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- **read locks**: prevents overlapping write locks
  allows read locks by other processes
- **write locks**: prevents overlapping read and/or write locks (exclusive locking)

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Advisory Locking Procedure

1. Try to set lock
2. If lock is acquired, read/write as desired
3. Release the lock

fcntl()

```
#include <unistd.h>
#include <fcntl.h>
int fcntl(int fd, int cmd,...)
```

cmd

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3rd arg is a struct flock *pflk:

```
struct flock {
    short l_type;      type of lock
    short l_whence;    reference address for l_start
    off_t l_start;     offset from l_whence
    off_t l_len;       qty bytes in locked region
    pid_t l_pid;       pid of owning lock process
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Some systems also have the l_sysid field (system id)

fcntl(): struct flock

l_type	F_RDLCK	sets a read lock on a region
	F_WRLCK	sets a write lock on a region
	F_UNLCK	unlocks region

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l_whence, l_start	SEEK_CUR	current file ptr + l_start
	SEEK_SET	l_start
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	SEEK_END	end-of-file ptr + l_start
l_len	=0	start to ∞
	+	length of locked region in bytes
	-	formerly illegal
		allowed for Linux kernels 2.4+
		allowed for POSIX.1-2001
		locks l_start+l_len to l_start-1

Promotion and Splitting

lock promotion handling overlapping locks

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unlocking [50,100] ⟶ lock[0,49] and lock[101,150] *(two locks!)*

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(Locks are associated with inodes)

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(see filelock.c)

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- A single file may not simultaneously have both shared and exclusive locks.

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- Not even root can override file locks (although root can kill the process that holds the lock, indirectly removing them)

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```
struct stat statbuf;
if(stat("FILENAME",&statbuf)) perror("stat: ");
else {
        int flag;
        flag= (statbuf.st_mode & ~(S_IXGRP)) |S_ISGID;
        if(chmod("FILENAME",flag)) perror("chmod: ");
        }
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- Locks are never inherited via fork()
- locks may be inherited by a new program across an exec() (Posix does not require this, but SysV and BSD do)
- Processes may use file locks to insure that only one copy of the program is running:
  open a file, write the process's pid to the file (see getpid()), write lock the file.

Directory API

#include <sys/stat.h>

#include <sys/types.h>

int mkdir(const char *pathname, mode_t mode)

Returns 0=success, -1=failure (use perror() for more details on errors)

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- Directory records are specified by one of the following structures:

  BSD,linux: struct dirent SysV: struct direct

  You may recollect that readdir() returns pointers to one of these on various unix systems.

rmdir()

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- Must have search (ie. exec) privileges for *every* component of the path
- May not remove the current directory

Device File API

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#include <sys/stat.h>
#include <fcntl.h>
#include <unistd.h>
int mknod(const char *pathname, mode_t mode, dev_t dev);
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- Permissions are controlled by the process' `umask` item File types: File type must be one of S_IFREG, S_IFCHR, S_IFBLK, S_IFIFO, or S_IFSOCK (regular file); character special file or block special file; a FIFO (named pipe); or a Unix domain socket

Device File API

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#include <unistd.h>
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- Creates a file system node; ie. a device driver (character and block devices). These days usually **udev** creates/removes device nodes automatically. Udev receives device events directly from the kernel when a device is added or removed.
