CS/SE 3377

File system

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Persistent Storage

- Keep a data **intact** even if there is a power loss
  - Hard disk
  - Solid-state device

- Files are stored in a persistent store

File

- Sequence of persistent bytes that can be read/written
  - Offset is the relative location from the beginning where a byte is stored
- Logical storage unit with contiguous logical address space to store user data
- A **file system** organizes and stores file
- A file has many attributes

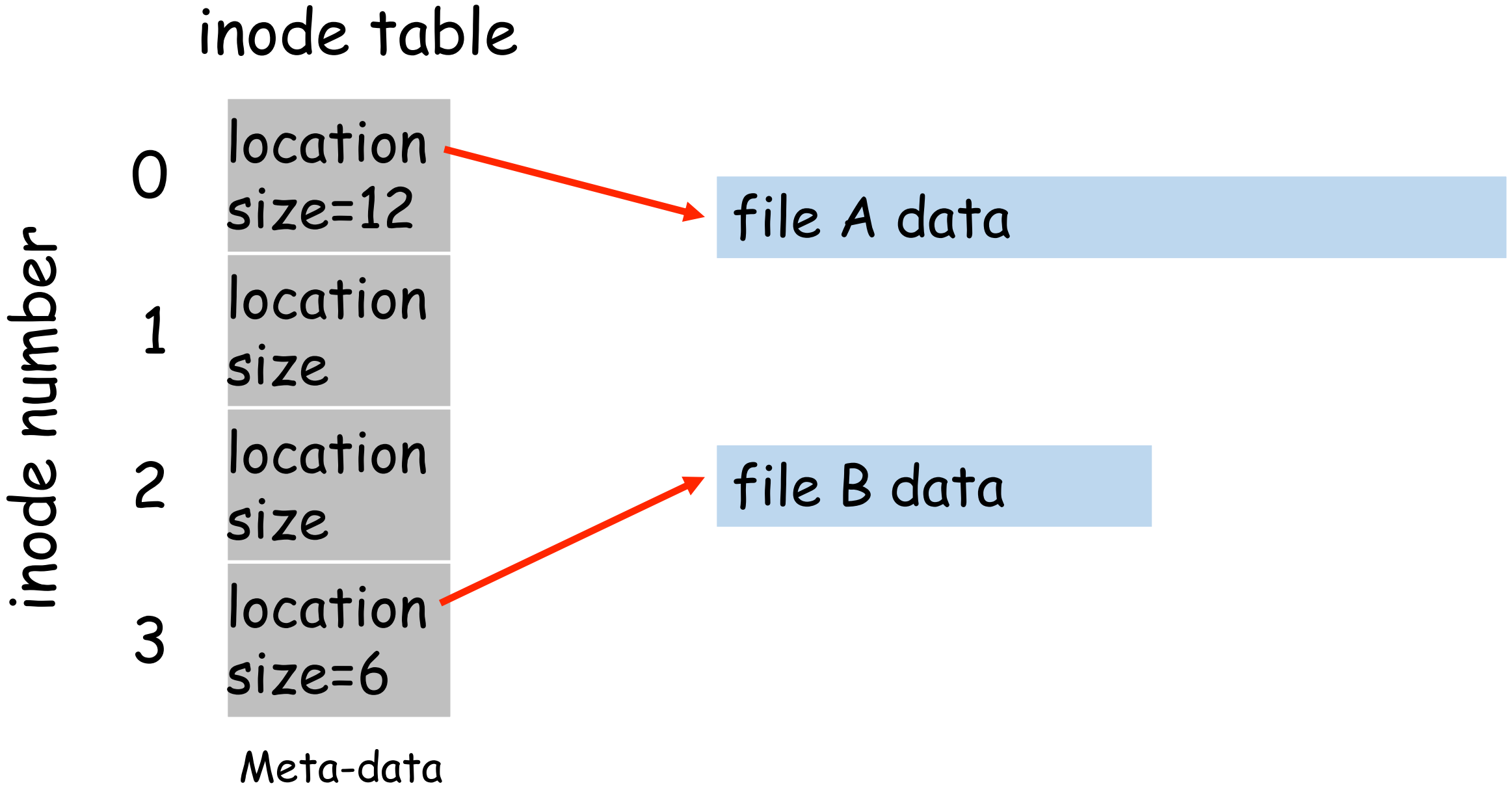
File attributes (meta data)

- Name – only information kept in human-readable form
- Identifier – unique number identifies file within file system
- Location – pointer to file location on device
- Size – current file size
- Protection – controls who can do reading, writing, executing
- Time, date, and user identification – data for protection, security, and usage monitoring

Meta data should be persistent

Inode

- Inode is an **on-disk** data structure that contains a file's attributes
- Every file has a unique inode
- Inode number is the file identification number within the file system


inode table
inode number
0
location
size=12
1
location
size
2
location
size
3
location
size=6
file A data
file B data
Meta-data

How to access a file?

