

# *A Day at the Races*

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# The Menu



- What is a Race Condition?
- Examples
- File Access
- Temporary Files
- Locking







# *What is a Race Condition*



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```
/* Lots of include directives omitted */

unsigned char* read_file(const char* filename) {
  /* We run suid root, so we have to check access before calling open(2). */
  if (access(filename, R_OK) == 0) {
    int fd = open(filename, O_RDONLY); /* Can't fail, we checked! */
    unsigned char* buf = malloc(1024);

    if (buf != 0)
      (void) read(fd, buf, 1024); /* Ignore error */
    (void) close(fd);             /* Ignore error */
    return buf;
  } else
    return 0;
}
```



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If you try it and it doesn't work, try it again ⇒ let a computer do it for you!







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The passwd program must run suid root (i.e., with superuser privileges).







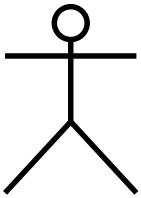
# Passwd Operation



/etc/passwd

passwd program

```
root:abcdef:0:0:Superuser:/root:/bin/bash
stn:bcdefg:7006:100:Stephan Neuhaus:/home/stn:/bin/bash
zeller:cdefgh:7001:100:Andreas Zeller:/home/zeller:/bin/bash
```



User

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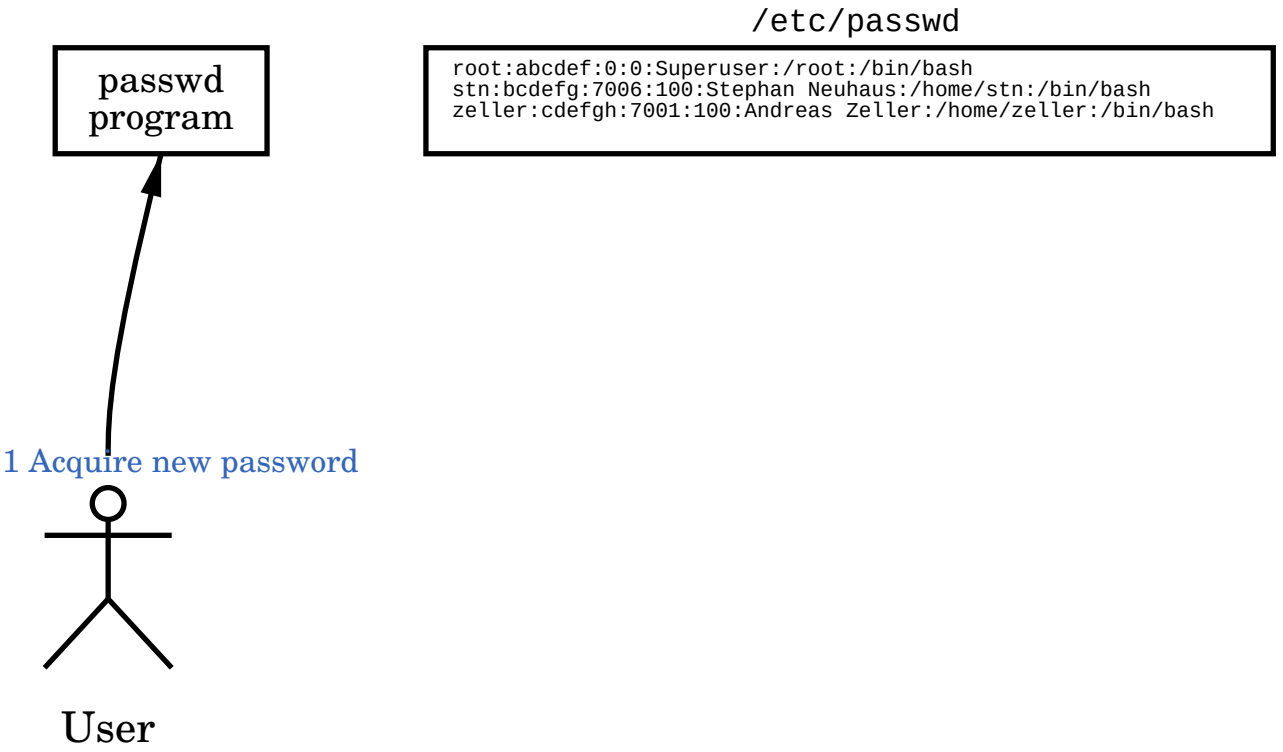

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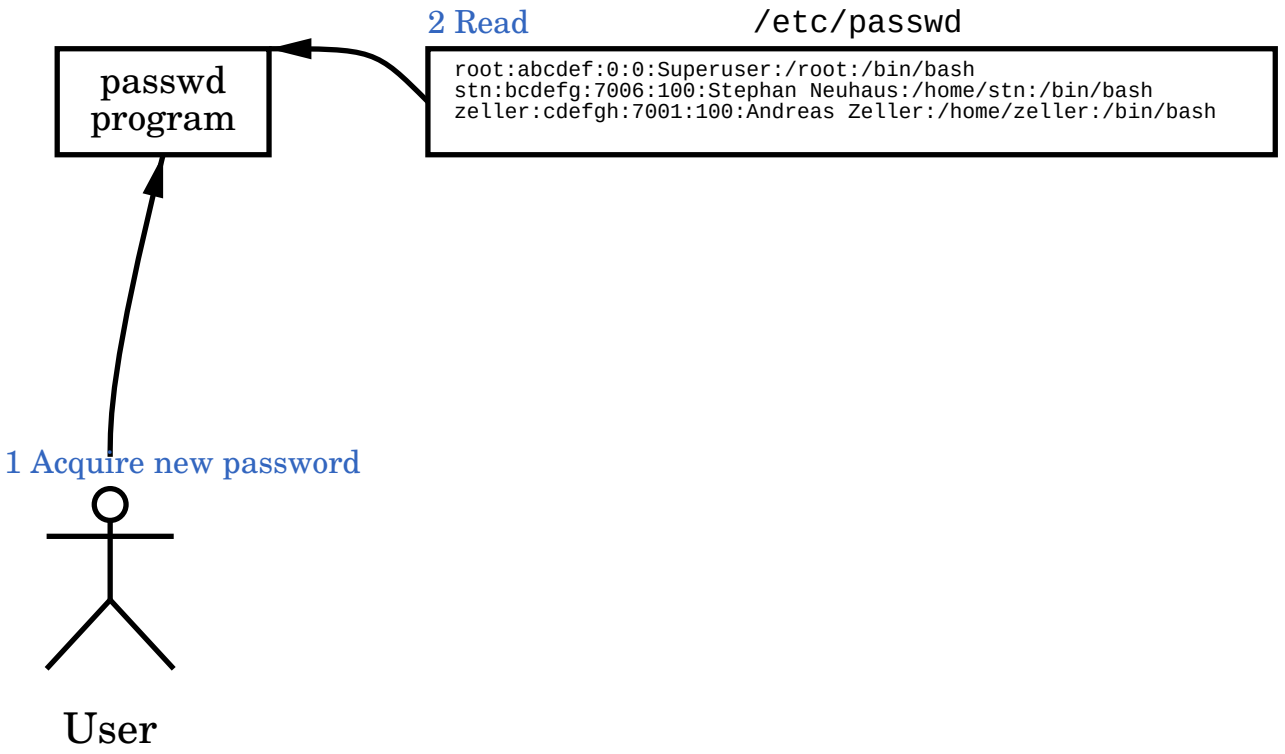

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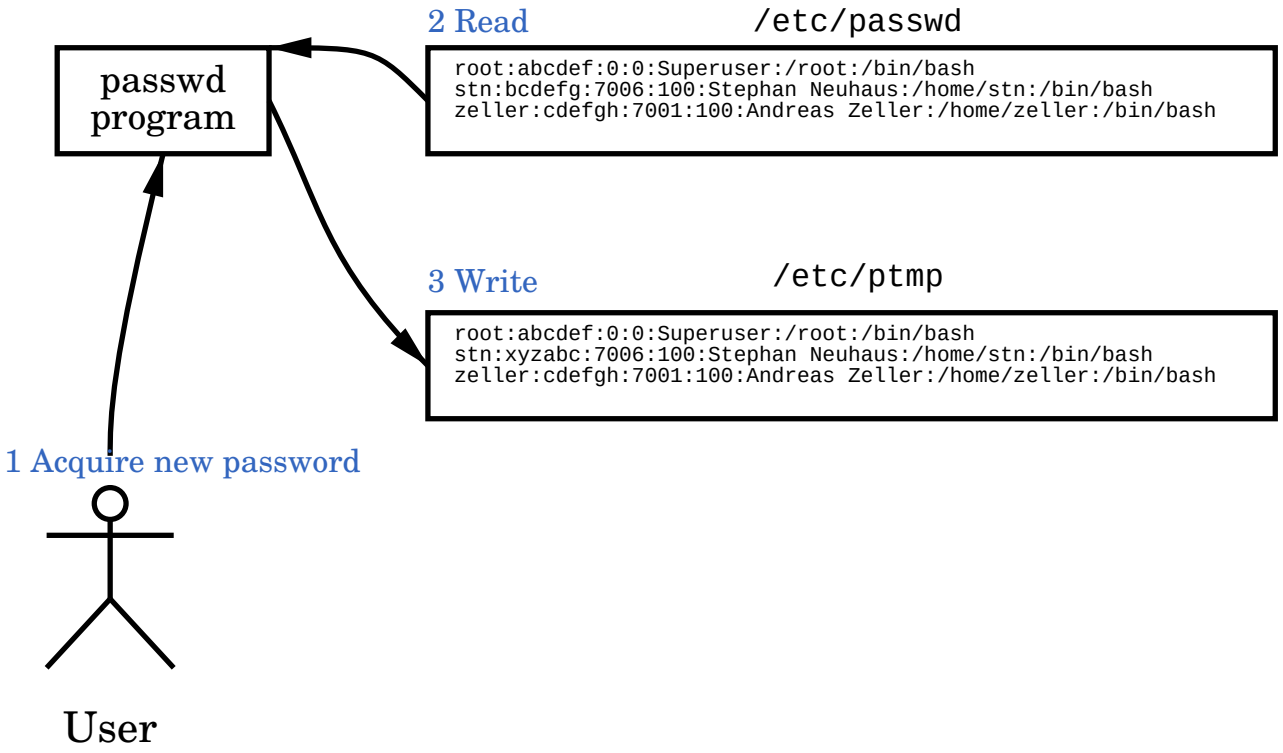

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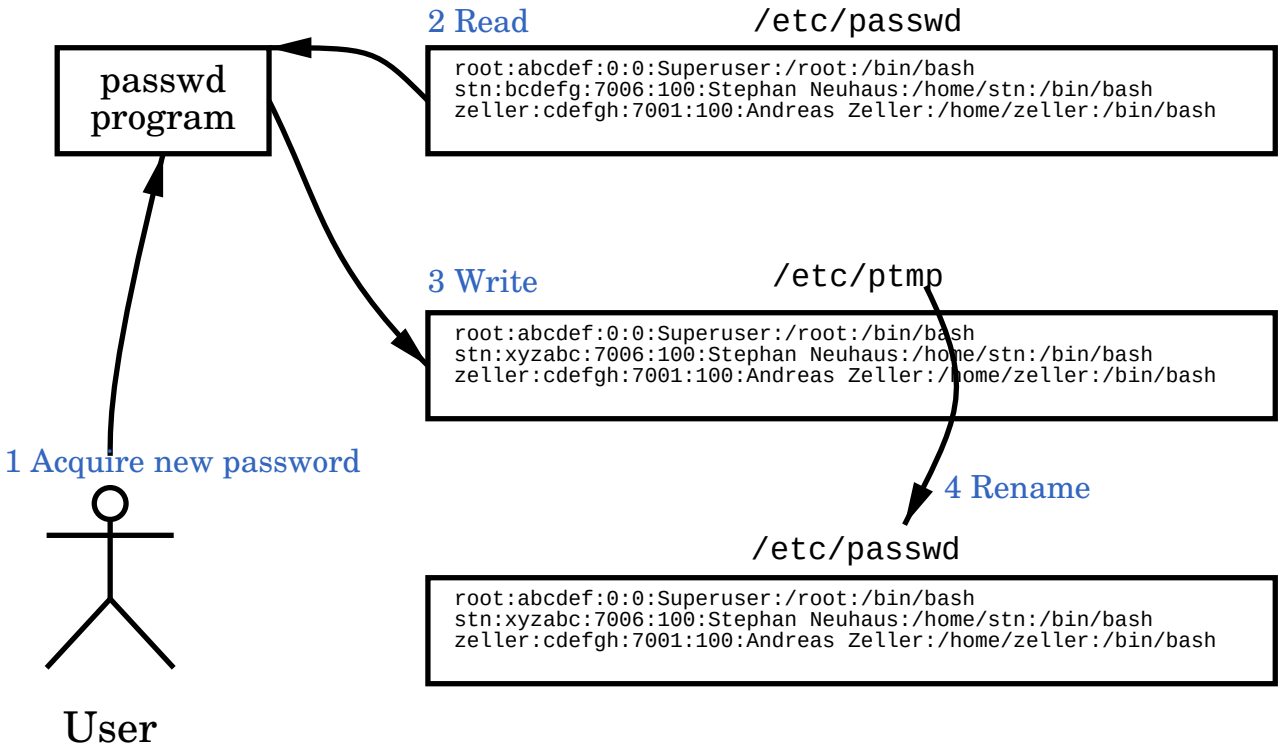

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This file contained hostname/username pairs that were permitted to use the `rsh` command to login to the user's account without a password. For example:

```
goscinny.cs.uni-sb.de neuhaus
```

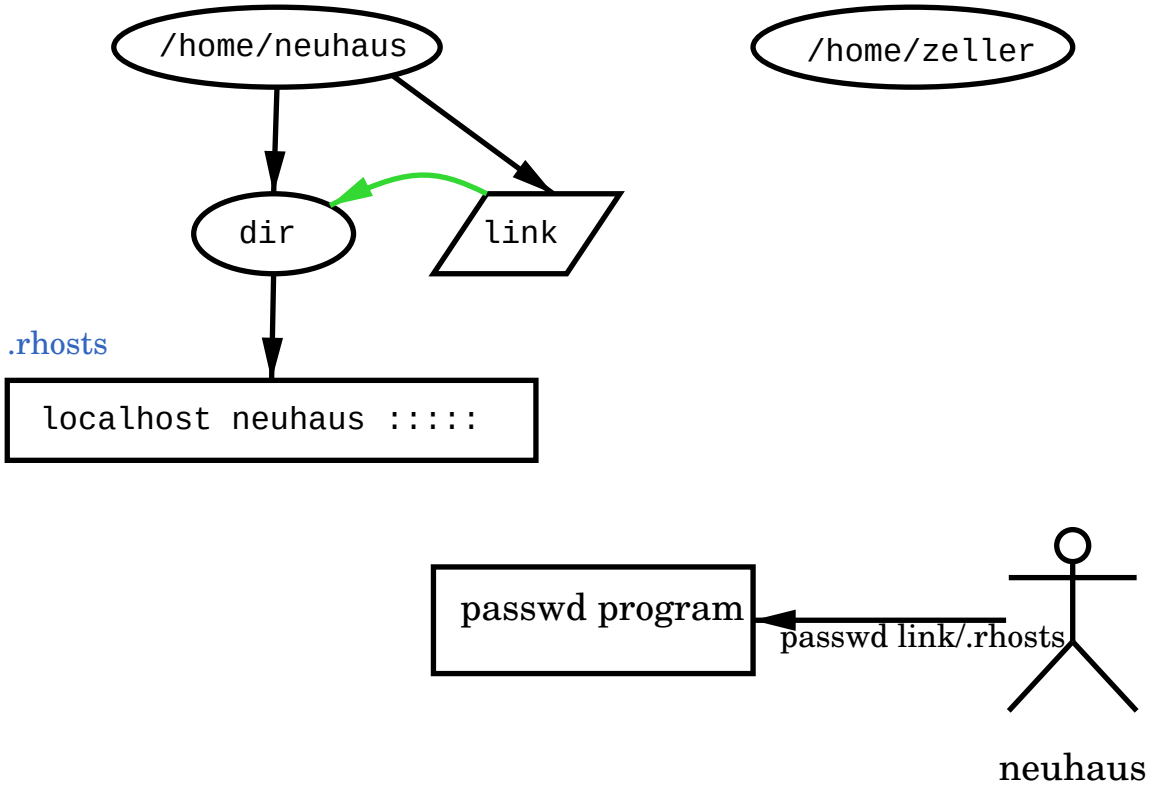
This would allow a user `neuhaus` on `goscinny.cs.uni-sb.de` to rsh to this machine and log in without a password.







# *Stealing a* `.rhosts` *File*



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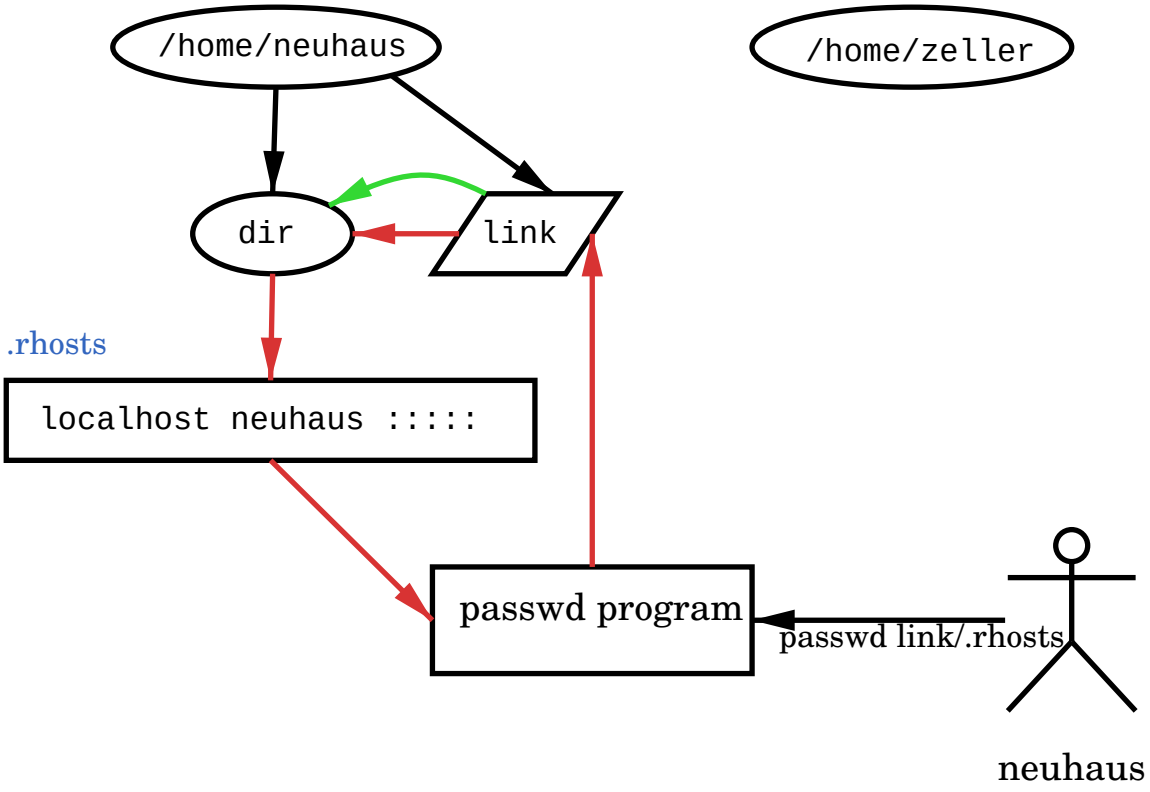

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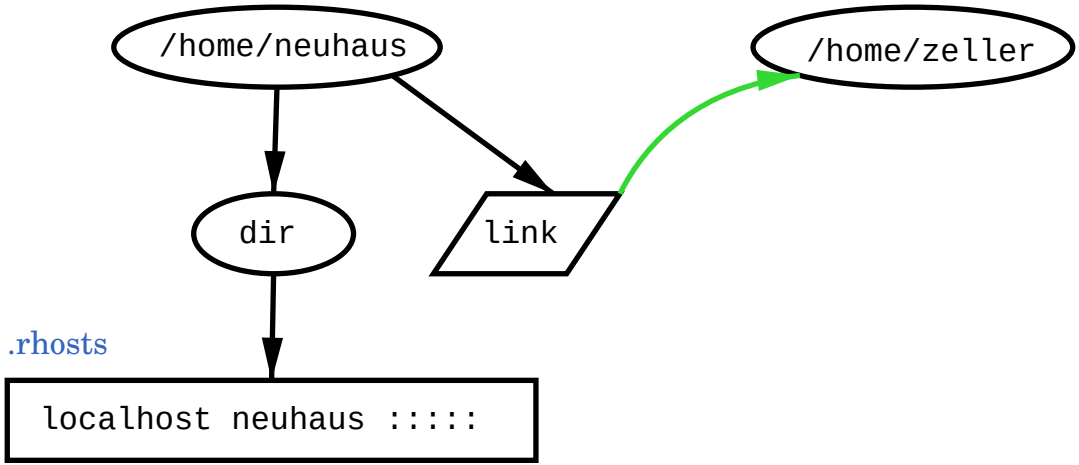


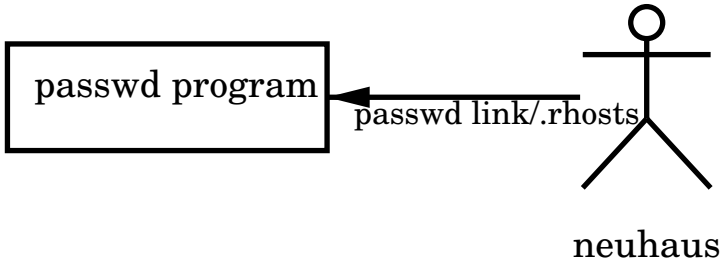

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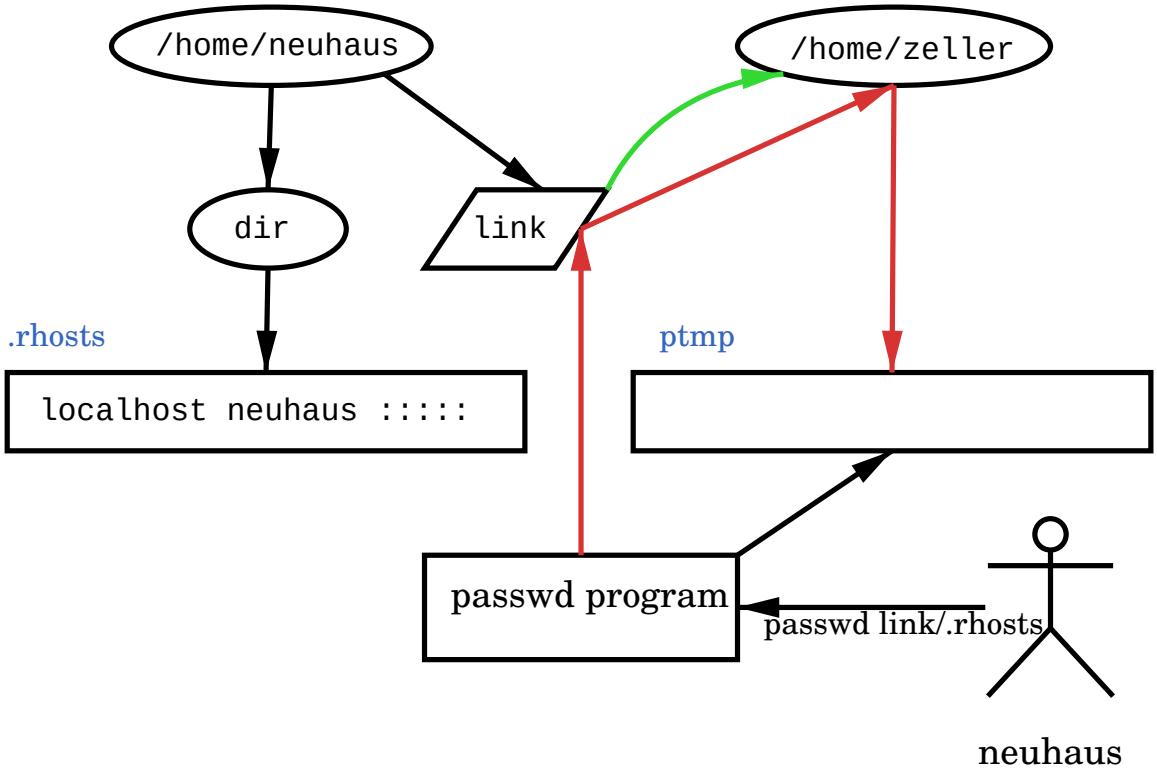

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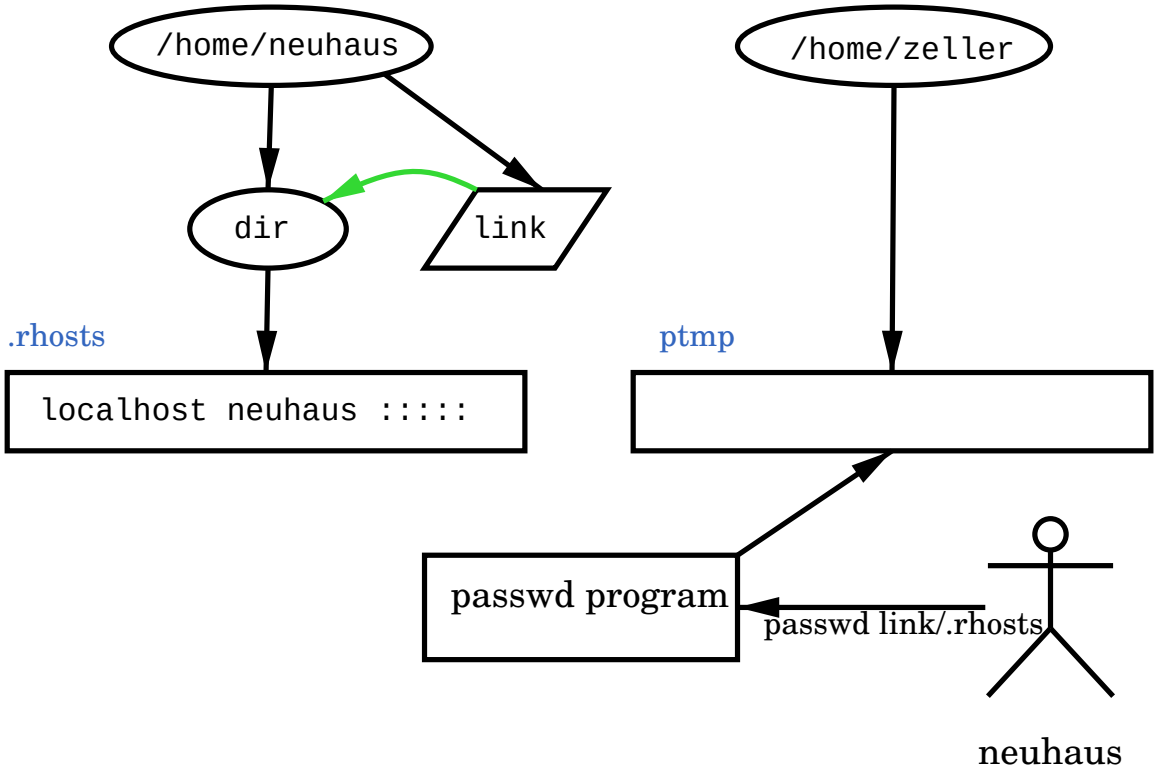