- Permissions are controlled by the process' `umask` item File types: File type must be one of S_IFREG, S_IFCHR, S_IFBLK, S_IFIFO, or S_IFSOCK (regular file); character special file or block special file; a FIFO (named pipe); or a Unix domain socket
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- Writing to a FIFO that has no reading process will cause a SIGPIPE to be sent to the writing process
- Normally an open for write will block (assuming that O_NONBLOCK is not used) until the FIFO gets opened for reading

Anonymous Pipes

#include <unistd.h>

int pipe(int pipefd[2])

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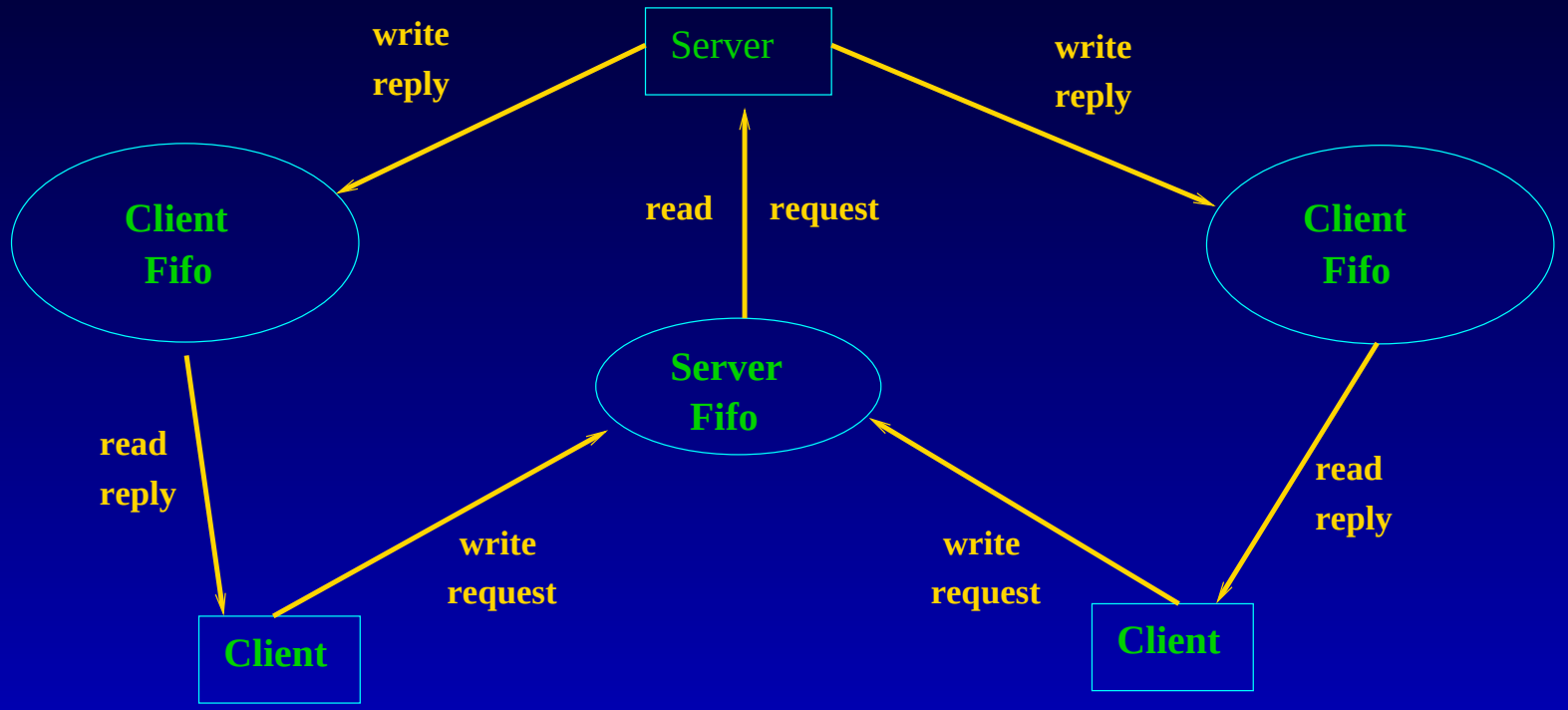
(see pipes.c)

Client-Server Communications

with FIFOS



A communications net with one server and multiple clients typically involves a server FIFO and (multiple) client FIFOs, one per client.

To send a packet of information:

Client-Server Communications

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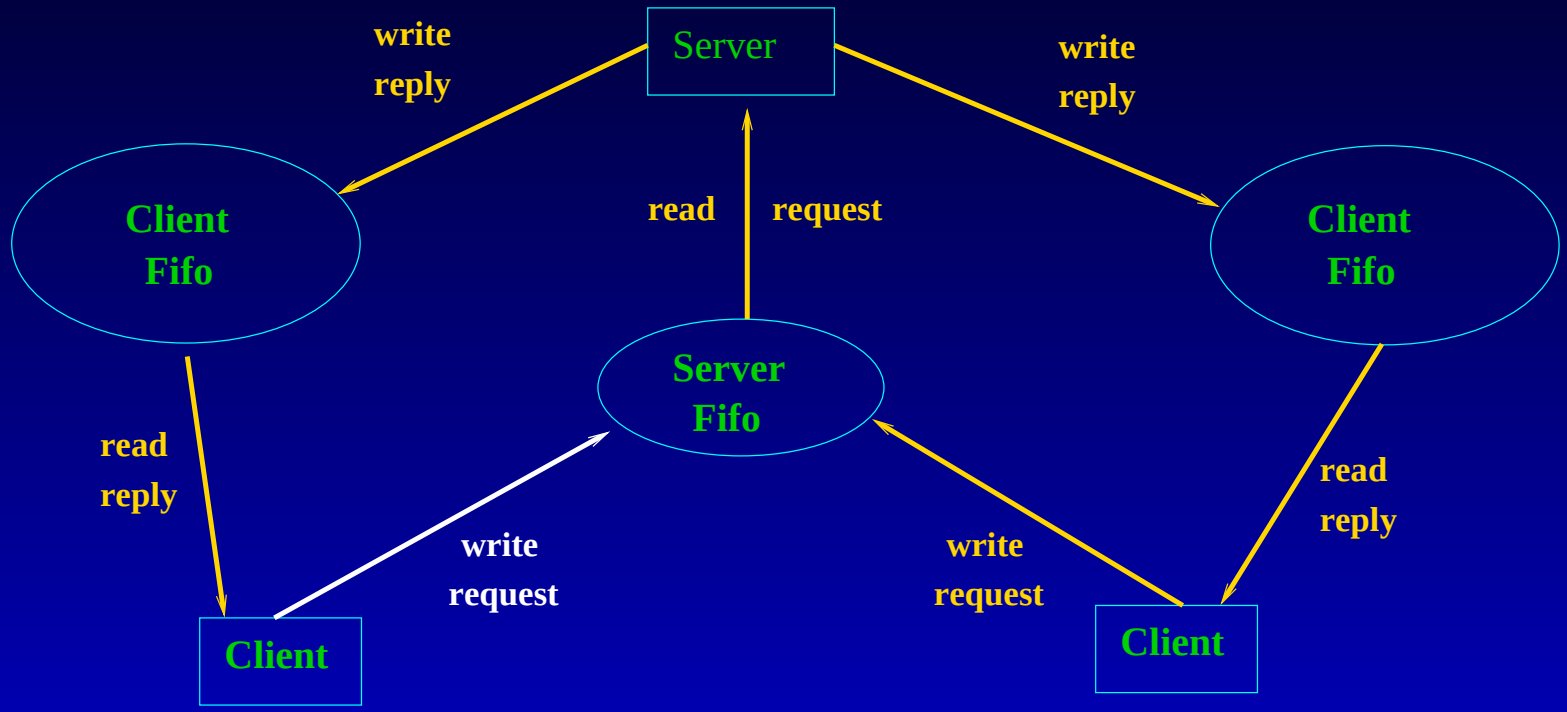

