Linux Systems Troubleshooting

Thomas Uphill

thomas@uphillian.com

http://bit.ly/33NpWEk

Me

consulting@uphillian.com

http://bit.ly/33NpWEk

Resources

https://github.com/uphillian/lisa2019

https://github.com/uphillian/troubleshootinglinux

tutorial.md

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A story

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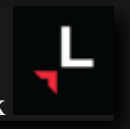

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DB

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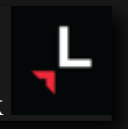
DB ⇨



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DB ⇨ gethostname

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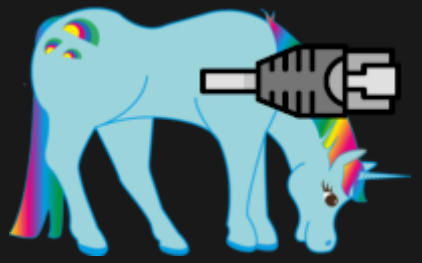
DB ⇨ gethostname



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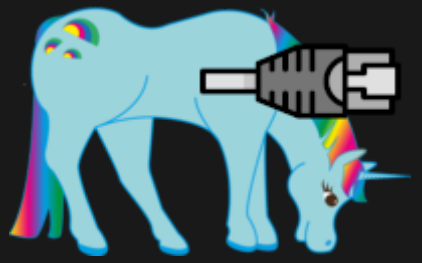

Backup

http://bit.ly/33NpWEk

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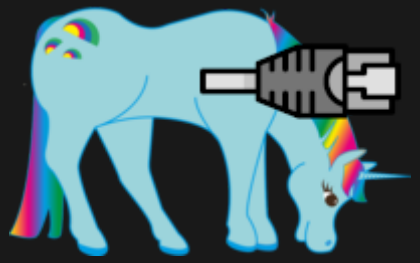
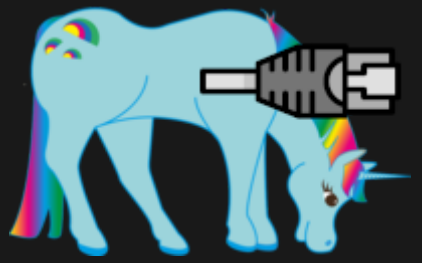


Backup ⇨

http://bit.ly/33NpWEk

DB ⇨ gethostname



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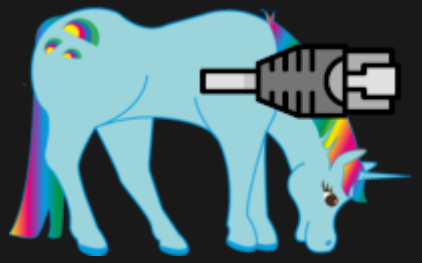

Backup ⇨ gethostname

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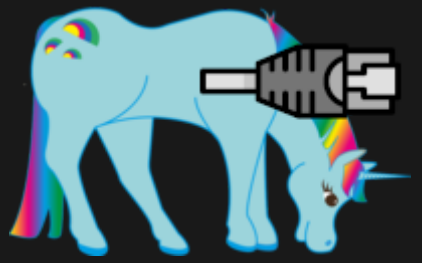
DB ⇨ gethostname



Backup ⇨ gethostname

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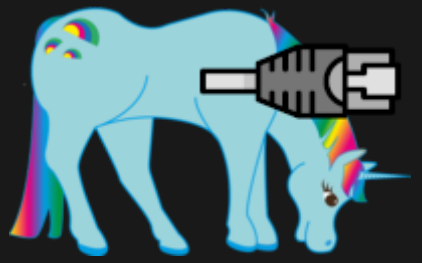
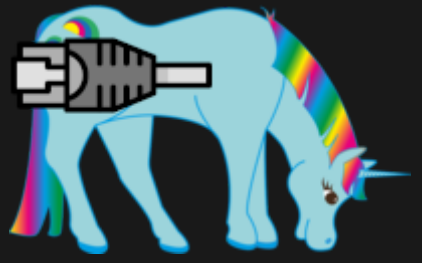
DB ⇨ gethostname



Backup ⇨ gethostname



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Where to start?

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ltrace

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ltrace

Why?

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ltrace

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ltrace

Because UNIX is old

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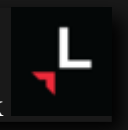