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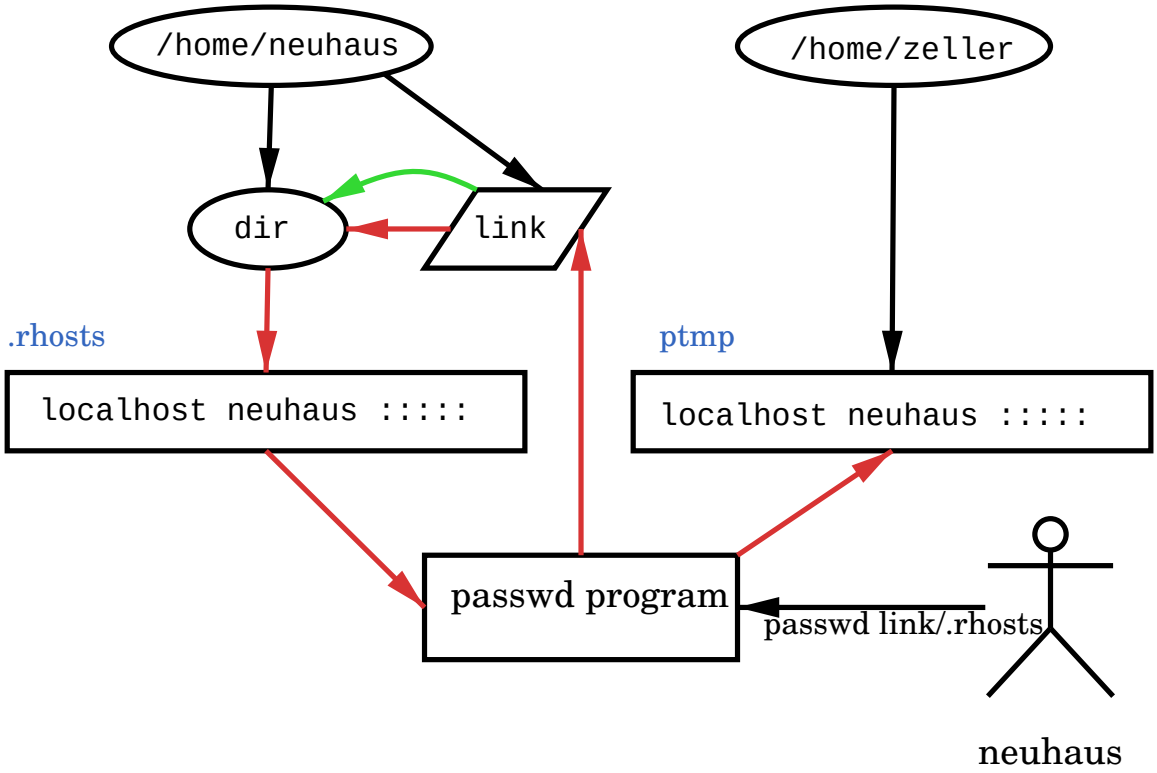

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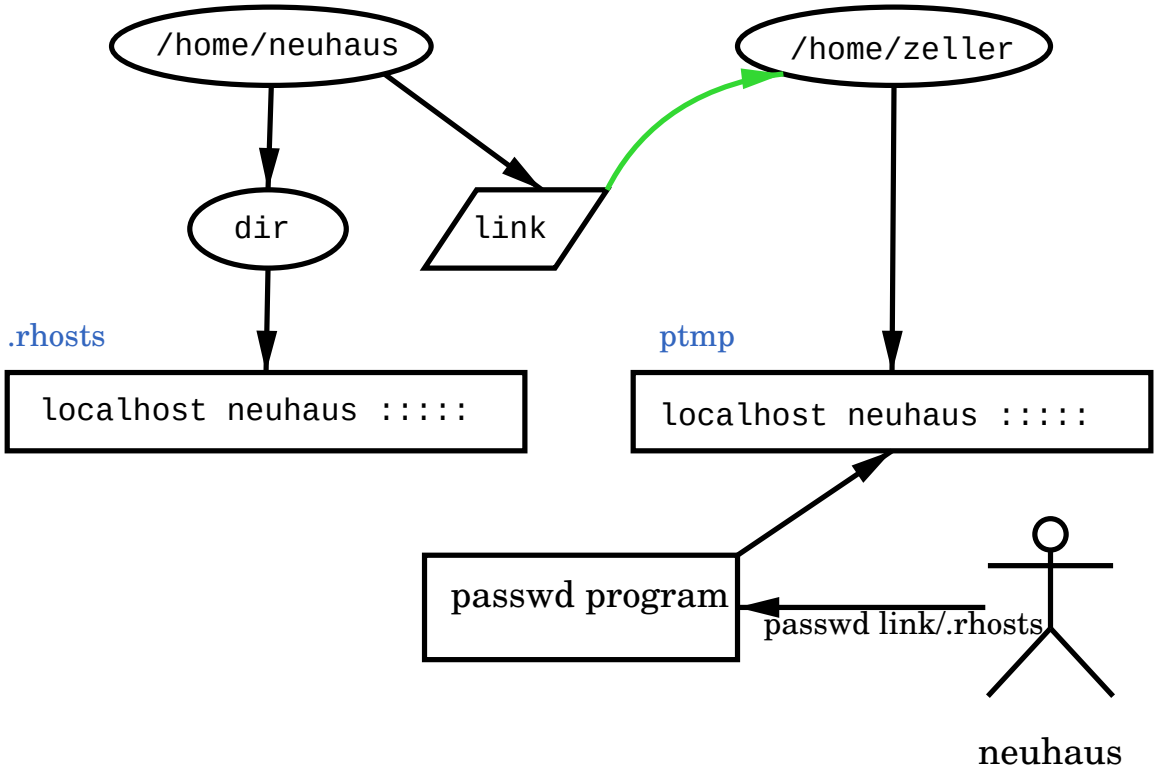

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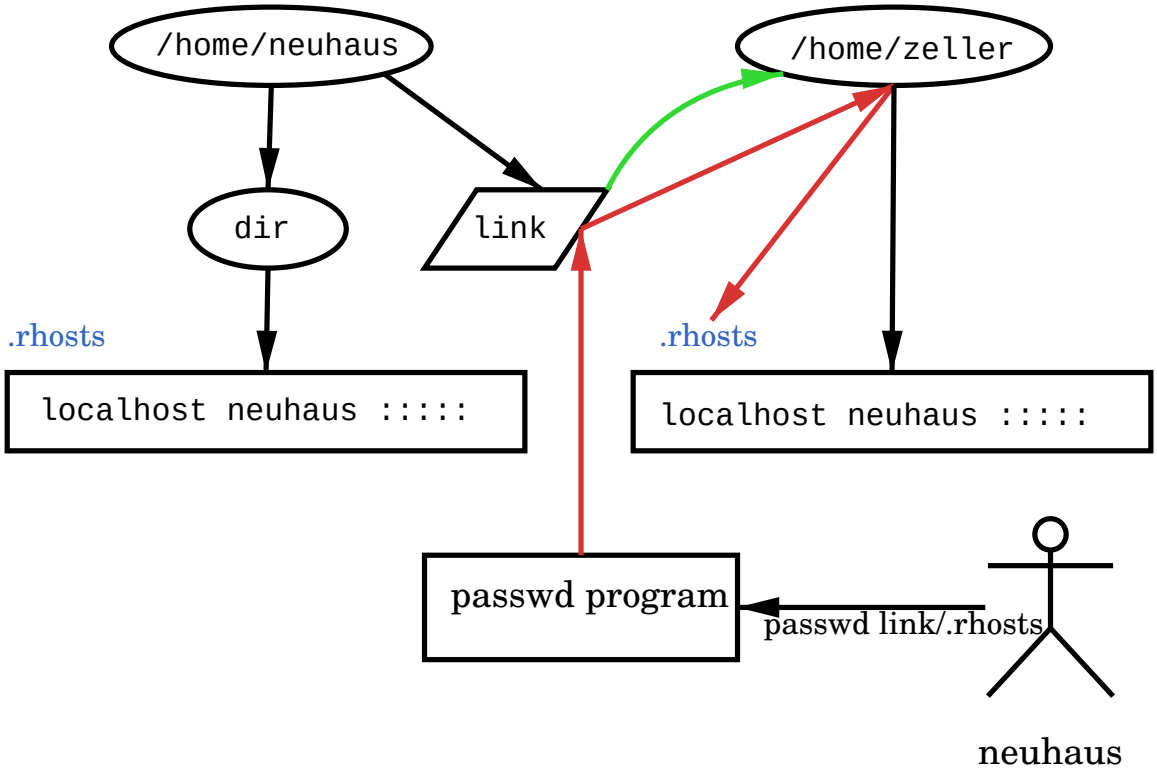

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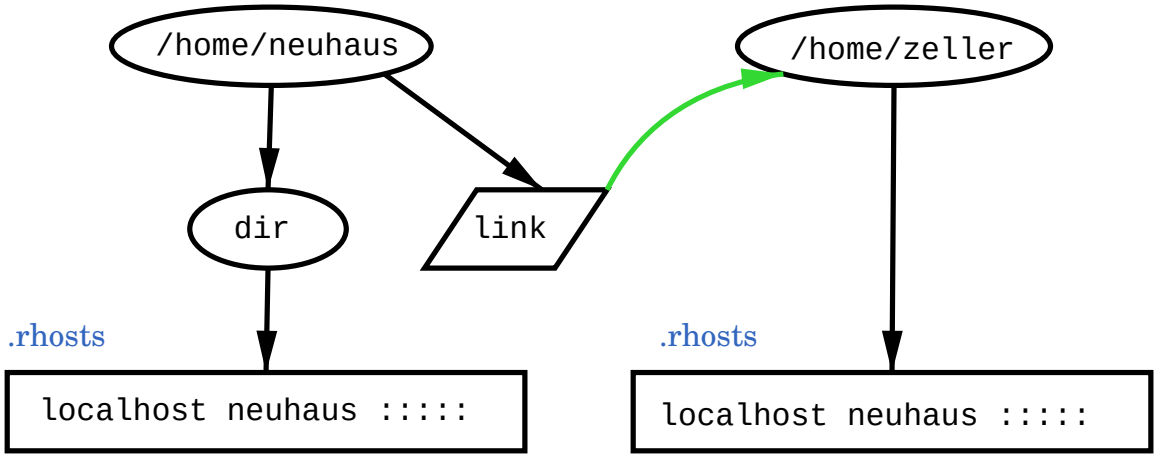


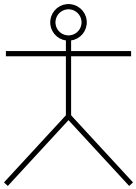

neuhaus

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- *Never* use *access*(2)!







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There is also the *saved* user ID, which was added since the ruid and euid weren't enough.







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Usually not necessary anyway: If you find that you are changing UIDs back and forth, *beware*!

Dropping privileges is tricky (see references for a tutorial)







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This has of course a TOCTOU problem. If between steps 1 and 2 someone creates a symlink to the password file, step 2 will open and truncate it.







# *Opening Files: Solution*



This code was copied from Viega, McGraw, *Building Secure Software*, Addison-Wesley, 2001. Code available from `http://www.buildingsecuresoftware.com`

(See handout)







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Worse, some NFS servers don't even tell you that the file was already there.

Therefore, make sure that the file is on a local file system.







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The standard C library has *tmpfile*(3), but this is often not implemented in a secure manner.







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- Use *fdopen*(3) if necessary to create a file pointer.

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- Use *open*(2) or *fopen*(3) to create the file.
- Immediately afterwards, use *unlink*(2) to remove the file from the file system. (It won’t go away until you close the file again.)
- Use *fdopen*(3) if necessary to create a file pointer.

- Use the file and close it when you're done.









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One technique is to use lock files.







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4. The process deletes the lockfile, thereby releasing the lock.

If there are distributed processes around, chances are that for one of them is on a remote machine and that the lockfile is on a NFS-mounted file system (so O_EXCL won't work).







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An inode contains all information about a file *except* its name.

