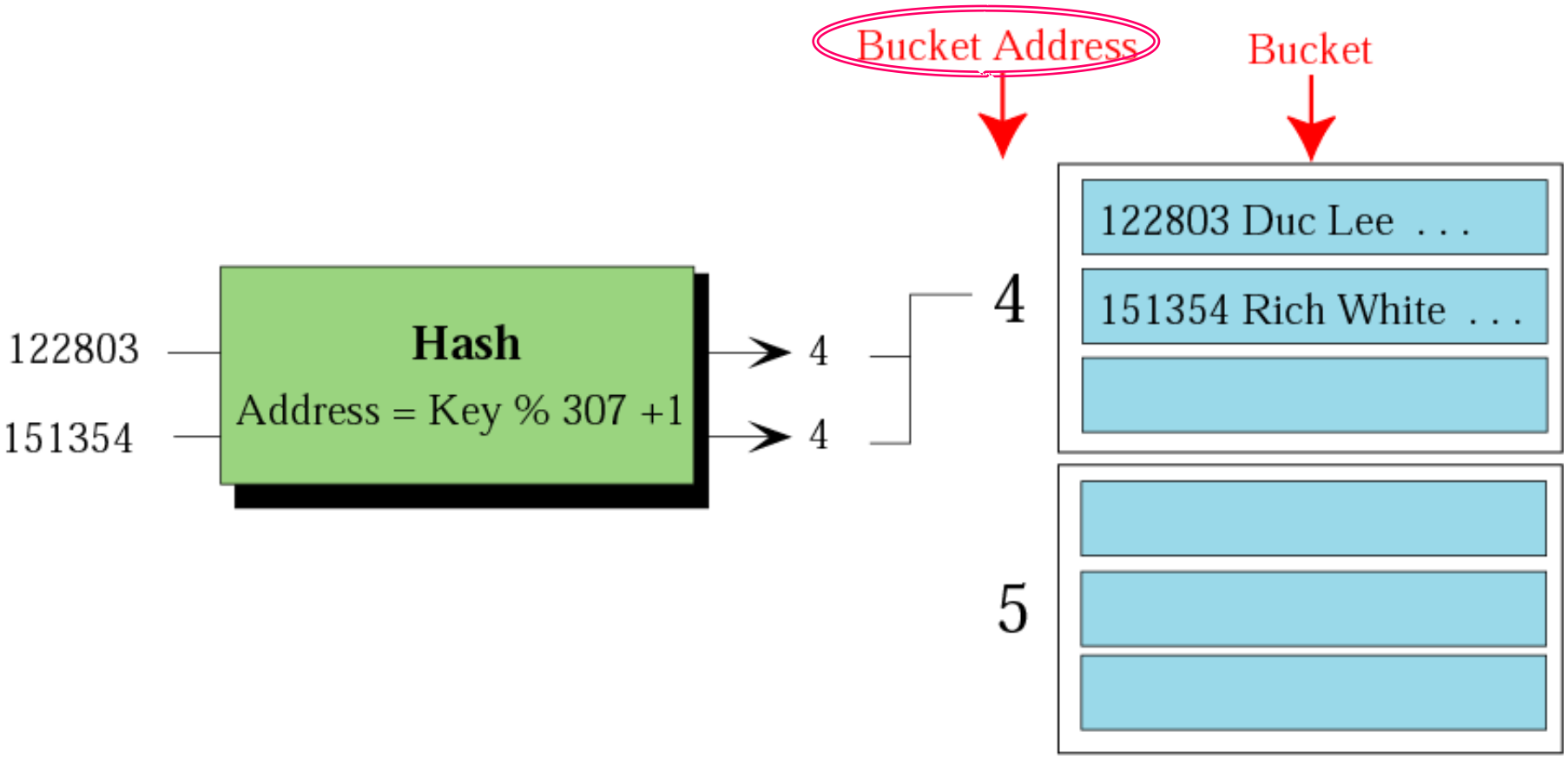


Figure 13-13

Bucket hashing resolution

- Bucket –
  a node that can accommodate more than one record.



Applications

- Applications –
  that need to access all records from beginning to end.
  - Personal information
- Because you have to process each record, sequential access is more efficient and easier than random access.

- Sequential file is not efficient for random access.

- Q. Explain Sequential file organization.