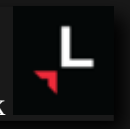

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Love Ken

http://bit.ly/33NpWEk

Love Ken

KISS

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How it all works

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Kernel

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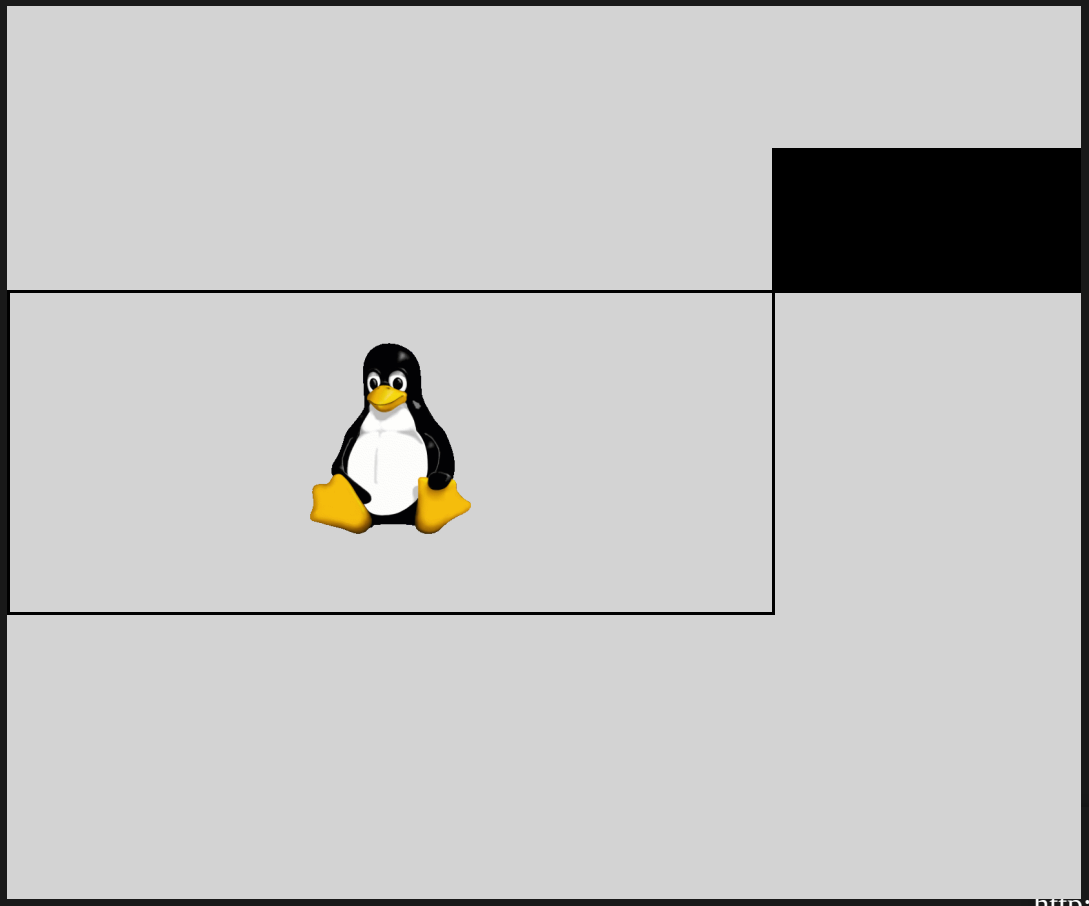
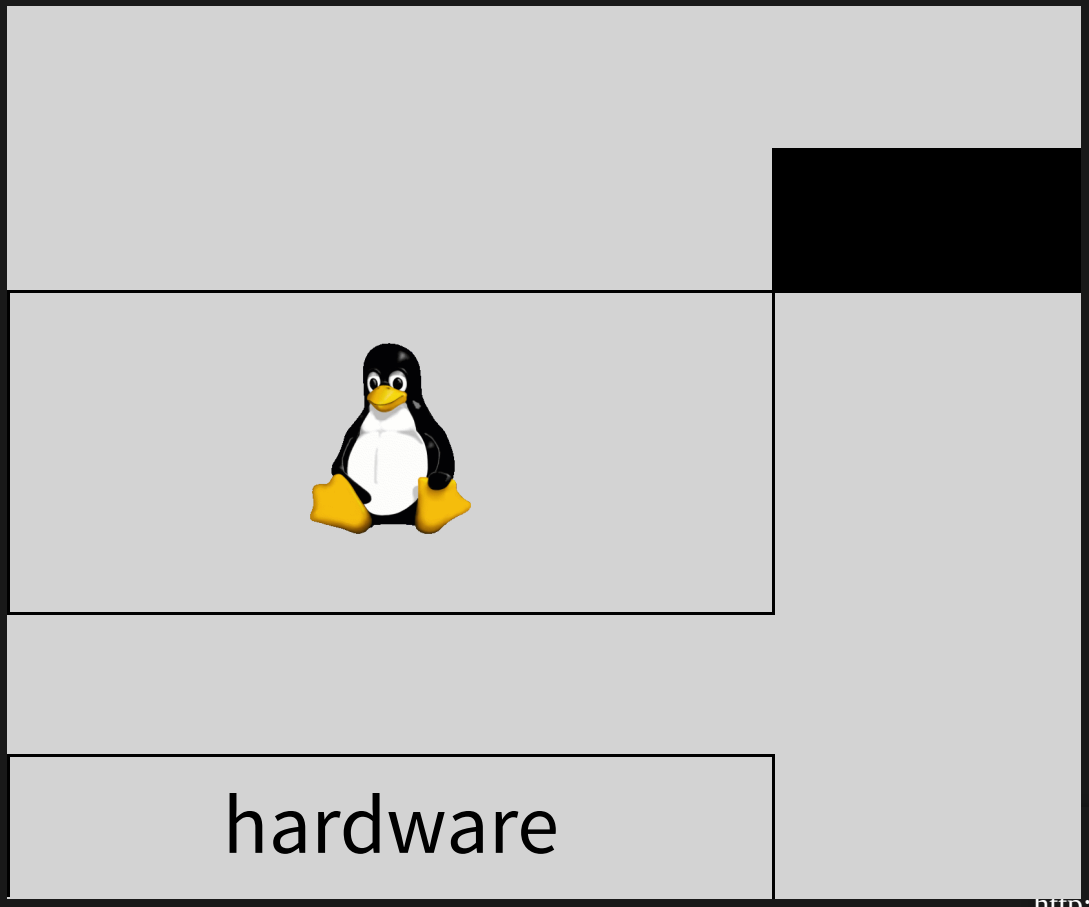
Kernel



