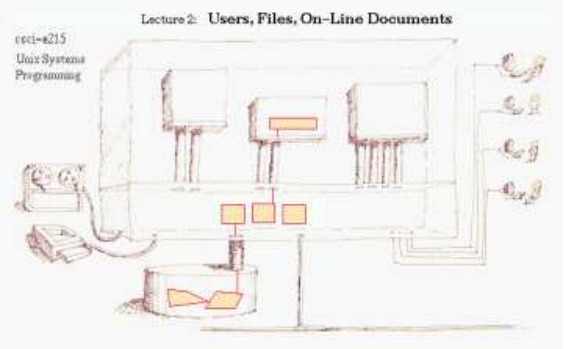
page000.html **News and Intro** **000**



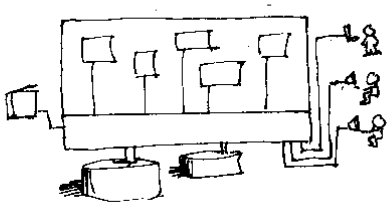
page001.html **001**

Class 2: Files, Users, On-line Documentation

Summary: Today we shall write a version of the who utility. In the process, we shall learn about:

☆ files, users, time, buffering, AND the fact that Unix is self-documenting. ☆

Recall:



page002.html **Understanding who** **002**

II *How Does who Work?*

A. *What does it do?*
purpose:
output:

B. *How does it do it?*

C. *How can I learn about the details?*

page003.html

003

II How Does who Work?

A. What does it do?

purpose: list users currently logged on

output: logname, terminal, time, from where

* By running the command we see what it does.
* By consulting the on-line manual..

```
man who
```

we learn even more.

page004.html

004

II How Does who Work?

B. How does who do it?

To learn more about Unix commands:

* read the manual

```
man who
```

* search the manual

```
man -k user | more
```

* read the .h files in /usr/include

```
more /usr/include/foo.h
```

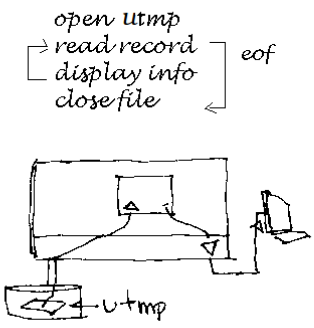
* follow the "See Also" links

page005.html

005

Answer

who works by:



page006.html

006

Q: How Do I Read structs from a File?

If you have used getc() and fgets(), you know how to read characters and lines, but what about structs of raw data?

What Does the Manual Say?

```
man -k file | grep read
```

```
man 2 read
```

topic

section

page007.html

007

Answer:

We use open(), read(), and close().

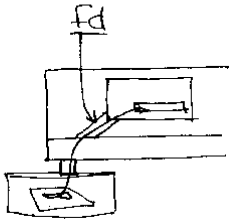
```
fd = open(name, mode)
```

char *

O_RDONLY
O_WRONLY
O_RDWR

returns -1 on error
OR an int on success

creates a connection to a file.



page008.html

008

Answer:

We use open(), read(), and close().

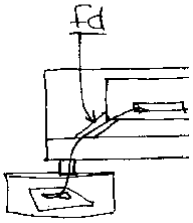
```
fd = open(name, mode)

n = read(fd, array, numchars)
```

* transfers numchars from file to the array

* returns number of chars actually transferred, OR -1 on error

```
close(fd)
```

* destroys the connection



page009.html **009**

Now we can write who1.c

It is getting pretty close,
but it needs some work..

IV. How Do We Get It to Look Good?

A. Suppress blank entries

B. Format time

Let's Check the Manual

(And the header files)

page010.html **Unix time** **010**

A. Suppress blank entries

check ut_type (see utmp.h)

B. Format time

localtime() converts time to parts
strftime() formats those parts

Unix stores time as seconds
since the beginning of the
Epoch

Result: who2.c

Moral: Unix provides complete
documentation on system
structures and programs

page011.html **cp: reading and writing** **011**

V. Project 2: cp (read and write)

In who, we read from a file.
How do we write to a file?
Let's explore a real example:

```
cp  sourcefile  copyfile
```

(1) What does cp do?

