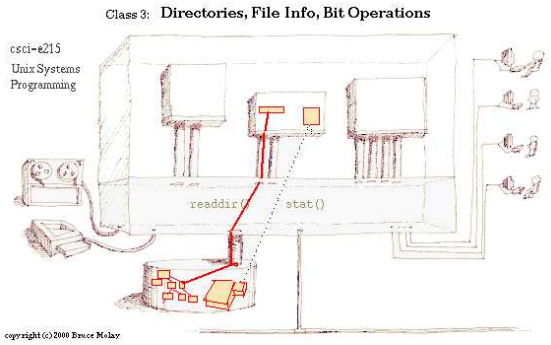
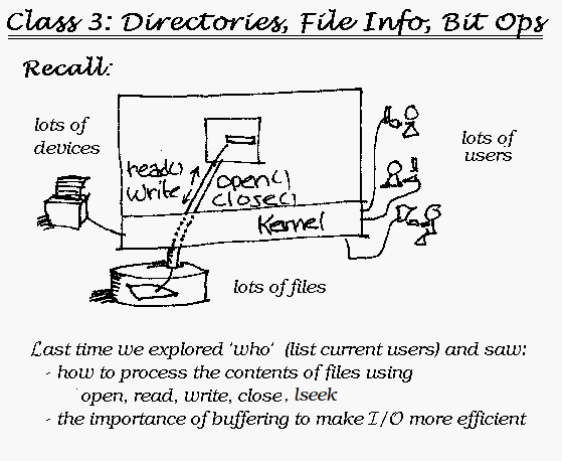
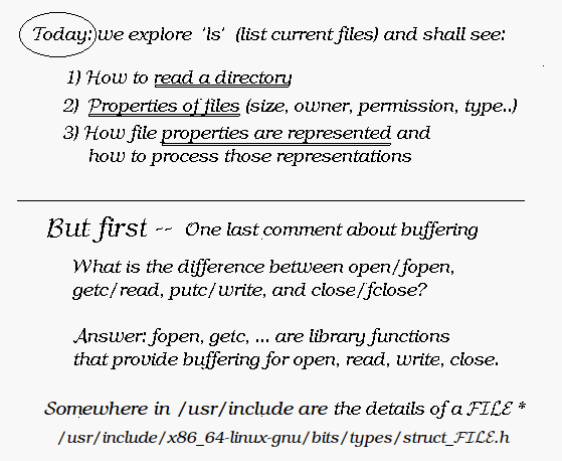
page000.html **000**



page001.html **001**



page002.html **Properties of files** **002**



page003.html **Files and Directories** **003**

Writing ls (with our 3-step method)

1) What does ls DO?

ls lists the contents of directories
AND displays information about files.

Examples

`ls` (dir)	`ls -l` (lists and shows info)
`ls /tmp`	`ls -l /etc`
`ls hello.c` (file)	`ls -l hello.c`

type

```
-rw-r--r--  1 lib215 extlib 8415 2010-02-08 10:23 hello.c
  permiss    owner  group  size  modtime          name
```

page004.html **004**

Other ls options

```
ls -a          shows "." files
ls -a /
ls -lu         shows access time
ls -s          shows size in blocks
```

Note: arguments to ls may be:

none	=>	show current directory
filenames	=>	show info about files
dirs	=>	show directory contents

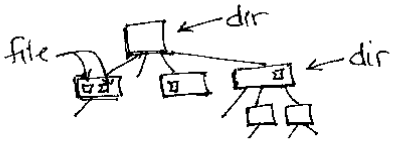
so. We need to learn:

How to read a list of files from a directory
How to get info about files
How to present info about files

page005.html **005**

3 Brief Review of the File System Tree

The disk is organized as a tree of directories, each of which contains files and/or directories.



The commands cd, pwd, ls allow you to explore a FILE SYSTEM.

page006.html **006**

4 So... writing ls should be easy:

```
     open directory          EOD?
|--> read entry      ------+
|--- display entry         |
     close  <--------------+
```

Maybe it is just like writing the who command.

Is a directory like a file?

page007.html **Reading Directories** **007**

5 Q. What IS A Directory?

A: A special kind of file that contains a list of files and or other directories.

Note: Every directory contains the items "." and ".."

6 Q: Can We Use open, read, close to Read This List?

A: yes. The open(2) system call can open a dir

But...

A: no. The read(2) system call returns -1 (see man)

Let's Try: cat / ; more /tmp; od -c /etc

Code demo: open_a_dir.c

page008.html **008**

Ans2: Even if you could, you don't want to, because different types of disks have different directory formats.

For example, Unix can read CDROMS, VFAT floppy disks, USB flash drives, each with a different format of directory content. It is better to rely on the kernel to know about formats.

7 OK, How DO I Read a Directory ?

```
man -k direct
man -k direct  | grep read
```

Ans: opendir(), readdir(), closedir().

page009.html

009

Using these Directory Functions

```
#include <dirent.h>

opendir(name)
```

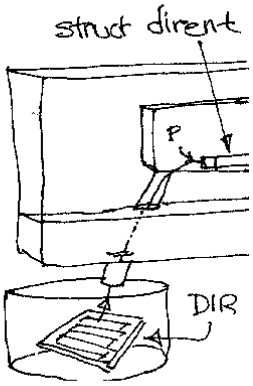
Creates a connection.
Returns a DIR *

```
readdir(DIR *)
```

Gets next record from dir. Returns a struct dirent *

```
closedir(DIR *)
```

Closes the connection.



page010.html

Writing ls

010

Writing ls1.c

```
main()
    opendir
    while ( readdir )
       print d_name

    closedir
    return 0
```

Let's compile and run the code...