http://bit.ly/33NpWEk

Kernel



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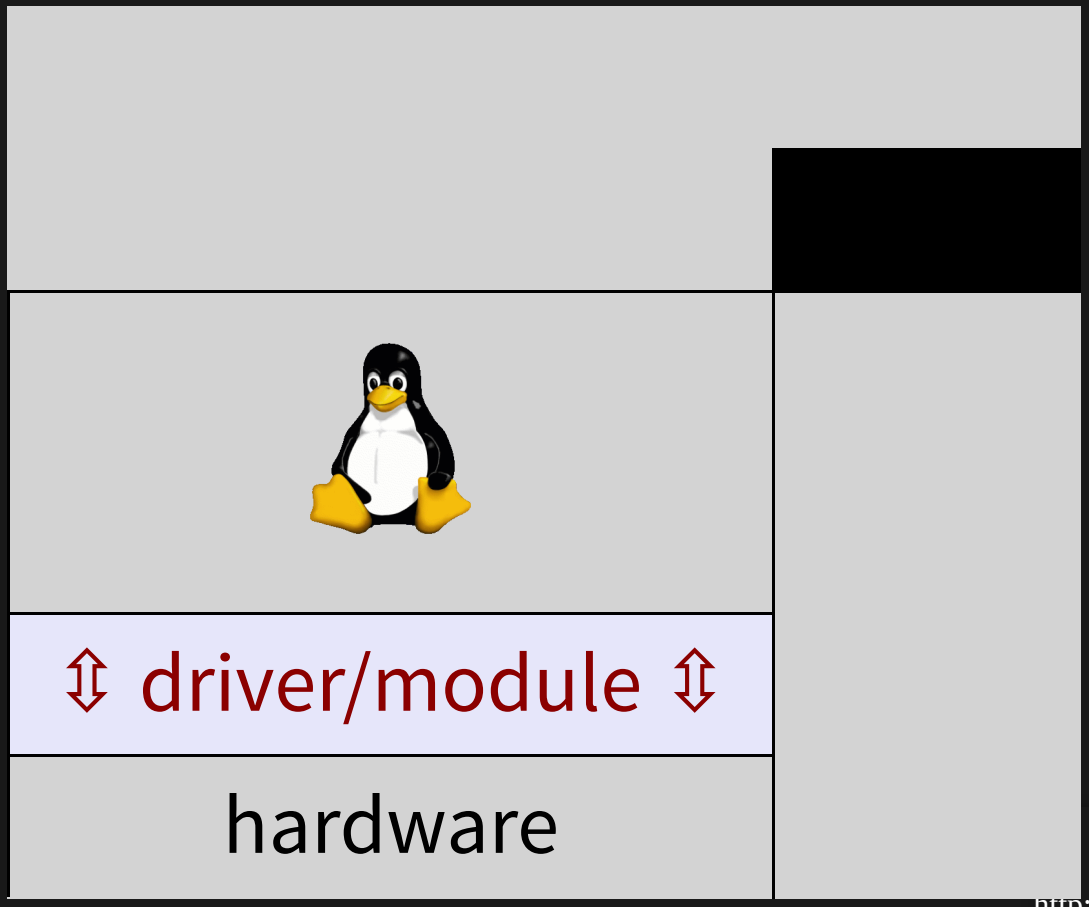
Kernel



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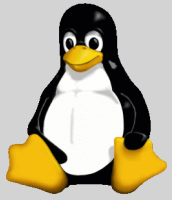
Kernel

application



⇳ driver/module ⇳

hardware

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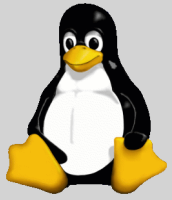
Kernel

application	
⇳ system calls ⇳	
	
⇳ driver/module ⇳	
hardware	

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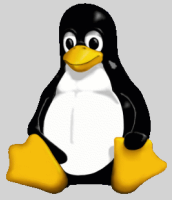
Kernel

application	user
⇳ system calls ⇳	
	
⇳ driver/module ⇳	
hardware	

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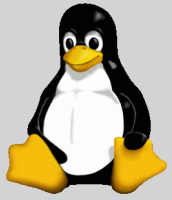
Kernel

application	user
⇳ system calls ⇳	
	kernel
⇳ driver/module ⇳	
hardware	

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System Calls

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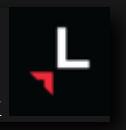

Documentation

http://bit.ly/33NpWEk

Documentation

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Documentation

man syscalls

http://bit.ly/33NpWEk

Documentation

man syscalls ⇒

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Shared Libraries

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Shared Libraries

glibc

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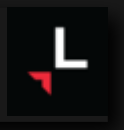

Shared Libraries

glibc

libc.so

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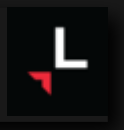

ltrace

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ltrace

...finally

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```
[root@localhost ~]# ltrace hostname
__libc_start_main(0x401230, 1, 0x7ffd4a91dd48, 0x401ea0 <unfinished ..
rindex("hostname", '/')                                          = ni
strcmp("hostname", "domainname")                                 = 4
strcmp("hostname", "ypdomainname")                               = -1
strcmp("hostname", "nisdomainname")                              = -6
getopt_long(1, 0x7ffd4a91dd48, "aAdfbF:h?iIsVy", 0x4028a0, nil)  = -1
__errno_location()                                               = 0x
malloc(128)                                                      = 0x
gethostname("localhost.localdomain", 128)                        = 0
memchr("localhost.localdomain", '\0', 128)                       = 0x
puts("localhost.localdomain"localhost.localdomain)               = 22
+++ exited (status 0) +++
```

```
[root@localhost ~]# ltrace -S hostname
brk@SYS(nil)
mmap@SYS(nil, 4096, 3, 34, -1, 0)
access@SYS("/etc/ld.so.preload", 04)
open@SYS("/etc/ld.so.cache", 524288, 01)
fstat@SYS(3, 0x7ffcfb5c0830)
mmap@SYS(nil, 22425, 1, 2, 3, 0)
close@SYS(3)
open@SYS("/lib64/libnsl.so.1", 524288, 022033410520)
read@SYS(3, "\177ELF\002\001\001", 832)
fstat@SYS(3, 0x7ffcfb5c0890)
mmap@SYS(nil, 2202232, 5, 2050, 3, 0)
mprotect@SYS(0x7f28902ba000, 2097152, 0)
mmap@SYS(0x7f28904ba000, 8192, 3, 2066, 3, 90112)
mmap@SYS(0x7f28904bc000, 6776, 3, 50, -1, 0)
close@SYS(3)
open@SYS("/lib64/libc.so.6", 524288, 022033410520)
read@SYS(3, "\177ELF\002\001\001\003", 832)
fstat@SYS(3, 0x7ffcfb5c0860)
mmap@SYS(nil, 3981792, 5, 2050, 3, 0)
mprotect@SYS(0x7f2890099000, 2097152, 0)
mmap@SYS(0x7f2890299000, 24576, 3, 2066, 3, 1843200)
mmap@SYS(0x7f289029f000, 16864, 3, 50, -1, 0)
```

```
# file /bin/hostname
/bin/hostname: ELF 64-bit LSB executable, x86-64, version 1 (SYSV), d
```

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Executable

and

Linkable

Format

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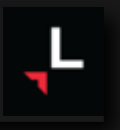

Linker

ld.so

/etc/ld.so.conf

/lib64/ld-linux-x86__64.so.2

man ld.so

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```
# ldd /bin/hostname
    linux-vdso.so.1 =>  (0x00007ffcda7dd000)
    libnsl.so.1 => /lib64/libnsl.so.1 (0x00007f43c4f06000)
    libc.so.6 => /lib64/libc.so.6 (0x00007f43c4b39000)
    /lib64/ld-linux-x86-64.so.2 (0x00007f43c5120000)
# objdump -R /bin/hostname

/bin/hostname:     file format elf64-x86-64

DYNAMIC RELOCATION RECORDS
OFFSET           TYPE              VALUE
...
0000000000603140 R_X86_64_JUMP_SLOT  gethostname@GLIBC_2.2.5
# man ld.so
```

man ld.so

LD_PRELOAD

A list of additional, user-specified, ELF shared libraries to be loaded before all others.