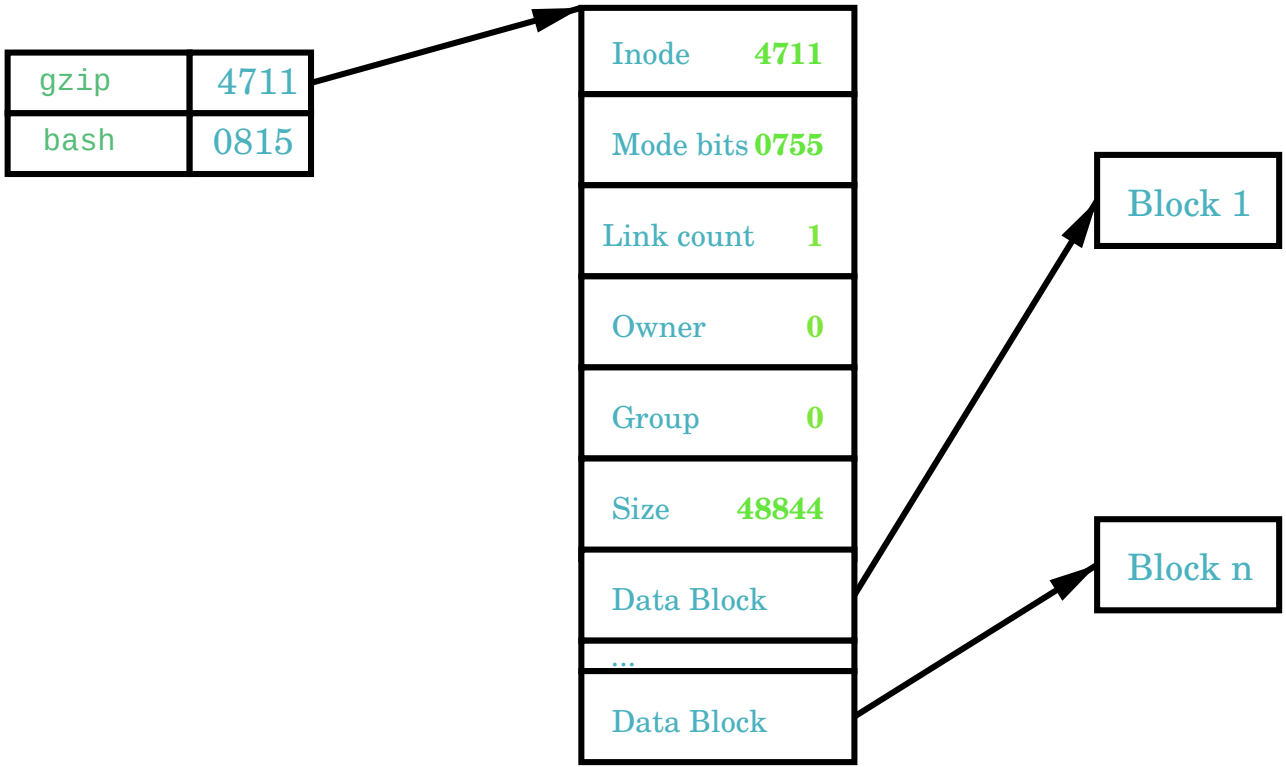
The name is provided by a *directory*, which is a special sort of file that contains (*name*, *inode number*) pairs.







# Excursion: Unix File System (2)



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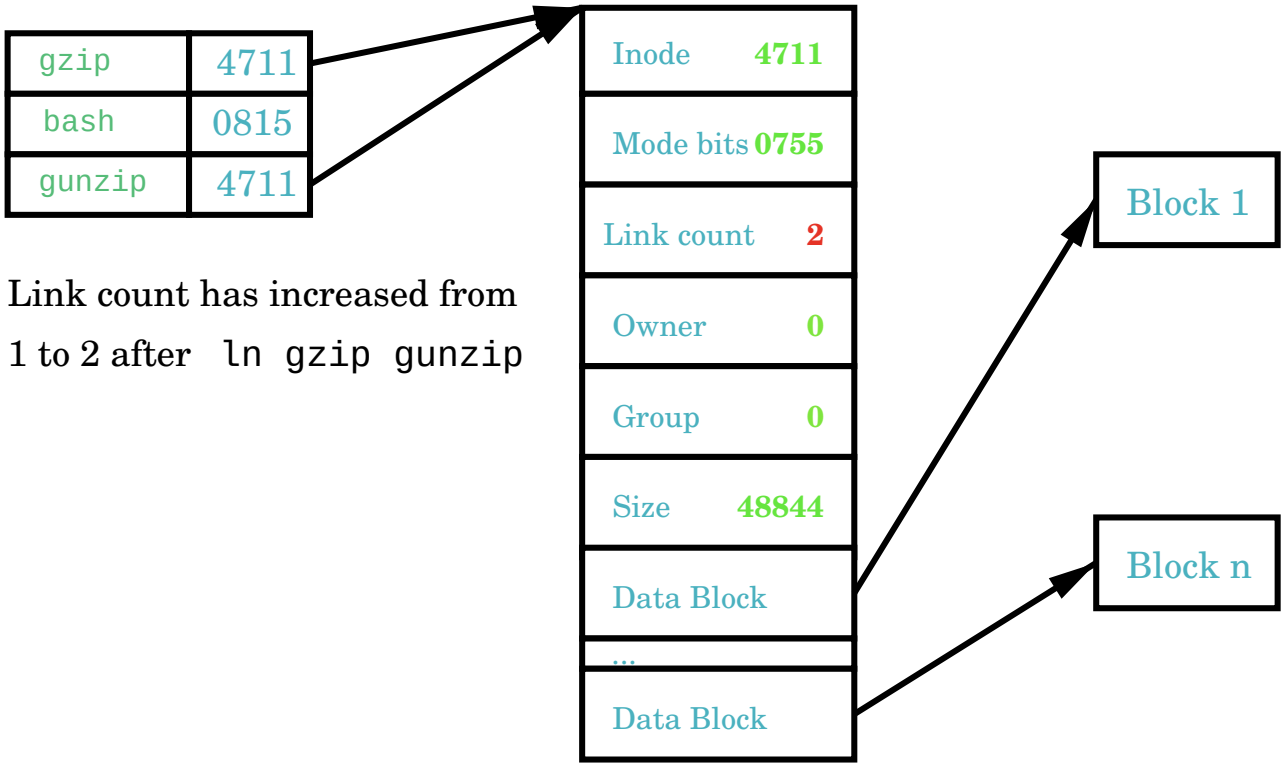
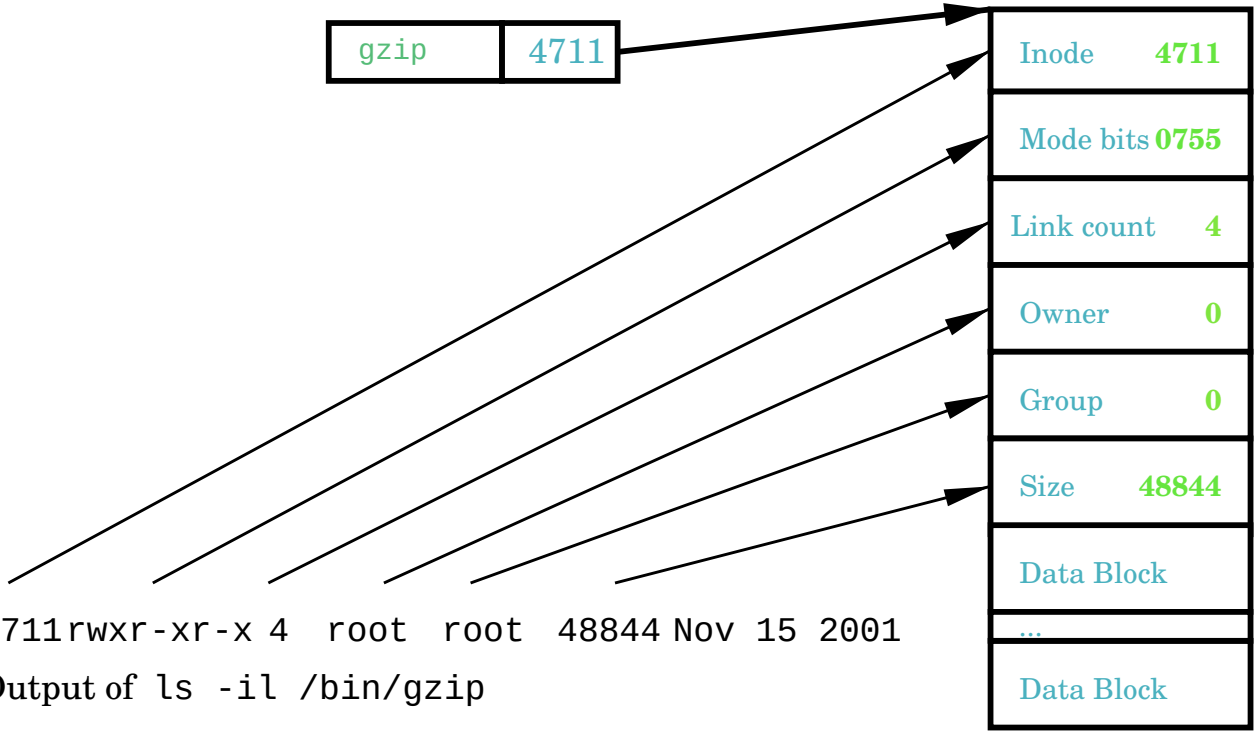



Link count has increased from 1 to 2 after `ln gzip gunzip`

# *Interpreting* `ls -il`




```
4711 rwxr-xr-x 4  root  root  48844 Nov 15 2001
```

Output of `ls -il /bin/gzip`

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Because NFS is supposed to be *stateless*, i.e., the server has no memory of outstanding client requests.

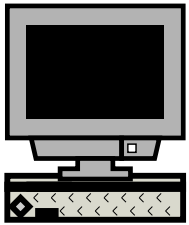
This is so that the server can continue to operate even if any component crashes and remoots in the middle of an operation.