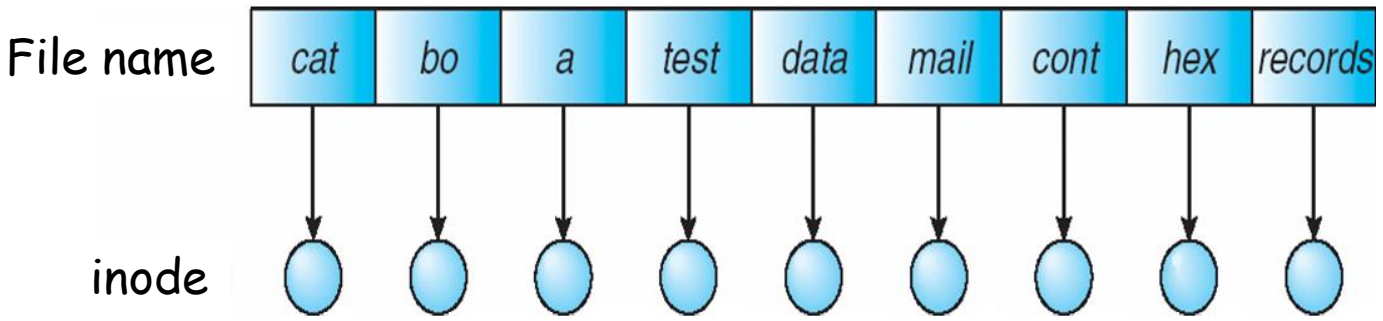
- Find its inode
- Need a mapping between file name and file's inode number
- Where will this mapping be stored?