Note how permission bits (rwx) affect opendir/readdir

page011.html

011

How Well Does ls1.c Work?

a) No columns

solution: doable, interesting

b) Not sorted

solution: use qsort() on array

c) No -a option (lists all files)

solution: simple string handling
write ls1-nodots. to see how easy it is

d) No -l option

solution: .... hmmmm.
is this as easy as -a ?

page012.html **012**

9 How Do We Add the -l Option ?

Note: The other info is NOT in the directory

Q: What Does -l Display?

A: modtime, size, owner, group, links, type, permission,...

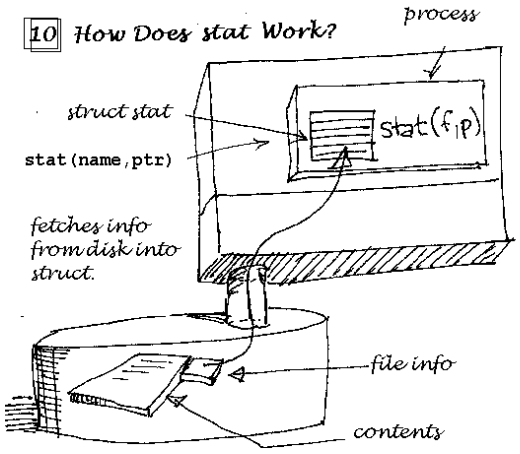
Q: Where do we learn about reading these properties?

A: Search the manual

Result: the stat() system call

page013.html **013**

10 How Does stat Work?



page014.html **014**

11 What Do We Get From stat ?

The struct contains:

st_mode,
st_uid,
st_gid,
st_size,
st_links,
st_mtime, ...

So.. We Just:

1) Read a dirent for the filename,
2) Use stat to get file info for that name
3) Display the items in the struct

(code: stat1.c)

page015.html **015**

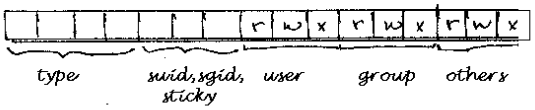
12 How'd We Do with stat1.c?

filename?	Perfect!	
filesize?	Perfect!	
mod time:	Use ctime() or localtime() to convert	
owner, group:	These are stored as numbers. We need to map numbers to names.	
type?	??	in the mode
permission?	??	

page016.html **Type and permission bits** **016**

13 Where Are Type and Permissions Stored?

A: st_mode is a 16-bit value. Fields are encoded in sections of this value:



Four bits means 16 patterns:

Each file type has a pattern.

Each permission is on or off, so a single 1 or 0 will do:

page017.html **017**

Programming for File Types and File Permissions -- Subfield Coding

* Subfield coding is not magic:

```
617-222-3333   phone
011-22-4567    social security #
102.102.34.34  IP number
```

* A computer stores integers as a string of bits:

```
215 = 0 0 1 1 0 1 0 1 1 1
  ? = 0 0 0 0 0 1 1 0 1 0
```

* As with telephone numbers, people define the size and coding in each region.

page018.html

018

Programming for File Types and File Permissions -- Masking to Read Fields

Q: How do I examine a bit or subfield?

A: Use "bitwise AND: &" to MASK the rest

Ex:

	1	0	1	1	0	1	0	0	1	value	551
&	0	0	0	1	1	1	0	0	0	mask	070
	0	0	0	1	0	1	0	0	0	result	050 — octal base 8

* The & operator compares values bit by bit. Its result contains 1's only where both numbers have a 1.
* 1's in the mask allow a value to `show through'

* skill: expressing binary numbers in base 8: group by 3s

page019.html

019

Testing Permission Bits with Masks:

Picture:

		user			group			others		
mode		1	0	1	1	0	1	0	0	1
& mask		0	0	0	0	0	0	1	0	0

= 004

Code:

```
if ( st_mode & 004 )
    printf("readable by others");
if ( st_mode & 002 )
    printf("writable by others");
```

Testing File Type with Masks

	type			user			group			others		
mode												
& mask	1	1	1	1	0	0	0	0	0	0	0	0
octal value	1	7		0			0			0		

* Masks are in <sys/stat.h> and/or <bits/stat.h> or <linux/stat.h> or somewhere else in /usr/include

page020.html

User and group databases

020

-rwxr-wr-w 2 dce-lib215 Domain Users 787 Feb 12 2020 ls1.c

[14] How Do We Convert UID to Name?

Check the manual. We learn about:
/etc/passwd -- traditional Unix user database
but not good a network of machines
ldapsearch -x "(uid=lib215)" | more
Asks a server on the network for user information

Fact: Unix identifies users by UID (userID) and stores that value. The passwd and ldap databases associate a string to a UID number.

getpwuid(3) looks up user information given the UID.

[15] How Do We Convert GID to Name?

Use getgrgid(3) passing the GID as an argument. Get back a pointer to a struct group.

page021.html

021

[16] stat2.c Now Has Correct Format

type, permissions, links, owner, group,
size, mod time, name!

[17] Writing ls2.c

Combine ls1.c to get names with stat2.c
to get info.