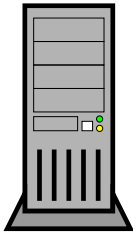


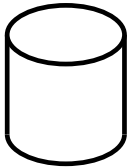




# Link System Call on NFS: Scenario 1







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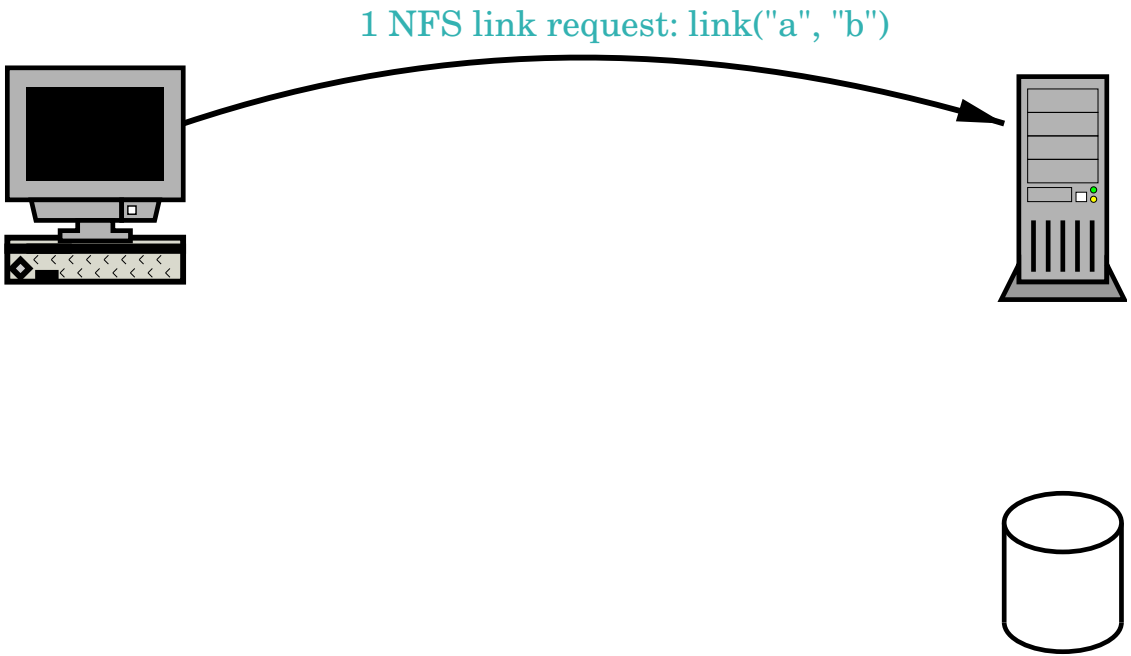

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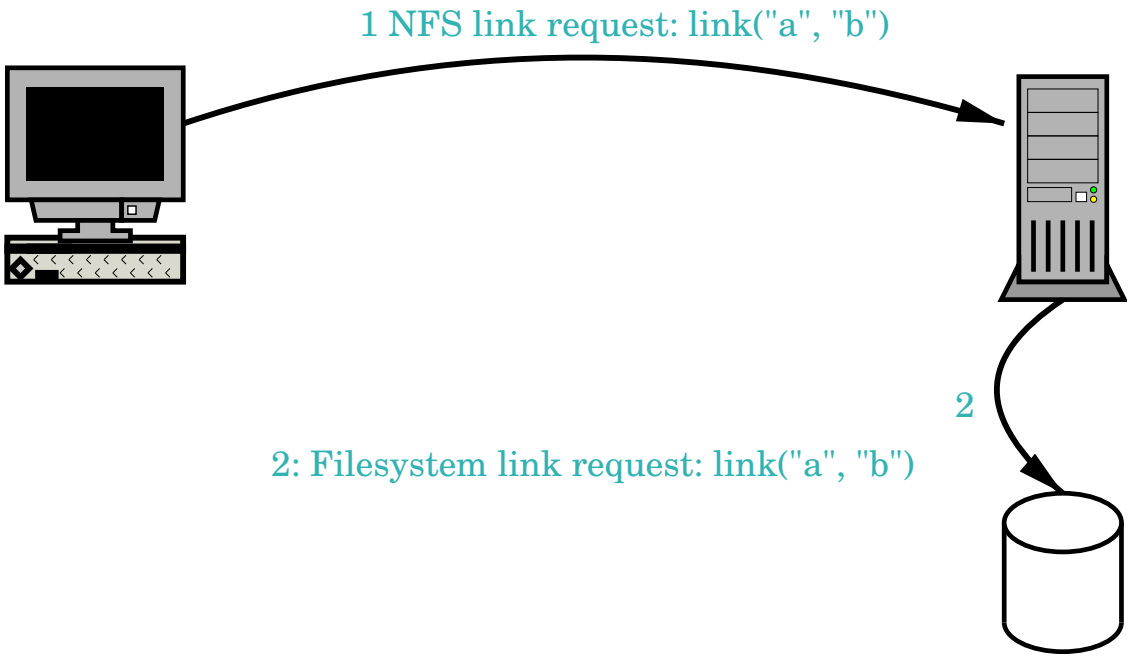

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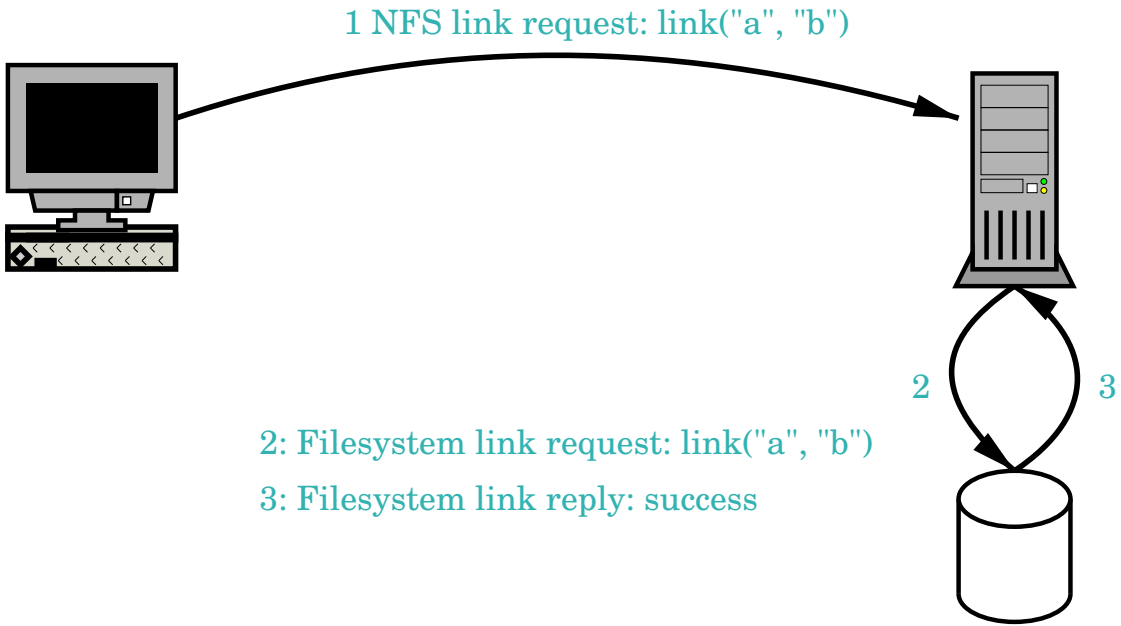

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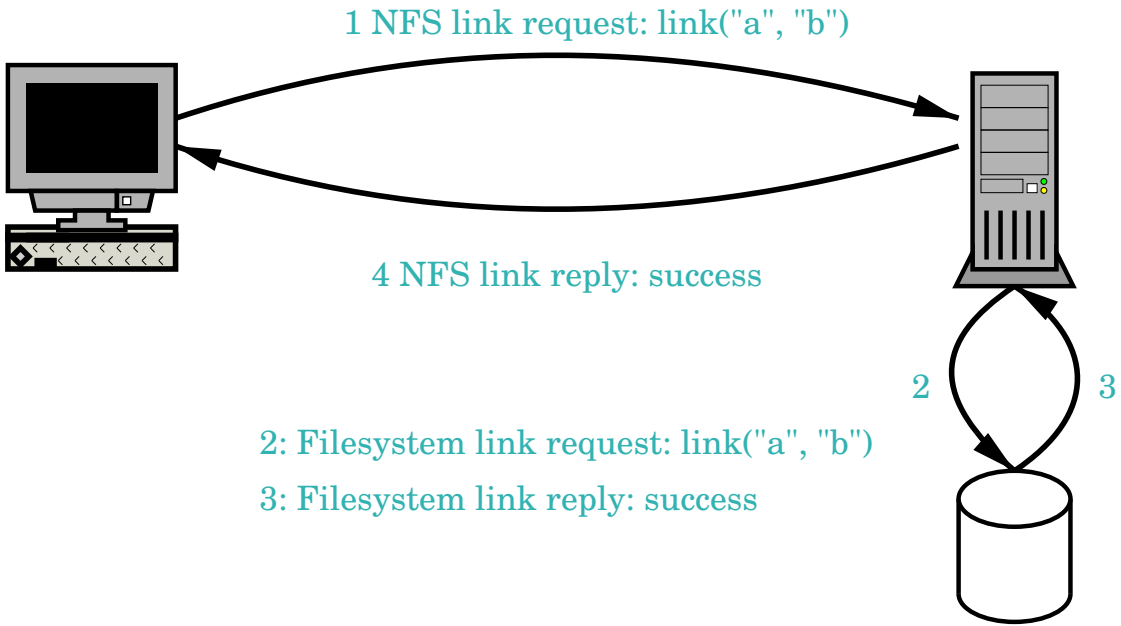
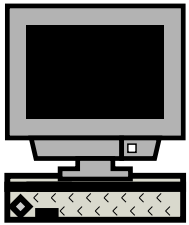
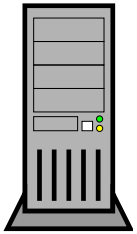
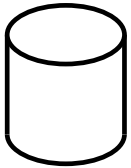


# Link System Call on NFS: Scenario 2







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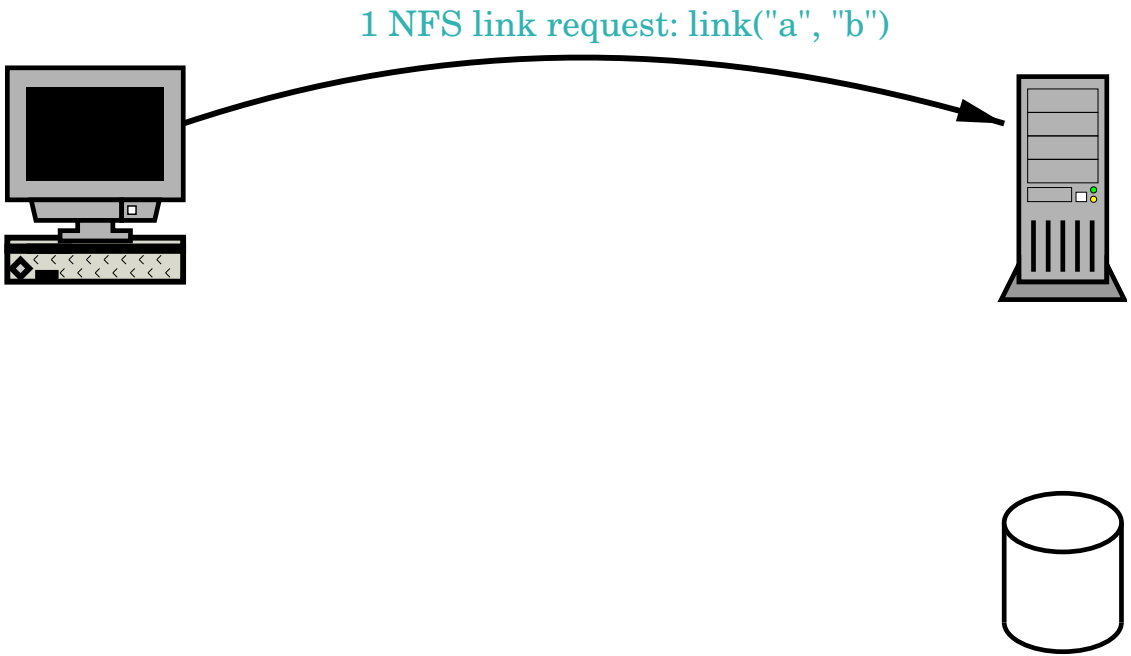