Directory

Try ls -i

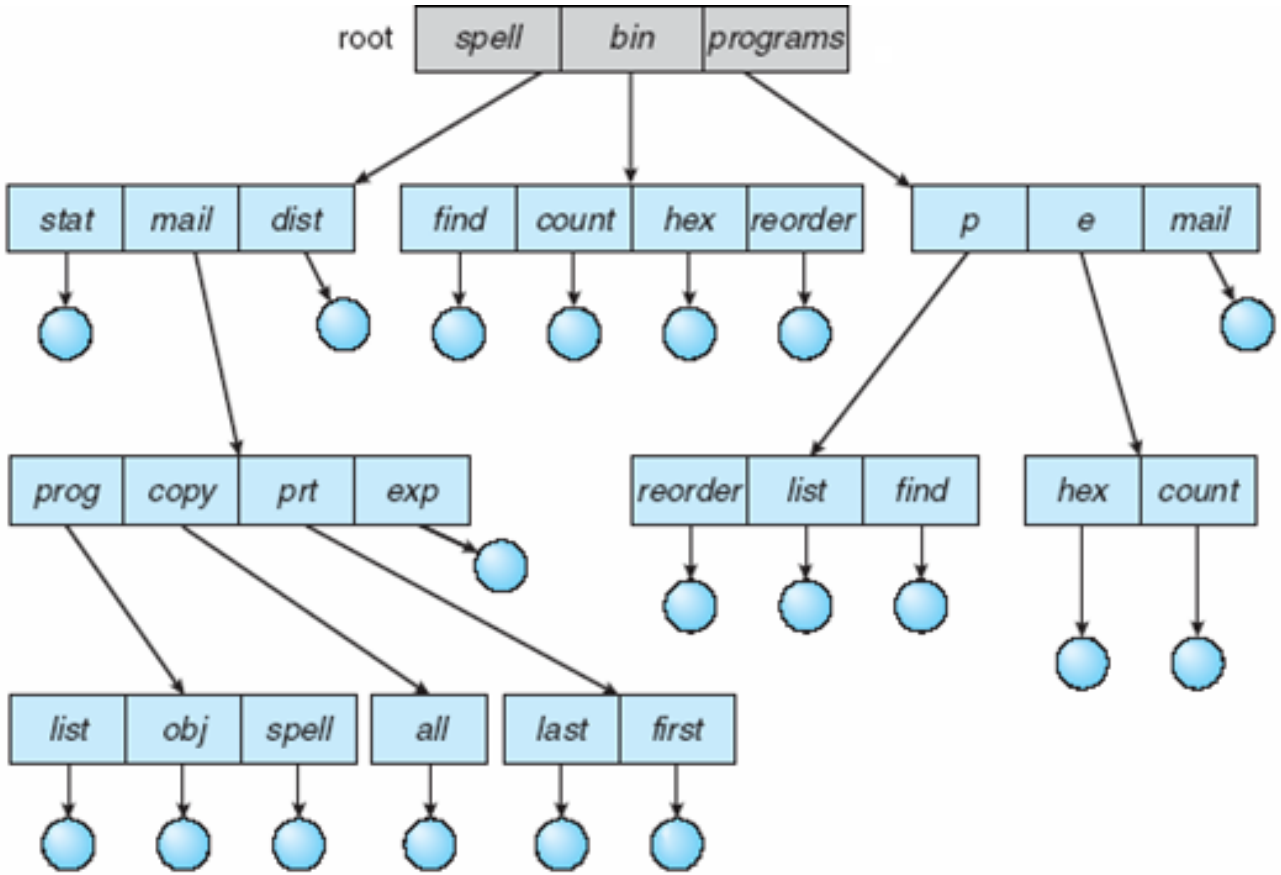
Directory Structure

- Single level



- Naming problem
- Grouping problem

Tree Structured Directories



- File name is specified with the path

  /bin/count

  /spell/mail/prog/list

- File (path) name is unique

Where is a directory stored?

- In the persistent store as a file
- Every entry in the directory is a file or a (sub)directory

Home/current/parent Directories

- Current working directory after you login
- '~' is the shortcut for home directory
- '.' represents current working directory
- '..' represents parent of current working directory

Access Permissions

- Tells who and how can access

- Three types of users:
  - owner of the file (owner)
  - member of a group associated with file (group)
  - everyone else (others)

Try ls -l

Change Access Permissions - *chmod*

- Use chmod to change the access permission of a file

```
chmod a+rw filename   //read-write for all
chmod o-w filename    //no write for others
chmod g+r filename    //read for group
chmod u+rwx filename  //read, writ, ex for owner
```

- 'x' for directory means can change into that directory

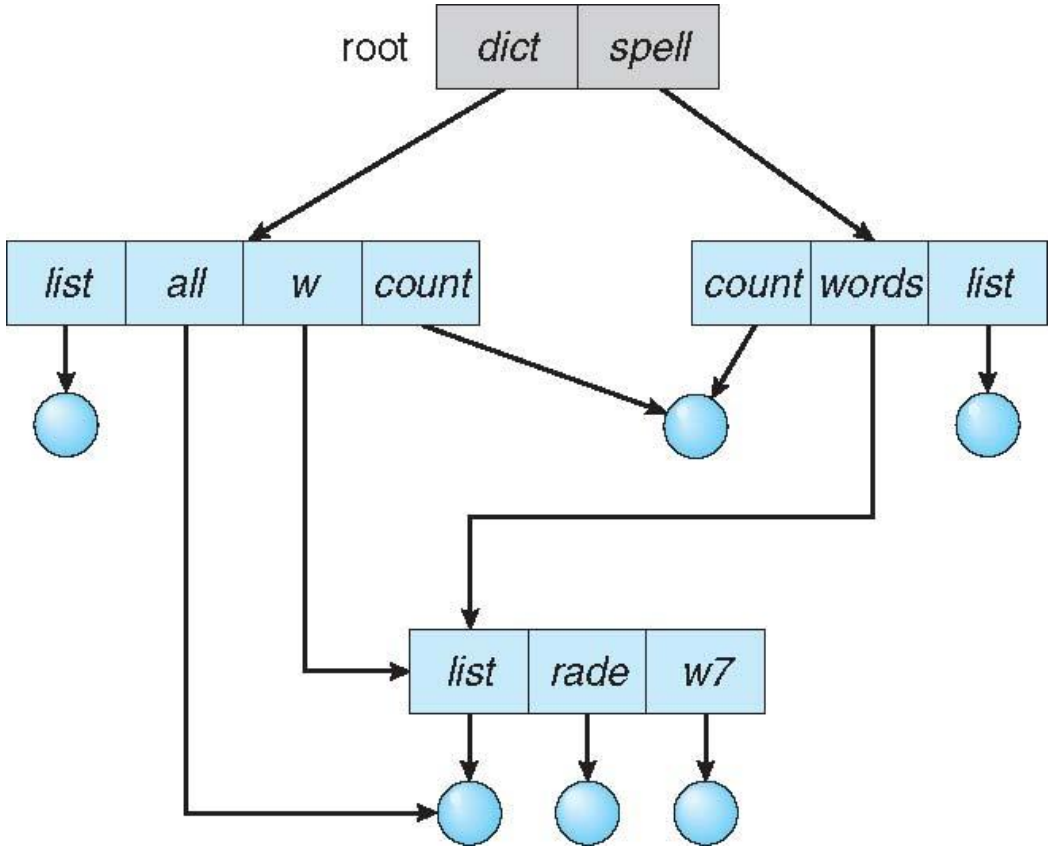
Links to Files

- *ln* creates a new (hard) link to existing file
  - inode not created
  - reference count increases
  - cannot link directories

- *rm* removes a link
  - If it is the last link to the file, deletes the file

- What is the directory structure now?

Acyclic Graph Directories



Option –s creates symbolic link to directories

What is the directory structure when a symbolic link to a parent directory is created?

Directory structure – Graph (with cycles)