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man ld.so

LD_DEBUG

```
# LD_DEBUG=help /bin/true
Valid options for the LD_DEBUG environment variable are:

  libs        display library search paths
  reloc       display relocation processing
  files       display progress for input file
...
# LD_DEBUG=versions /bin/true
checking for version `GLIBC_2.3' in file /lib64/libc.so.6 [0]
checking for version `GLIBC_2.3.4' in file /lib64/libc.so.6 [0
checking for version `GLIBC_2.14' in file /lib64/libc.so.6 [0]
```

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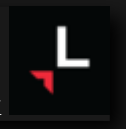

man ld.so

LD_DEBUG

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  libs        display library search paths
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...
# LD_DEBUG=versions /bin/true
checking for version `GLIBC_2.3' in file /lib64/libc.so.6 [0]
checking for version `GLIBC_2.3.4' in file /lib64/libc.so.6 [0
checking for version `GLIBC_2.14' in file /lib64/libc.so.6 [0]
```

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Terminal

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You cannot escape

wikipedia.org

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getip.c

```c
#include <netdb.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <netinet/in.h>
#include <sys/socket.h>
#include <sys/types.h>
#include <arpa/inet.h>

int main()
{
  char hostname[256];
  char *IPbuffer;
  struct hostent *hostStruct;
  int h;

  gethostname(hostname, sizeof(hostname));

  hostStruct = gethostbyname(hostname);
```

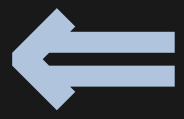
gethostname

```
#include <unistd.h>

int gethostname(char *name, size_t len);
```

gethostname_wrap.c

```c
#include <unistd.h>
#include <string.h>
#include <stdio.h>
#include <stdlib.h>

int gethostname (char *name, size_t len) {
  char newname[] = "getip_hostname";
  int name_len = strlen(newname);
  memcpy(name,newname, name_len < len ? name_len : len);
  return 0;
}
```

Solution



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Solution

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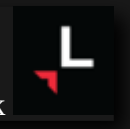
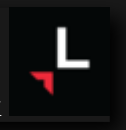
It's a machine, Skroeder.
It doesn't get pissed off.
It doesn't get happy,
it doesn't get sad,
it doesn't laugh at your jokes.
It just runs programs.

Short Circuit



http://bit.ly/33NpWEk

More background



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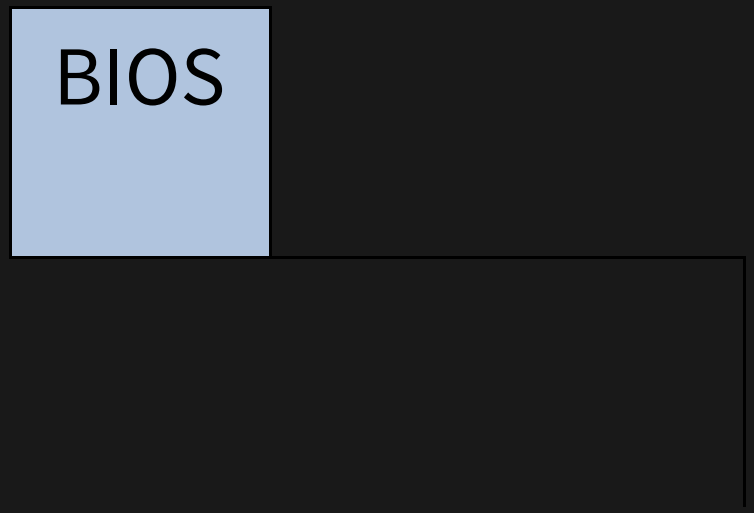
Booting process

http://bit.ly/33NpWEk

Booting process



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Booting process

BIOS	Bootsector 0

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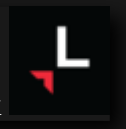
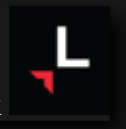


Booting process

BIOS	Bootsector 0	Bootloader 512

http://bit.ly/33NpWEk



Booting process

BIOS	Bootsector 0	Bootloader 512
		Kernel [0]

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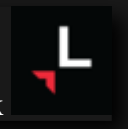
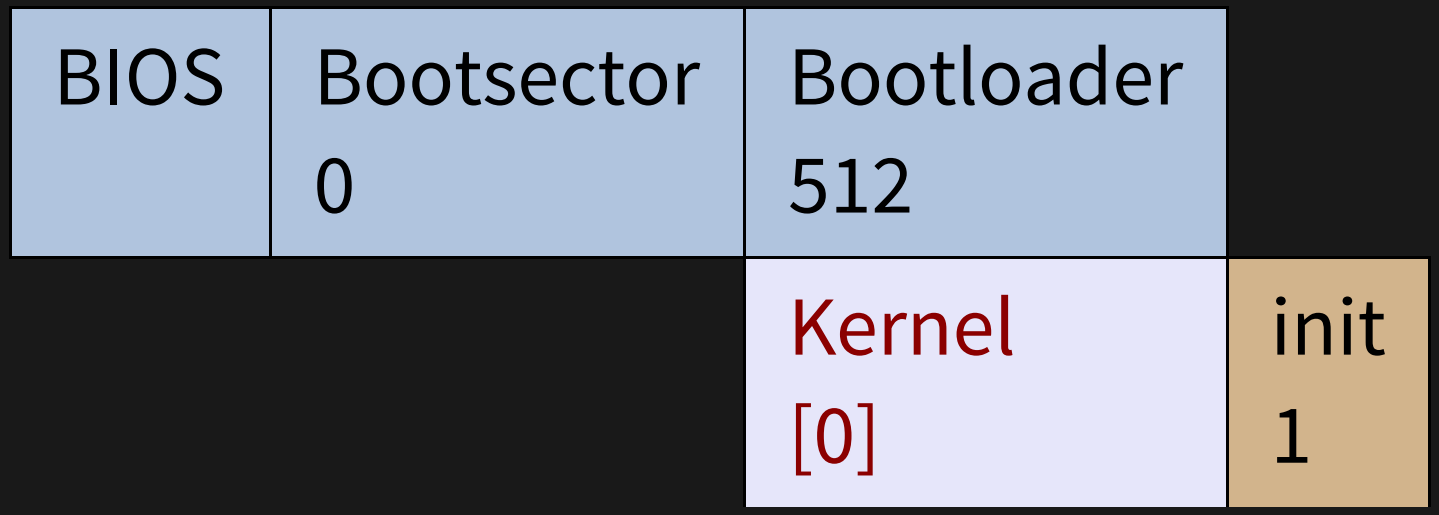


Booting process



http://bit.ly/33NpWEk

Processes

http://bit.ly/33NpWEk

Processes

fork

http://bit.ly/33NpWEk

Processes

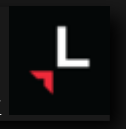
fork

http://bit.ly/33NpWEk

parent/child

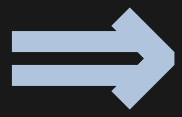
```
$ ps -eo "ppid pid stat cmd" |sort -n |less
$ psx
$ psk
```

http://bit.ly/33NpWEk



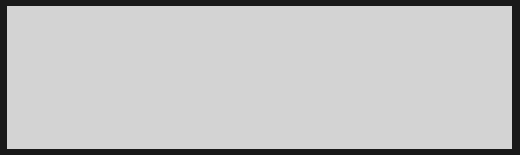
parent/child

