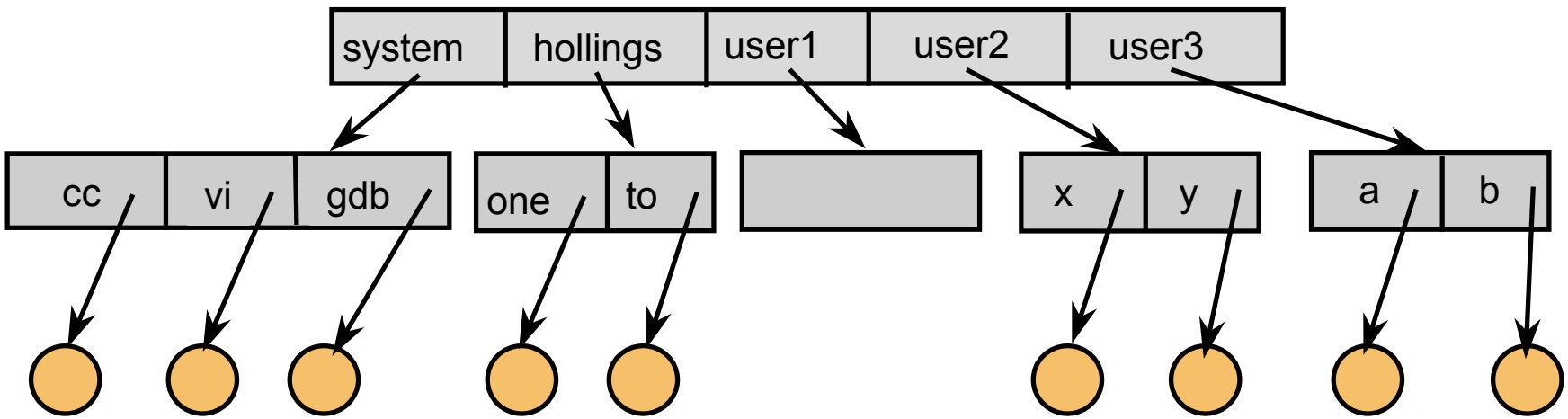
Announcements

- Reading Chapter 11

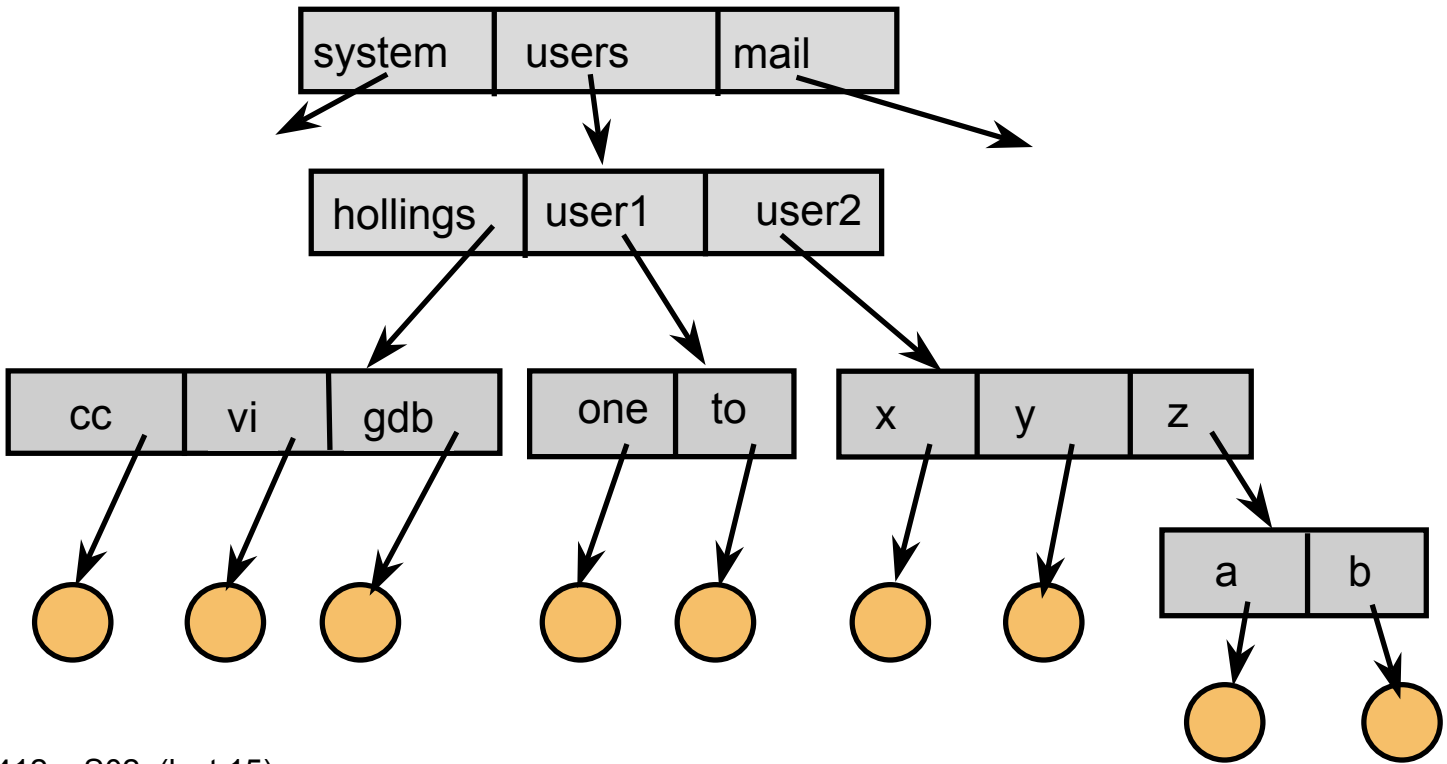
Simple Directory Structures

- One directory
  - Having all of the files in one name space is awkward
  - lots of files to sort through
  - different users would have to coordinate file names
  - each file has to have a unique name
- Two level directory
  - top level is users
  - second level is files per user