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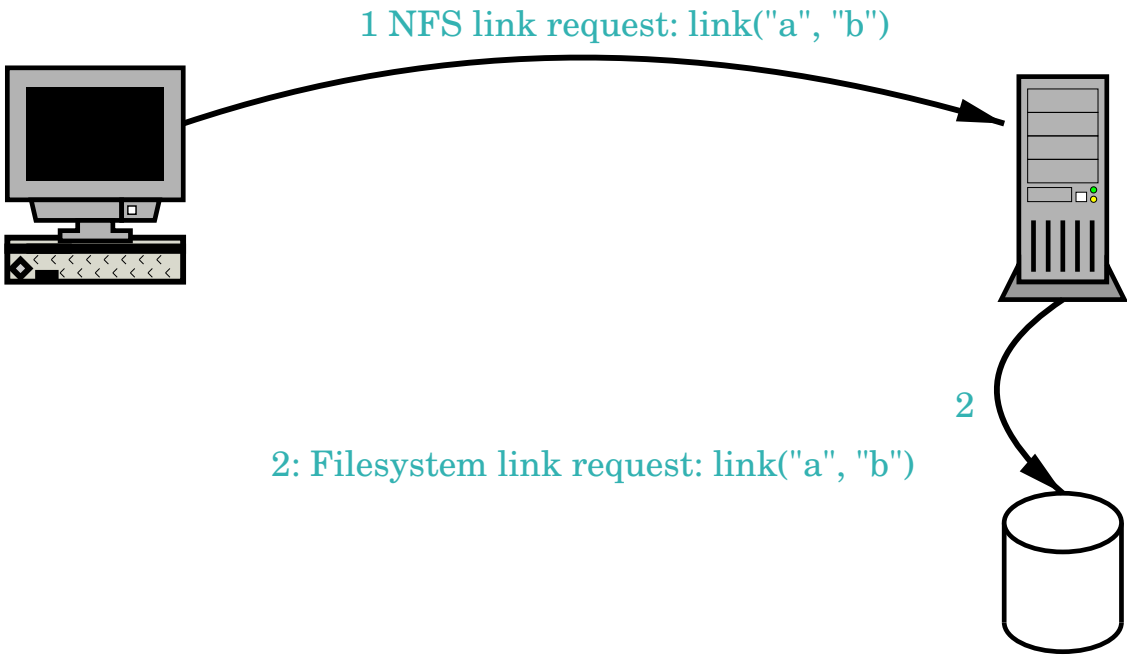

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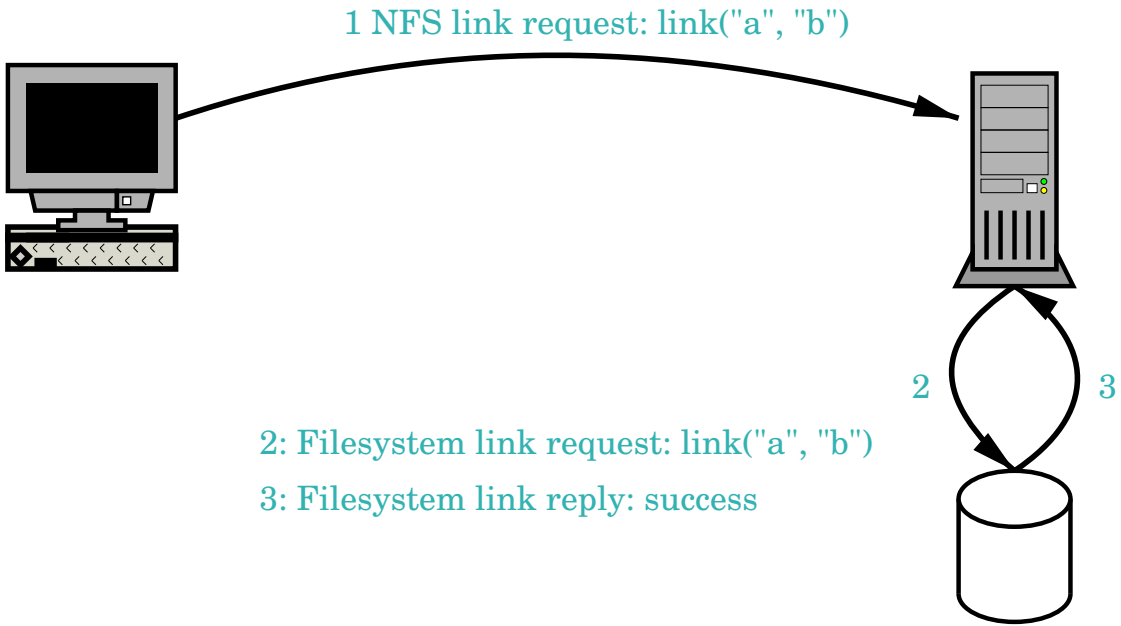

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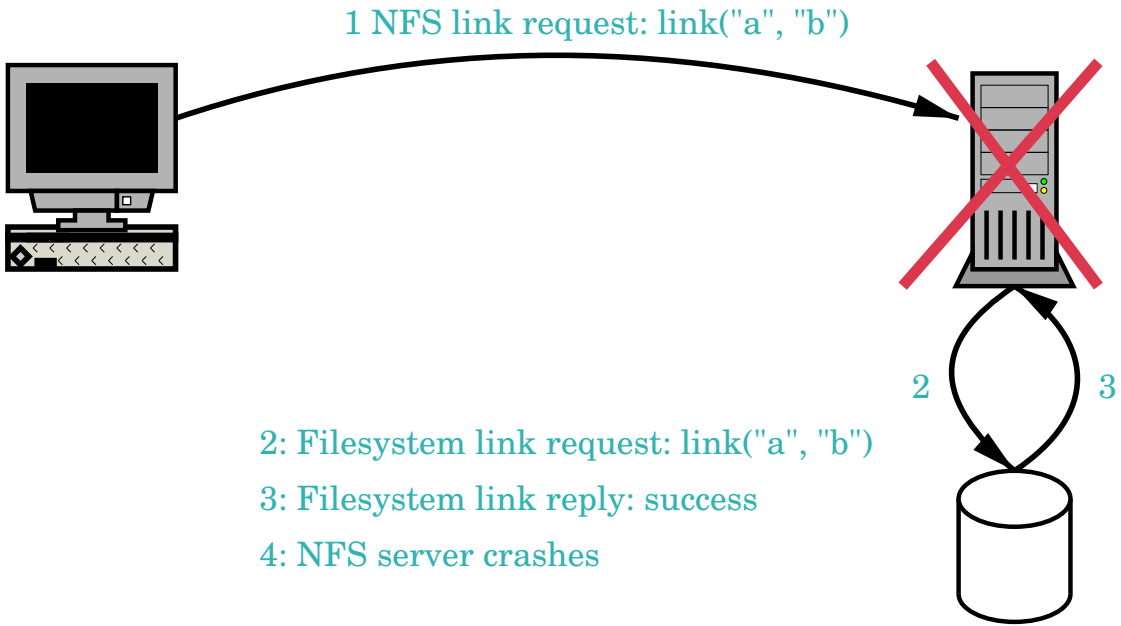


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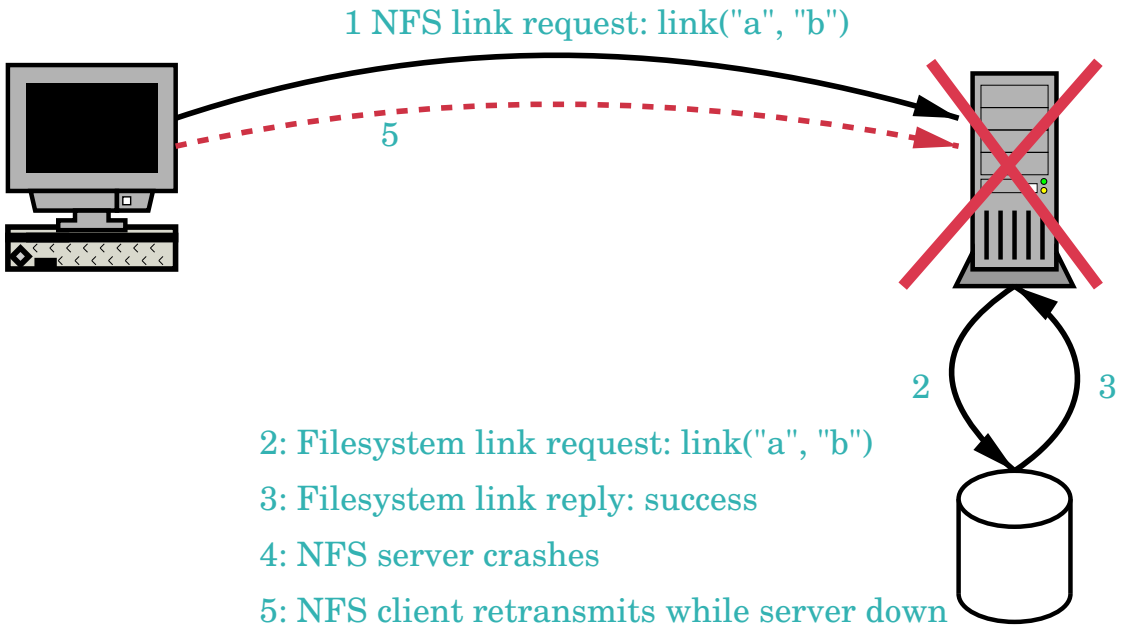


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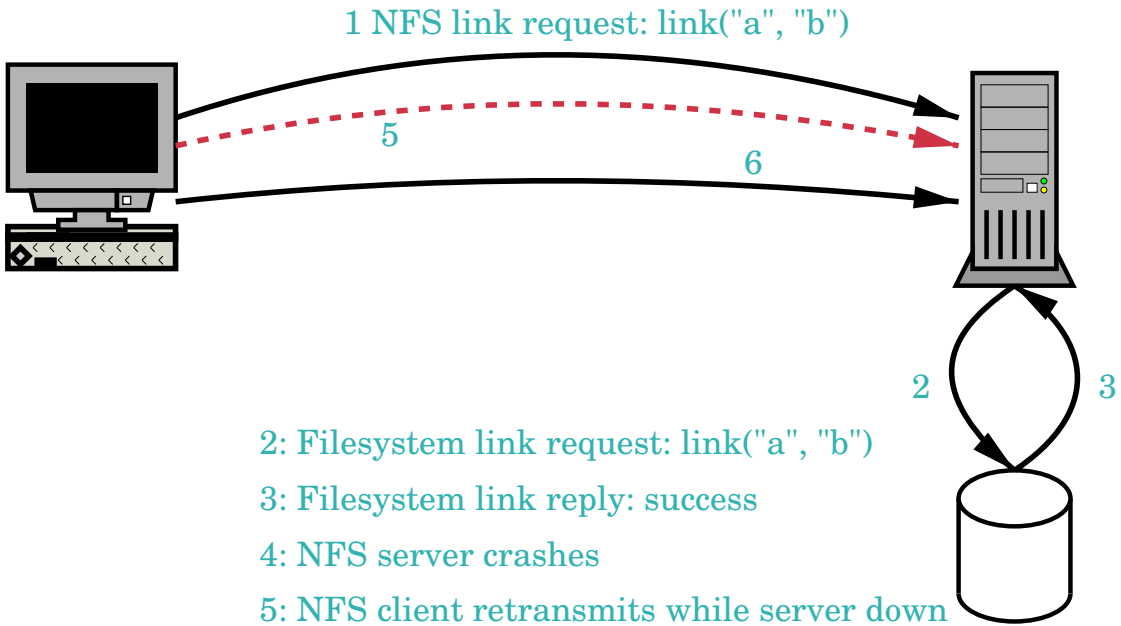


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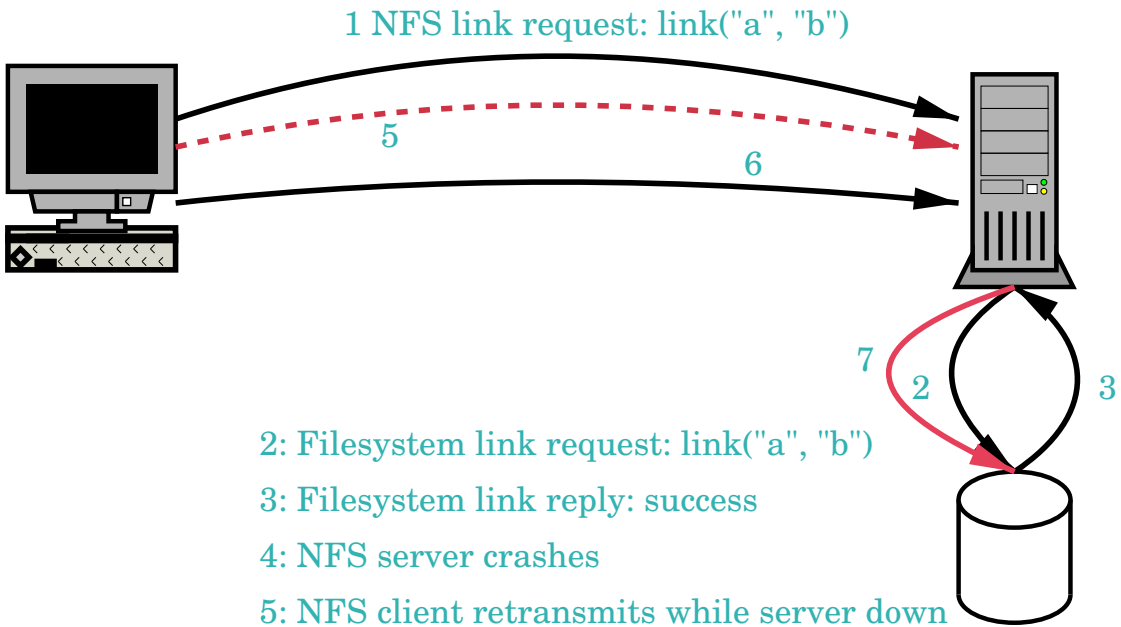


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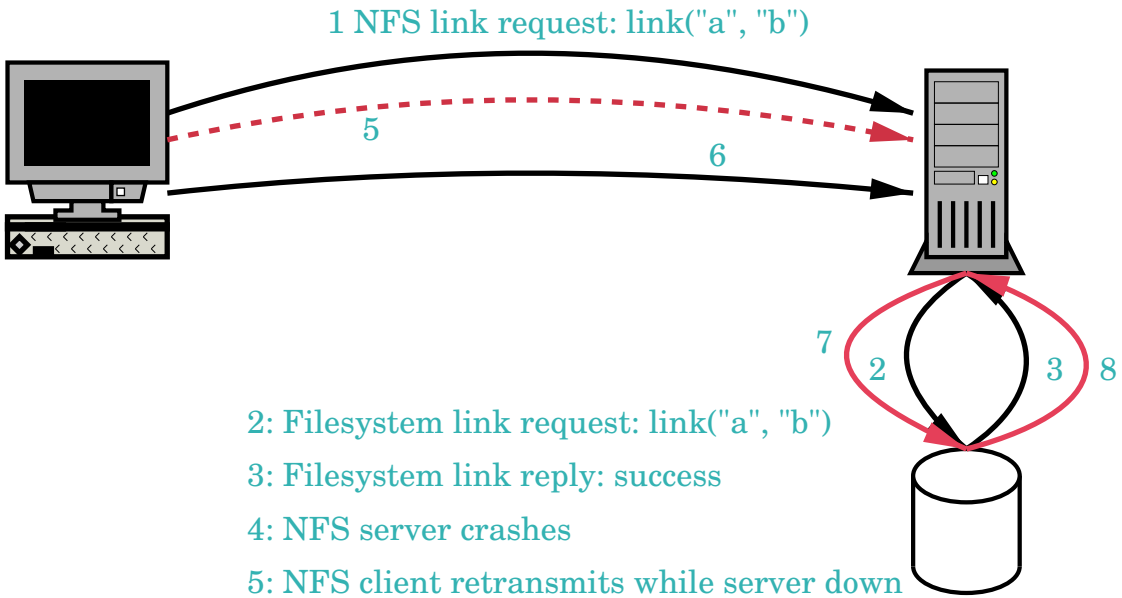


