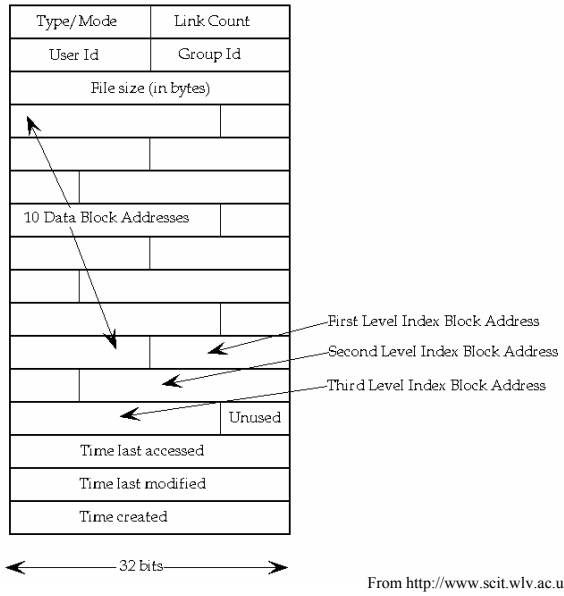
File Systems

- Reading: OS Concepts: Chapters 11 & 12
- Contents
  - Introduction
  - Allocation
  - NFS
  - Recovery

What is a File?

- A file is
  - ☞ _____
  - ☞ _____
  - ☞ _____
  - ☞ _____
    _____
- Attributes
  - ☞ E.g. _____
    _____
  - ☞ _____
  - ☞ _____
    _____

File Example



From http://www.scit.wlv.ac.uk/~jphb/spos/notes/ufs.inode.html

File Structure & Operations

- Operations: _____
  _____
- Structure defined by the OS and/or the application
  - _____
  - E.g. In UNIX files can be
    - Ordinary: _____
    - Directory: _____
    - Special: _____

```
csh> ls -l
drwx------   2 kdawson  csc         512 Oct  9  2001 nsmail
-rwxr--r--   1 kdawson  csc        2717 Jul  3 10:02 projects.txt
-rwxr--r--   1 kdawson  csc      244019 Mar  6  2002 ss-projects.html
-rwxr--r--   1 kdawson  csc       10897 Jul  3 10:33 students.txt
-rwxr--r--   1 kdawson  csc        3331 Jul  2 15:44 supervisors.txt
lrwxrwxrwx   1 kdawson  csc          20 Oct  8  2001 www_3ba3 -> /www/courses/ba/3ba3
lrwxrwxrwx   1 kdawson  csc          21 Sep 21  2001 www_4ba10 -> /www/courses/ba/4ba10
```

File Protection

- Types of access: _____
- Classes of user: _____
- E.g. In Windows NT
  - Access types: _____
  - User classes: _____
- UNIX – chmod 761 myfile
  - Access types: _____
  - User classes: _____

```
csh> ls -l
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lrwxrwxrwx   1 kdawson  csc          21 Sep 21  2001 www_4ba10 -> /www/courses/ba/4ba10
```
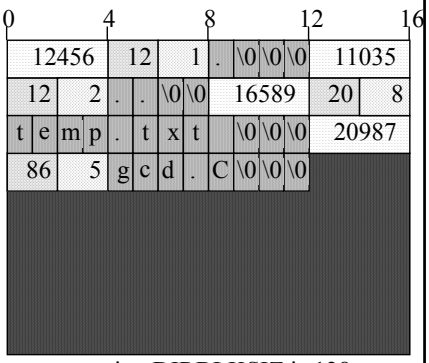


Directories

- Definition: _____
  _____
- Location: _____
  _____
- Operations: _____
  _____
  _____
- Purpose: Directories are organized to allow
  - _____
  - _____
  - _____

Directory Implementation

- A UNIX directory is a linear list of file names together with pointers to the data blocks
  - ☞ _____
  - ☞ _____
- Improvements
  - ☞ _____
  - ☞ _____
  - _____

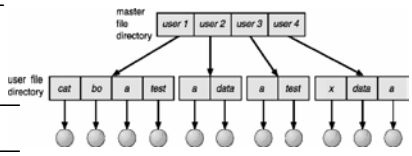


assuming DIRBLKSIZ is 128

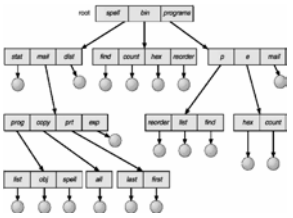
Directory Structure

- Single directory
  - ☞ _____
  - ☞ _____
  - _____

- One per user
  - ☞ _____
  - ☞ _____
  - _____

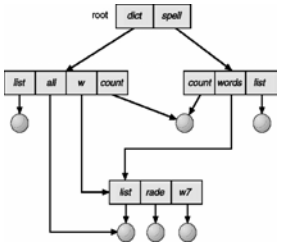


- Tree structure
  - ☞ _____
  - ☞ _____
  - ☞ _____
  - ☞ Example OS _____

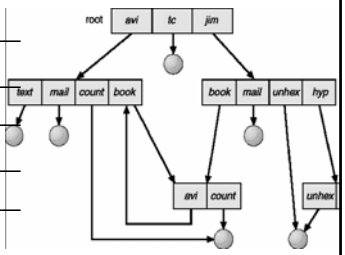


Directory Structure (cont'd)