ANS: creates or truncates a file,
then writes data into it

(2) How does cp create and write?

ANS: search the manual for
the answers

page012.html

012

Creating/Truncating A File

```
fd = creat(name, 0644)
```

First: creates or truncates a file
Then: opens the file for writing
If create, set mode to, 0644

returns -1 on error,
otherwise a file descriptor

Writing to A File

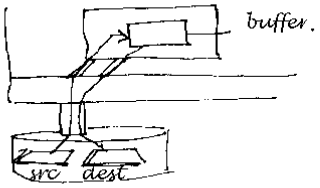
```
n = write(fd, buffer, num)
```

* sends 'num' chars to the file
* returns actual number sent
OR returns -1 on error

page013.html

013

Writing llcopy.c



Logic:

```
open sourcefile
creat copyfile

--> read source -> buffer ---+  eof?
--- write buffer -> copy     |
                             |
close <----------------------+
close
```

page014.html

014

VI. Does Buffer Size Matter?

Ex: Filesize = 2500 bytes
if buffer = 100 bytes,
=> 25 read() and 25 write() calls

if buffer = 1000 bytes
=> 3 read() and 3 write() calls

explore: strace [-c] llcopy sampfile s2
time llcopy sampfile s2

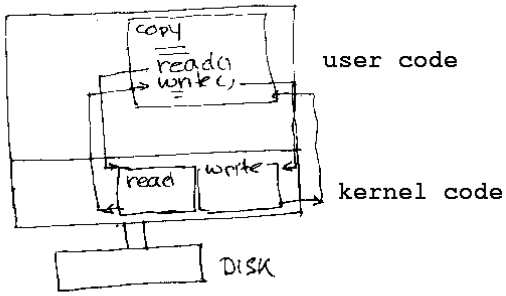
Important Idea:

A system call is resource 'expensive' (i.e. takes time). It runs various kernel functions, and it also requires a shift from USER MODE to KERNEL MODE and back.

** Thus, try to minimize system calls **

page015.html **015**

Control flow in copying a file:

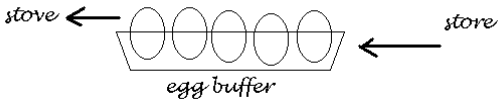


page016.html **016**

VII. Does This Mean who2.c Is Inefficient?

Yes! Making one system call for each line of output makes as much sense as buying pizza by the slice or eggs one at a time.

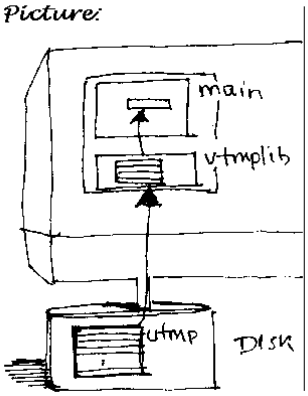
Better Idea: Read in a bunch of records at a time and then, as with eggs in a carton, take them one by one.



page017.html **utmplib.c** **017**

Adding Buffering to who2.c

Picture:



main calls functions in utmplib.c

utmplib.c keeps a utmp buffer with space for 16 utmp structs.

utmplib.c reads only when the buffer empties.

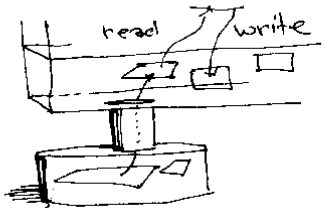
Result: who3.c

page018.html **018**

VIII. If Buffering Is So Smart, Why Doesn't the Kernel Do It?

It does!

The kernel keeps copies of disk blocks in memory. It writes those blocks to disk now and then. The read() call actually copies data from kernel buffers, not from the disk.



page019.html **tail + lseek** **019**

Consequences of Buffering

1) Faster "disk" I/O
2) Optimal disk reads and writes
3) Need to sync disks before shutdown

IX. Final Example: tail

1) What does tail do?

2) How does tail work?

...

page020.html **020**

IX. Final Example: tail

1) What does tail do?

2) How does tail work?

Q: How can a program jump to the end (or to any arbitrary location) of a file?

A: `lseek(fd, offset, base)`

`# of chars`

`0: start,`
`1: current`
`2: end`

The next read or write occurs there.