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To send a packet of information:

Client writes to server FIFO: client pid, qty bytes, data

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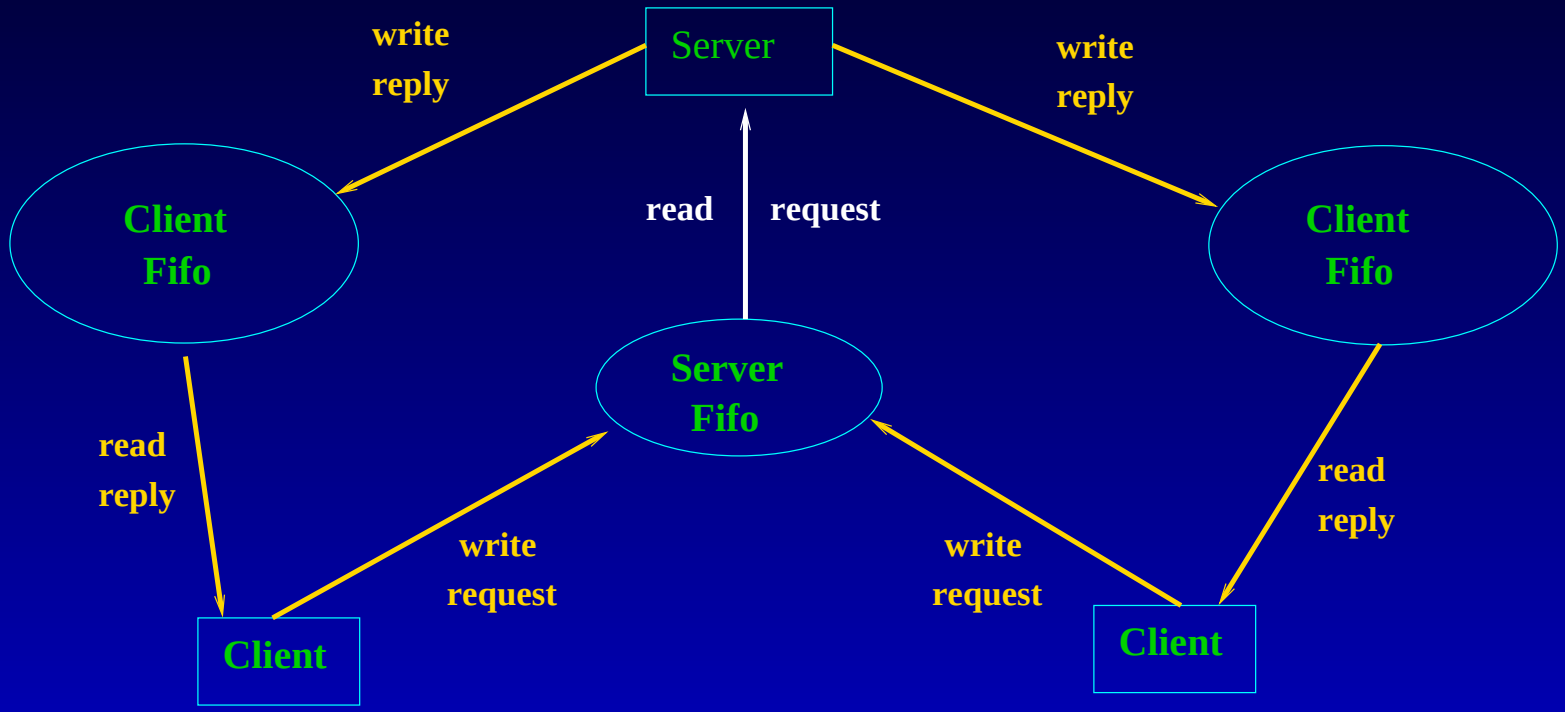

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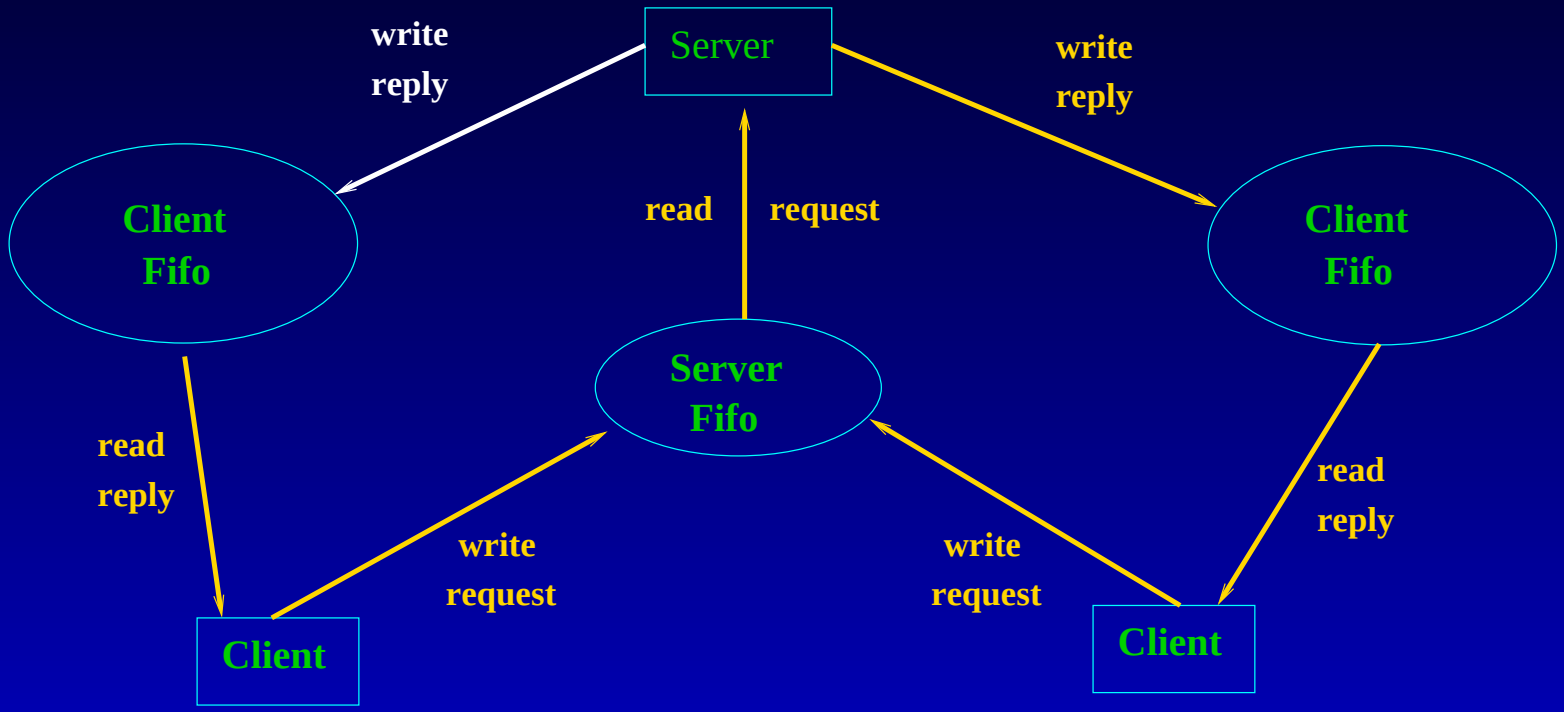

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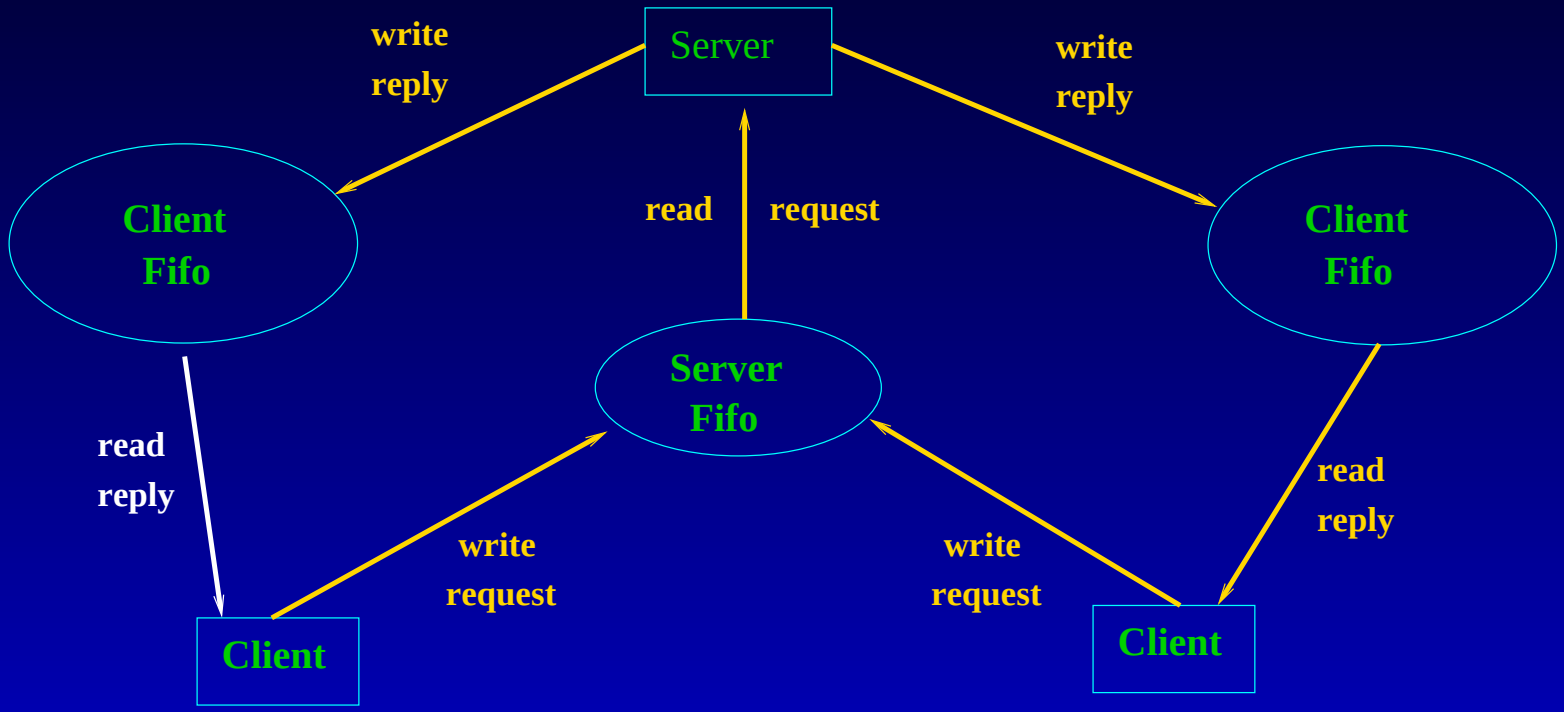

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Symbolic Link API

```
#include <unistd.h>
int symlink(const char *reallink, const char *fakelink);
ssize_t readlink(const char *path, char *buf, size_t bufsiz);
int lstat(const char *path, struct stat *buf);
```

symlink creates a symbolic link named fakelink which links to the file named by reallink.

A symbolic link may point to an existing file or even a nonexistent one. In the latter case, its called a **dangling link**.

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lstat query file atttributes of the link file itself (as opposed to what its pointing to). Otherwise, its just like the stat() function.