- Acyclic-Graph
  - ☞ _____
  - ☞ _____
    _____
  - ☞ _____
    _____



- General Graph
  - ☞ _____
  - ☞ _____
    _____
  - ☞ _____
    _____



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Disk Space Allocation

- ☞ Contiguous
- ☞ Linked
  - ☞ FAT
- ☞ Indexed
  - ☞ Multi-level

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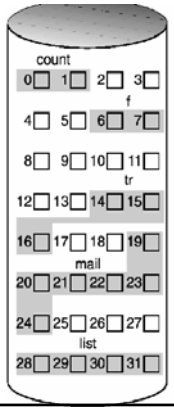
Considerations (Evaluation)

- Constraints
  - E.g. _____
- Efficiency
  - Fragmentation: _____
  - Overhead: _____
- Speed
  - Depends on type of access required: e.g. _____
    _____
- Performance
  - _____

Contiguous Allocation

- Method: _____
  _____
- File Control Block
  - _____
  - _____
- Disadvantages
  - _____
  - _____
- Advantages
  - _____
  - _____



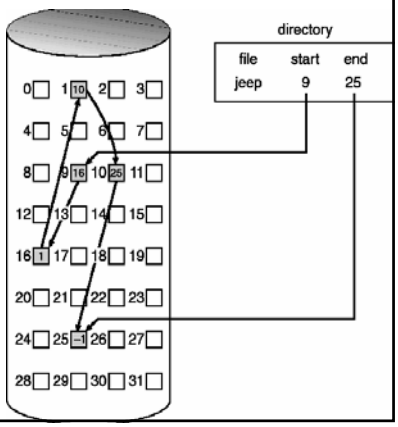
directory

file	start	length
count	0	2
tr	14	3
mail	19	6
list	28	4
f	6	2

Linked Allocation

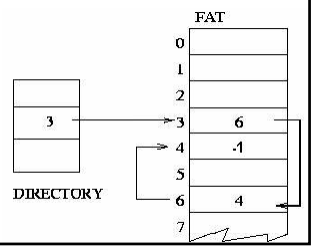
- Method: _____
  _____
- File Control Block
  - _____
- Disadvantages
  - _____
- Advantages
  - _____

block = | pointer |



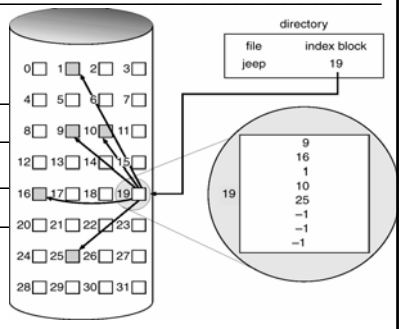
Linked Allocation - FAT

- Method
  - _____
  - _____
  - _____
- Disadvantages
  - Reliability: _____
  - Performance: _____
- Advantages
  - _____
  - _____
- Example
  - _____



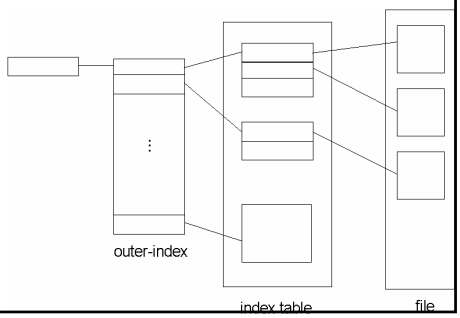
Indexed Allocation

- Method
  - ☞ _____
- Disadvantages
  - ☞ _____
  - _____
  - ☞ _____
  - _____
- Advantages
  - ☞ _____
  - ☞ _____
  - ☞ _____



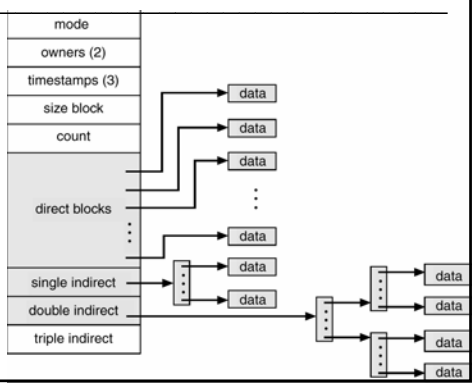
Indexed Allocation (cont'd)