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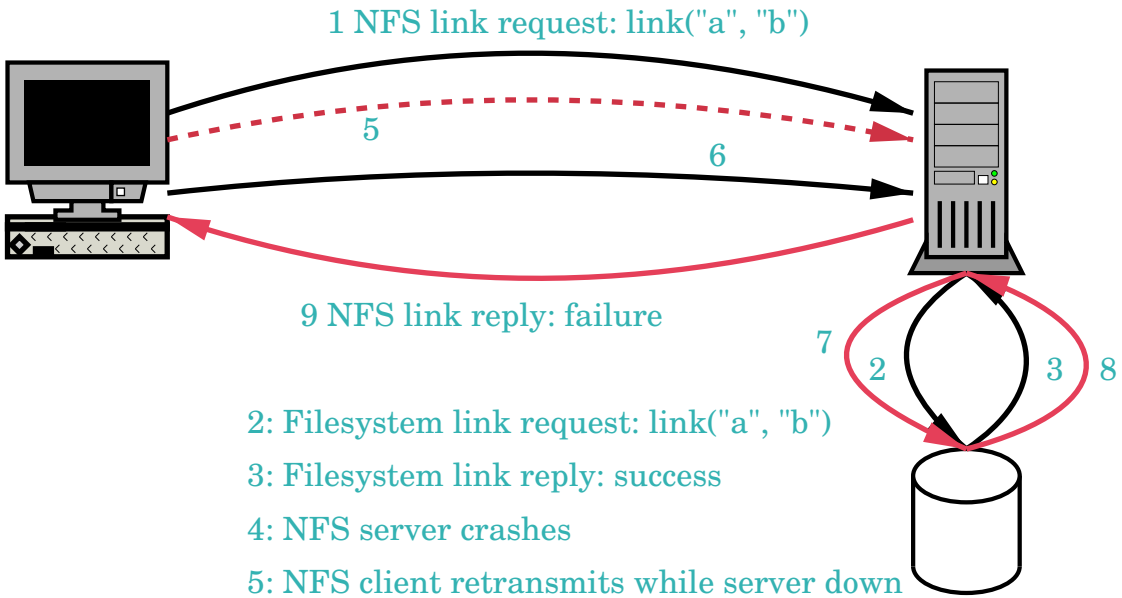


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# *Summary*

- What is a Race Condition?
- Examples
- File Access
- Temporary Files
- Locking
- Obscure NFS semantics (necessary for evaluating security)
- Distributed applications extremely hard to debug (out of principle, and because of obscure application “features”)







# References

Matt Bishop, *How Attackers Break Programs, and How to Write More Secure Programs*, http://nob.cs.ucdavis.edu/~bishop/secprog/sans2002/index.html

Carol Hurwitz, Scott McPeak, *Abolish Root Daemons!*, http://www.cs.berkeley.edu/~smcpeak/cs261/paper.ps, February 2001

Viega, McGraw, *Building Secure Software*, Addison-Wesley, 2001.