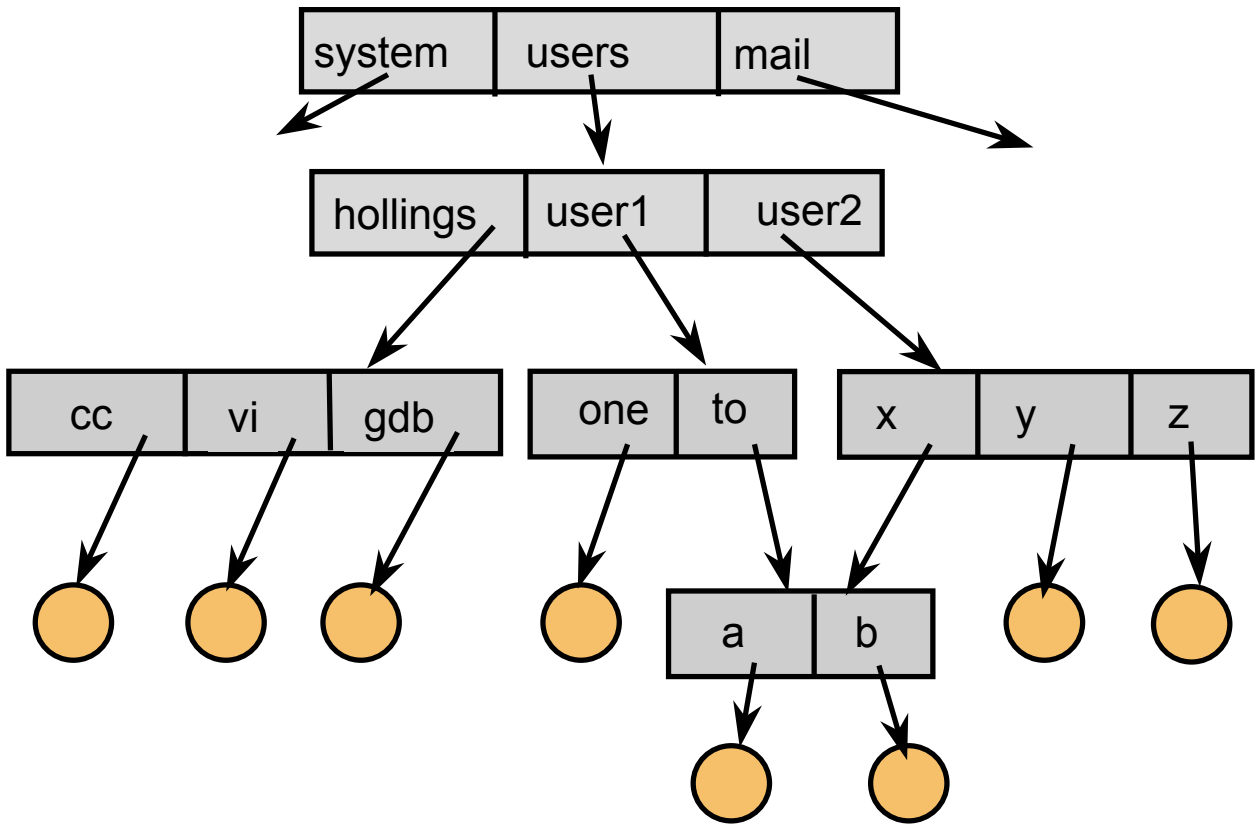
Tree Directories

- create a tree of files
- each directory can contain files or directory entries
- each process has a current directory
  - can name files relative to that directory
  - can change directories as needed



Acylic Graph Directories

- Permit users to share subdirectories



Issues for Acylic Graph Directories

- Same file may have several names
  - absolute path name is different, but the file is the same
  - similar to variable aliases in programming languages
- Deletion
  - if one user deletes a file does it vanish for other users?
    - yes, it should since the directory is shared
  - what if one user deletes their entry for the shared directory
    - no, only the last user to delete it should delete it
    - maintain a reference count to the file
- Programs to walk the DAG need to be aware
  - disk usage utilities
  - backup utilities

Does the OS know what is stored in a file?

- needs to know about some types of files
  - directories
  - executables
- should other file types be visible to the OS?
  - Example: word processing file vs. spreadsheet
  - Advantages:
    - OS knows what application to run
    - Automatic make (tops-20)
      - if source changed, re-compile before running
  - Problems:
    - to add new type, need to extend OS
    - OS vs. application features are blurred
    - what if a file is several types
      - consider a compressed postscript file

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Example of File Types

- Macintosh
  - has a file type that is part of file meta-data
  - also has an application associated with each file type
- Windows 95/NT
  - has a file type in the extension of the file name
  - has a table (per user) to map extensions to applications