```
$ ps -eo "ppid pid stat cmd" |sort -n |less
$ psx
$ psk
```

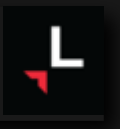


http://bit.ly/33NpWEk

fake filesystems



http://bit.ly/33NpWEk



fake filesystems

http://bit.ly/33NpWEk

fake filesystems

/proc

http://bit.ly/33NpWEk

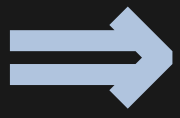
fake filesystems

/proc	/sys

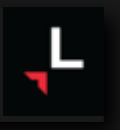
http://bit.ly/33NpWEk

fake filesystems

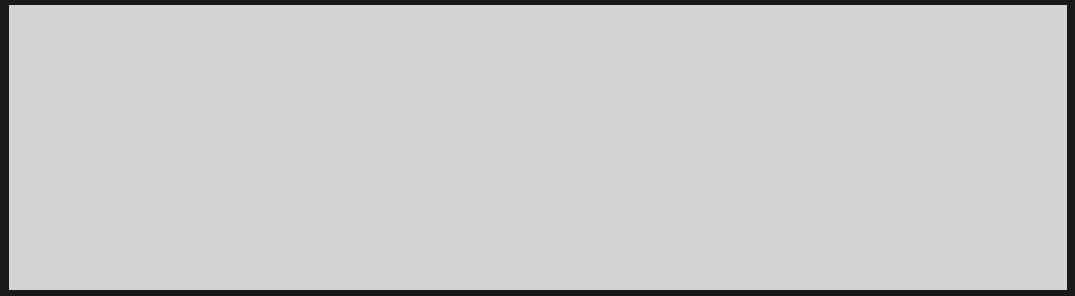
/proc	/sys



http://bit.ly/33NpWEk



File Descriptors

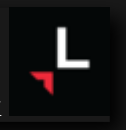


http://bit.ly/33NpWEk

File Descriptors

STDIN	
0	

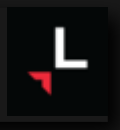
http://bit.ly/33NpWEk



File Descriptors

STDIN	STDOUT	
0	1	

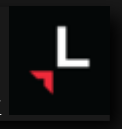
http://bit.ly/33NpWEk



File Descriptors

STDIN	STDOUT	STDERR
0	1	2

http://bit.ly/33NpWEk

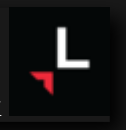


File Descriptors

everything is a file...

STDIN	STDOUT	STDERR
0	1	2

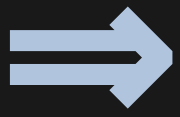
http://bit.ly/33NpWEk



File Descriptors

everything is a file...

STDIN	STDOUT	STDERR
0	1	2



http://bit.ly/33NpWEk

Processes

http://bit.ly/33NpWEk

Processes

fork

http://bit.ly/33NpWEk

Processes

fork	double fork	
		

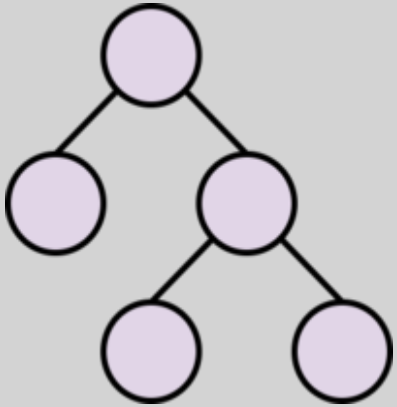
http://bit.ly/33NpWEk

Processes

fork	double fork	
		

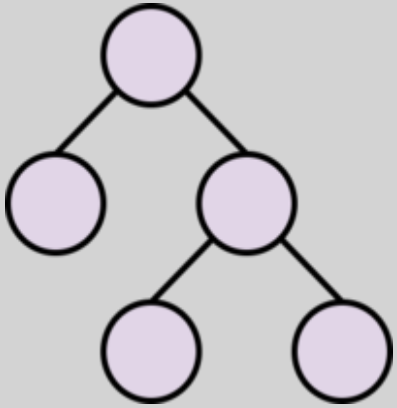
http://bit.ly/33NpWEk

Processes

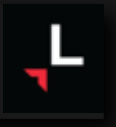
fork	double fork	
		

http://bit.ly/33NpWEk

Processes

fork	double fork	zombie
		

http://bit.ly/33NpWEk



fork

