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Computer Systems B

COMS20012

Introduction to Operating Systems and Security

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Naming

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Naïve naming

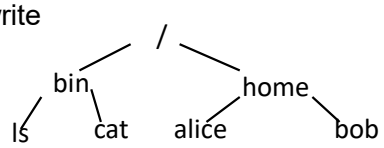
- One directory for the entire disk
- Small maximum name size
- Maximum number of files at creation
- Implementation
  - Allocate space for the directory
  - Directory structure is a big map
    - key: char file_name[MAX_SIZE]
    - value: file representation (see video 2) or an ID that easily map to it

- Pros:
  - Simple to implement
- Cons:
  - Hard to organize data
  - No two objects with the same name
  - Collision likely in multi-users systems
  - Names are limited

Hierarchical structure

- Tree structure
- Directories are normal files with a specific format
- Bit indicate if file or directory
- Contains directory entries
  - Map name to some ID
  - User can read
  - Only kernel can write

- Pros
  - Much better organization
  - Reuse file implementation
- Cons
  - File look up is a bit more complicated
    - Need to traverse directories



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Directory Implementation

- Directory are implemented like files
- Content of directory entries:
  - Name
  - inode number (the name come from the original UNIX)
  - Type
- Directory grows chunk of dirent the size of a single disk block (it is just a normal file!)
- Root directory has a designated inode (so we know where to start!)

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Root directory “/”

Name	inumber
home	6
etc	2254
net	3
sbin	4512
var	25615
tmp	14525
…	…

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What is this inode number?

Assume:

- inode stored from block 100
- inodes 8 per block
- block 100 contains 0-7, 101 contains 8-15 etc.
- There are 100 block of inodes
- Root ("/") inode number is 2!

	Block Number	Content							
inodes	100			200					
	101	202	203		201				
	102	204	205						
	...								
Data blocks	200	.,2	..,2	bin,8	usr,16	boot,35	text,11		
	201	.,11	..,2						
	202	.,8	..,2	ls, 91	cat, 105				
	203	.,9	..,16	libc.a,95	ssl.a,478				
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Find /usr/lib/libc.a

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/usr/lib/libc.a inode number is 95!

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Some notes

- Full path name are cumbersome
  - POSIX maintain a current directory for each processes (cwd)
  - cwd inode number is a process metadata
  - When solving path look for first character
    - If "/" start from root (which inode number is known)
    - Else start from working directory
- POSIX two special directory entries
  - "." refers to the directory itself
  - ".." refers to its parent
  - This is how file systems can resolve "../something"
- More than one directory can refer to a single file
  - Hard Link: a inode number appears in more than one directory
    - Need to maintain a reference count (incremented by one every time an inode is referenced in a directory)
    - When deleting reference decrease the reference count
    - If the reference count reaches 0, the file block(s) are free!
  - Soft Link (aka symbolic link): file contains the name of another file
    - When such file is encountered continue resolution using the name that appears in the file
    - Nothing is done on deletion (or need to maintain list some and fix it)

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Thank you

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