- Max File Size?
  - ☞ E.g. if block size is 2KB and we are using 32 bit addresses
  - ☞ _____
- To increase the file size:_____
  - ☞ _____
  - ☞ _____



Complex Indexed Example

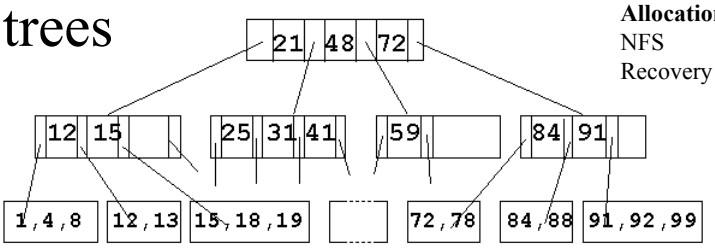
- In BSD UNIX with the i-node there are data pointers:
  - 12 Direct blocks: _____
  - 1 Single Indirect block: _____
  - 1 Double Indirect block: _____
  - 1 Triple Indirect block: _____
- Advantages:
  - _____
  - _____
  - _____
- Disadvantages:
  - _____
  - _____



Example - NTFS

- Under NTFS every object on the volume is a file
- NTFS provides file level security
  - _____
    _____
- Transaction logging _____
  _____
- To increase performance
  - _____
  - _____

B trees



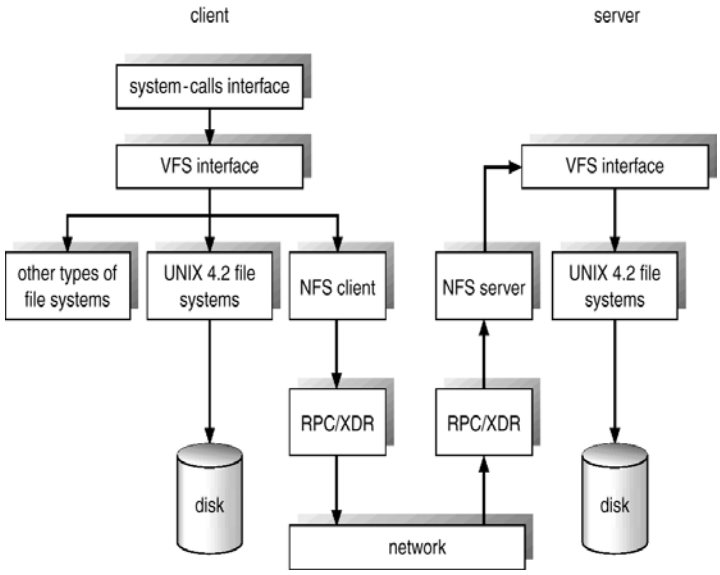
From http://www.onthenet.com.au/~grahamis/int2008/week10/lect10.html

- Algorithms & Efficiency
  - Search: _____
    - _____
  - Insertion: _____
    - _____
  - Deletion: _____
  - Balancing the tree: _____

NFS Introduction

- System for Remote Access across a network (LAN)
  - _____
- Independent machines with independent file systems
  - _____
  - _____
    _____
    - _____
    - _____
  - _____
- Designed to operate in heterogeneous environment through the use of
  - RPC primitives built on top of
  - XDR protocol:

NFS Architecture



NFS Mounting

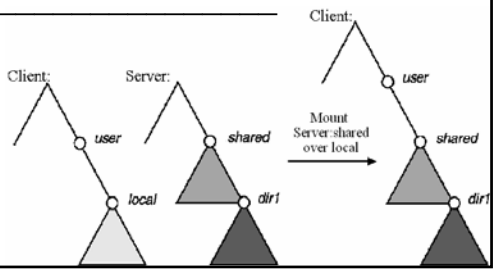
- Mounting establishes the logical connection between the server and client
- Mount request includes:_____

_____

- _____

  ☞ _____

- _____



NFS protocol

- RPCs for remote file operations:
  - Search: _____
  - Directory: _____
  - Manipulate: _____
  - Attributes: _____
  - Read/Write: _____
- NFS Servers are Stateless:
  - _____
  - _____
- _____
- _____
  _____

Recovery

- As information is cached in local memory a crash can result in
  - _____
  - _____
- Repairs are done by
  - OS _____ & Applications _____
- _____
  _____
- Backups should be
  - _____
  - _____
  - _____

Recovery – Example

- NTFS was designed to facilitate recovery
  - RAID: _____
    - _____
  - Logging transactions: _____