```
#!/usr/bin/env python

import os
import time

pid = os.fork()
if pid == 0:
  print("Child")
  while True:
    time.sleep(10)
else:
  print("Parent, Child PID: %s" % pid)
  while True:
    time.sleep(10)
```

doublefork

```
#!/usr/bin/env python

import os
import time

pid = os.fork()
if pid == 0:
  pid = os.fork()
  if pid == 0:
    print("I am the Grandchild(%s)\n" % os.getpid())
    while True:
      time.sleep(10)
  else:
    print("I am the Child(%s), Grandchild(%s)\n" % (os.getpid(),pid))
else:
  print("I am the Parent(%s), my Child(%s)\n" % (os.getpid(),pid))
```

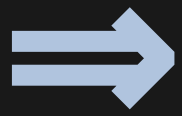
zombie

```
#!/usr/bin/env python

import os
import sys
import time
import signal

def sigalrm(signum, frame):
  print("Received %d" % signum)

signal.signal(signal.SIGALRM, sigalrm)
pid = os.fork()
if pid == 0:
  print("Child exiting")
  sys.exit(0)
else:
  print("Parent PID %s, Child PID: %s\nWaiting for Signal" % (os.getp
  signal.pause()
  os.wait()
  print("Zombie is gone\n")
  sys.exit(0)
```



http://bit.ly/33NpWEk

Threads

```
$ ./thread.py
$ pst thread
 PPID   PID STAT CMD                          SPID
 4671  6760 -    /usr/bin/python ./thread.py     -
    -     - Tl   -                            6760
    -     - Tl   -                            6761
    -     - Tl   -                            6762
    -     - Tl   -                            6763
    -     - Tl   -                            6764
    -     - Tl   -                            6765
    -     - Tl   -                            6766
    -     - Tl   -                            6767
    -     - Tl   -                            6768
    -     - Tl   -                            6769
    -     - Tl   -                            6770
$ ls /proc/6760/task
6760  6761  6762  6763  6764  6765  6766  6767  6768  6769  6770
```

Limits

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PAM

Pluggable Authentication Modules

http://bit.ly/33NpWEk

PAM

Pluggable Authentication Modules

`man pam`

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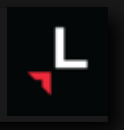

Terminal

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Another story

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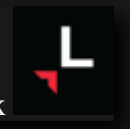

http://bit.ly/33NpWEk

inodes

http://bit.ly/33NpWEk

inodes

```
          $ stat /lib64/libc.so.6
  File: /lib64/libc.so.6 -> libc-2.29.so
  Size: 12 Blocks: 0 IO Block: 4096 symbolic link
Device: fd01h/64769d   Inode: 2268443   Links: 1
Access: (0777/lrwxrwxrwx) Uid:(0/root) Gid:(0/root)
Context: system_u:object_r:lib_t:s0
Access: 2019-10-24 20:01:01.282015177 -0700
Modify: 2019-09-04 12:33:47.000000000 -0700
Change: 2019-09-08 19:57:02.255027798 -0700
 Birth: 2019-09-08 19:57:02.254027799 -0700
```

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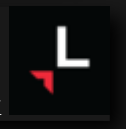


Unlink

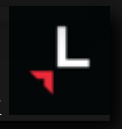
http://bit.ly/33NpWEk

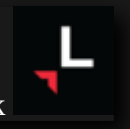
Unlink

```
# man 2 unlink
DESCRIPTION
  unlink() deletes a name from the filesystem.
  If that name was the last link to a file and
  no processes have the file open, the file is
  deleted and the space it was using is made
  available for reuse.

  If the name was the last link to a file but
  any processes still have the file open, the
  file will remain in existence until the last
  file descriptor referring to it is closed.
```

http://bit.ly/33NpWEk



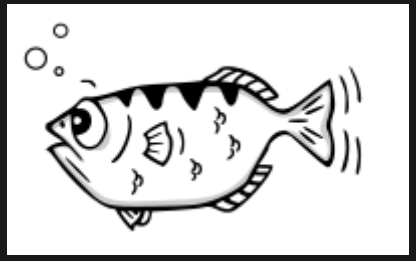


http://bit.ly/33NpWEk

gdb

http://bit.ly/33NpWEk

gdb



http://bit.ly/33NpWEk

```
# man open
  SYNOPSIS
    #include <sys/types.h>
    #include <sys/stat.h>
    #include <fcntl.h>
```

... /usr/include/fcntl.h

```
/* Get the definitions of O_*, F_*, FD_*: all the
numbers and flag bits for `open', `fcntl', et al.  */
#include <bits/fcntl.h>
```

... /usr/include/bits/fcntl.h

```
#define O_RDWR          02
#ifndef O_CREAT
# define O_CREAT     0100 /* Not fcntl.  */
#endif
```

http://bit.ly/33NpWEk

```
# man dup2
int dup2(int oldfd, int newfd);