- Unix
  - can use last part of filename like an extension
  - applications can decide what (if anything) to do with it

File Protection

- How to give access to some users and not others?
- Access types:
  - read, write, execute, append, delete, list
  - rename: often based on protection of directory
  - copy: usually the same as read
- Degree of control
  - access lists
    - list for each user for each file the permitted operations
  - groups
    - enumerate users in a list called a group
    - provide same protection to all members of the group
    - depending on system:
      - files may be in one or many groups
      - users may be in one or many groups
  - per file passwords (tedious and a security problem)

File Protection Example (UNIX)

- each file has three classifications
  - user: the user who owns the file
  - group: a named group of other users
  - world: all others
- each file has three access types:
  - read, write, execute
- directory protection
  - read: list the files in the sub dir
  - write: delete or create a file
  - execute: see the attributes of the files in the subdir
  - sticky bit: can only modify directory entries owned by yourself

Unix File Protection (cont)

- Files have 12 bits of protection
  - 9 bits are user, group, and world for:
    - read: list the files in the sub dir
    - write: delete or create a file
    - execute: see the attributes of the files in the subdir
  - sticky bit: leave executable in memory after is done
  - setuid: run the program with the uid of the file's owner
    - used to provide extra privilege to some processes
      - example: passwd command
  - setgid: run the program with the group id of the file's owner

UNIX File Protection Example