dup2()
  The dup2() system call performs the same task as dup(),
  but instead of using the lowest-numbered unused file
  descriptor, it uses the file descriptor number specified
  in newfd.  If the file descriptor newfd  was  previ-
  ously open, it is silently closed before being reused.
```

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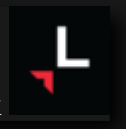

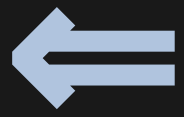

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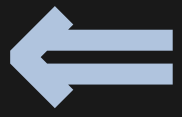

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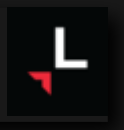
Troubleshooting

http://bit.ly/33NpWEk

Troubleshooting

...finally

http://bit.ly/33NpWEk



Have a Plan

- **What** is broken?
  - Did it ever work?
  - How do I know when it's fixed?
- What are the requirements?
  - How can I test the requirements?
- **When did it last work?**

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Troubleshooting Steps

- Make a backup
- Read Logs
- Just one thing.

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Troubleshooting Steps

- Make a backup
- Read Logs
- Just one thing.

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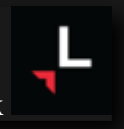
http://bit.ly/33NpWEk

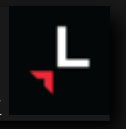
change **one** thing

http://bit.ly/33NpWEk



change **one** thing	verify status

http://bit.ly/33NpWEk

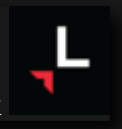


change **one** thing	verify status	if unfixed, **undo** change

http://bit.ly/33NpWEk

change **one** thing	verify status	if unfixed, **undo** change
repeat		

http://bit.ly/33NpWEk



Trace

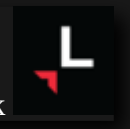
- ltrace
- man <call>
- SEE ALSO

http://bit.ly/33NpWEk

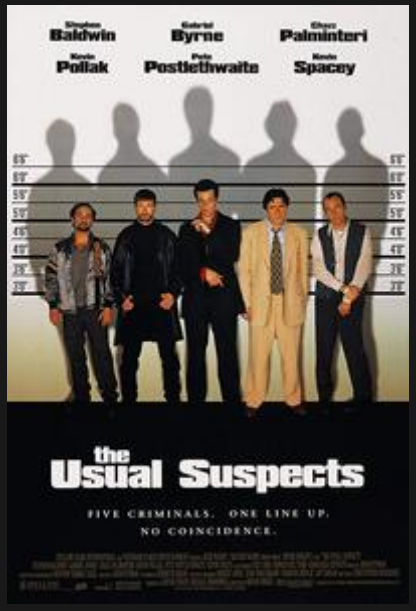
Trace

- ltrace
- man <call>
- SEE ALSO
- ...keep reading

http://bit.ly/33NpWEk

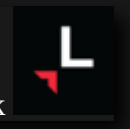


http://bit.ly/33NpWEk



imdb.com

http://bit.ly/33NpWEk



http://bit.ly/33NpWEk

- Processes

http://bit.ly/33NpWEk

- Processes
- Users/Groups

http://bit.ly/33NpWEk

- Processes
- Users/Groups
- Permissions

http://bit.ly/33NpWEk

- Processes
- Users/Groups
- Permissions

`runuser`

http://bit.ly/33NpWEk

- Processes
- Users/Groups
- Permissions

  `runuser`
- Space

http://bit.ly/33NpWEk

- Processes
- Users/Groups
- Permissions
  `runuser`
- Space
- NSS

http://bit.ly/33NpWEk

- Processes
- Users/Groups
- Permissions
  `runuser`
- Space
- NSS
- Network

http://bit.ly/33NpWEk

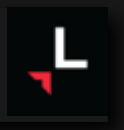
Always check permissions

`runuser`

http://bit.ly/33NpWEk

Please check permissions

Hokey religions and ancient weapons are no match for



http://bit.ly/33NpWEk

Please check permissions

Hokey religions and ancient weapons are no match for

BASIC UNIX PERMISSIONS

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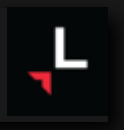
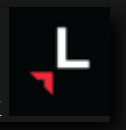


runuser

```
# cat /var/www/html/index.html
Hello World!
# runuser apache -s /bin/bash -c 'cat /var/www/html/index.html'
cat: /var/www/html/index.html: Permission denied
```

http://bit.ly/33NpWEk



Networking

http://bit.ly/33NpWEk

Networking

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nss

name service switch

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nss

name service switch

`/etc/hosts`

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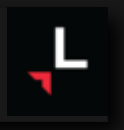


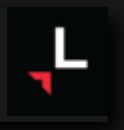
nss

name service switch

`/etc/hosts`

`/etc/nsswitch.conf`

http://bit.ly/33NpWEk

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```
hosts:  files mdns4_minimal [NOTFOUND=return] dns myhostname
```

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```
hosts:  files mdns4_minimal [NOTFOUND=return] dns myhostname
```

```
passwd: db sss files systemd
```

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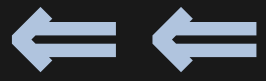

http://bit.ly/33NpWEk

```
# ltrace tar cf lisa2019:f.tar /etc/hosts 2>&1 |grep gethost
gethostbyname("lisa2019" <unfinished ...="">
            </unfinished>
```

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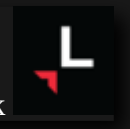

```
# ltrace tar cf lisa2019:f.tar /etc/hosts 2>&1 |grep gethost
gethostbyname("lisa2019" <unfinished ...="">
            </unfinished>
```

```
# ltrace -S ping -w1 -c1 lisa2019 2>&1 |grep nss
open@SYS("/etc/nsswitch.conf", 524288, 0666)     = 4
read@SYS(4, "#\n# /etc/nsswitch.conf\n#\n# An ex"..., 4096) =
open@SYS("/lib64/libnss_files.so.2", 524288, 020165240000) = 4
```

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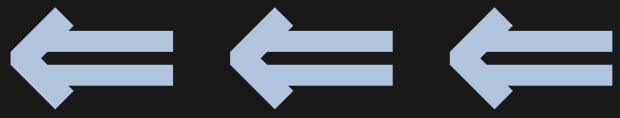
nc

http://bit.ly/33NpWEk

nc

http://bit.ly/33NpWEk



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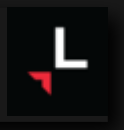
tcpdump / wireshark
mtr / traceroute

http://bit.ly/33NpWEk

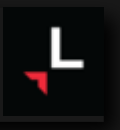


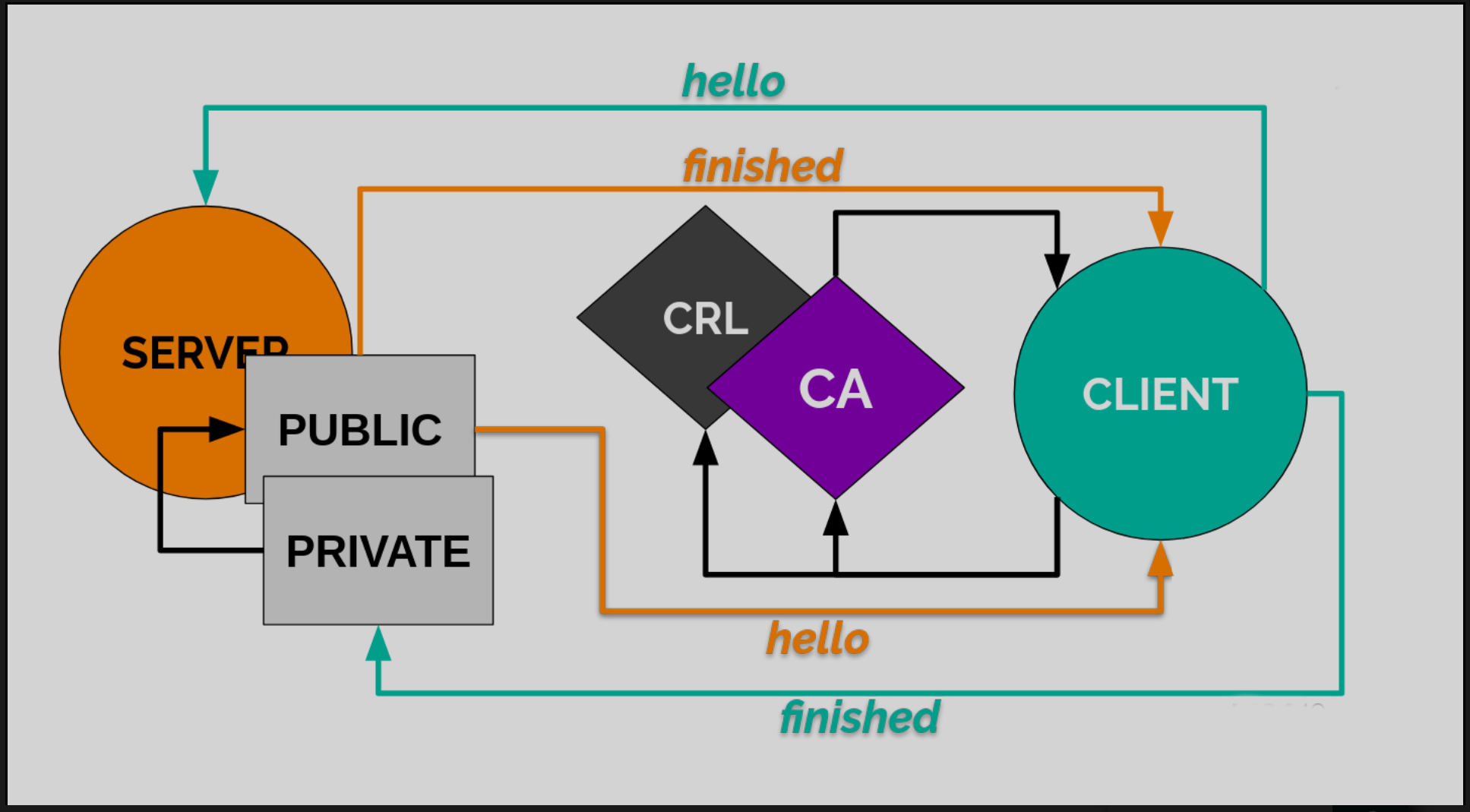
Encryption / Certificates

x509

large primes

http://bit.ly/33NpWEk





http://bit.ly/33NpWEk

CA / verify

```
$ openssl verify -CAfile ca.pem getip.example.com.pem
getip.example.com.pem: OK
```

http://bit.ly/33NpWEk

CA / verify

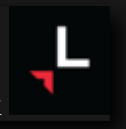
```
$ openssl verify -CAfile ca.pem getip.example.com.pem
getip.example.com.pem: OK
```

```
$ cat ca.pem crl-revoked.pem >ca_crl.pem
$ openssl verify -CAfile ca_crl.pem -crl_check getip.example.c
getip.example.com.pem: CN = getip.example.com
error 11 at 0 depth lookup:CRL is not yet valid
CN = getip.example.com
error 23 at 0 depth lookup:certificate revoked
```

http://bit.ly/33NpWEk

```
$ openssl x509 -in getip.example.com.pem -noout -modulus
Modulus=ACCBE50557F389F778505BD8C147FAD75A91DDA346D6CB4D006496
...
$ openssl x509 -in getip.example.com.pem -noout -modulus |sha2
2688b20c253241e1e291f4cab938d6a1b43a68ac158da47ebba60cfa48e641
```

http://bit.ly/33NpWEk



```
$ openssl x509 -in getip.example.com.pem -noout -modulus
Modulus=ACCBE50557F389F778505BD8C147FAD75A91DDA346D6CB4D006496
...
$ openssl x509 -in getip.example.com.pem -noout -modulus |sha2
2688b20c253241e1e291f4cab938d6a1b43a68ac158da47ebba60cfa48e641
```

```
$  openssl rsa -in private_keys/getip.example.com.pem  -noout
2688b20c253241e1e291f4cab938d6a1b43a68ac158da47ebba60cfa48e641
```

http://bit.ly/33NpWEk

```
$ gnutls-cli -p <port> <host>
$ openssl s_client <host>:<port>
</port></host></host></port>
```

http://bit.ly/33NpWEk

Summary

http://bit.ly/33NpWEk

Summary

Trust no one

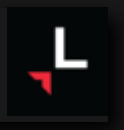
http://bit.ly/33NpWEk

Summary

Trust no one

Check permissions (runuser)

http://bit.ly/33NpWEk



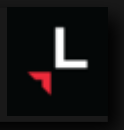
Summary

Trust no one

Check permissions (runuser)

Read: Logs, Docs

http://bit.ly/33NpWEk



Summary

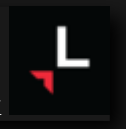
Trust no one

Check permissions (runuser)

Read: Logs, Docs

One thing

http://bit.ly/33NpWEk



Questions?

http://bit.ly/33NpWEk

Questions?

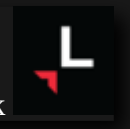
Thank-you

http://bit.ly/33NpWEk

Questions?

Thank-you

consulting@uphillian.com



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