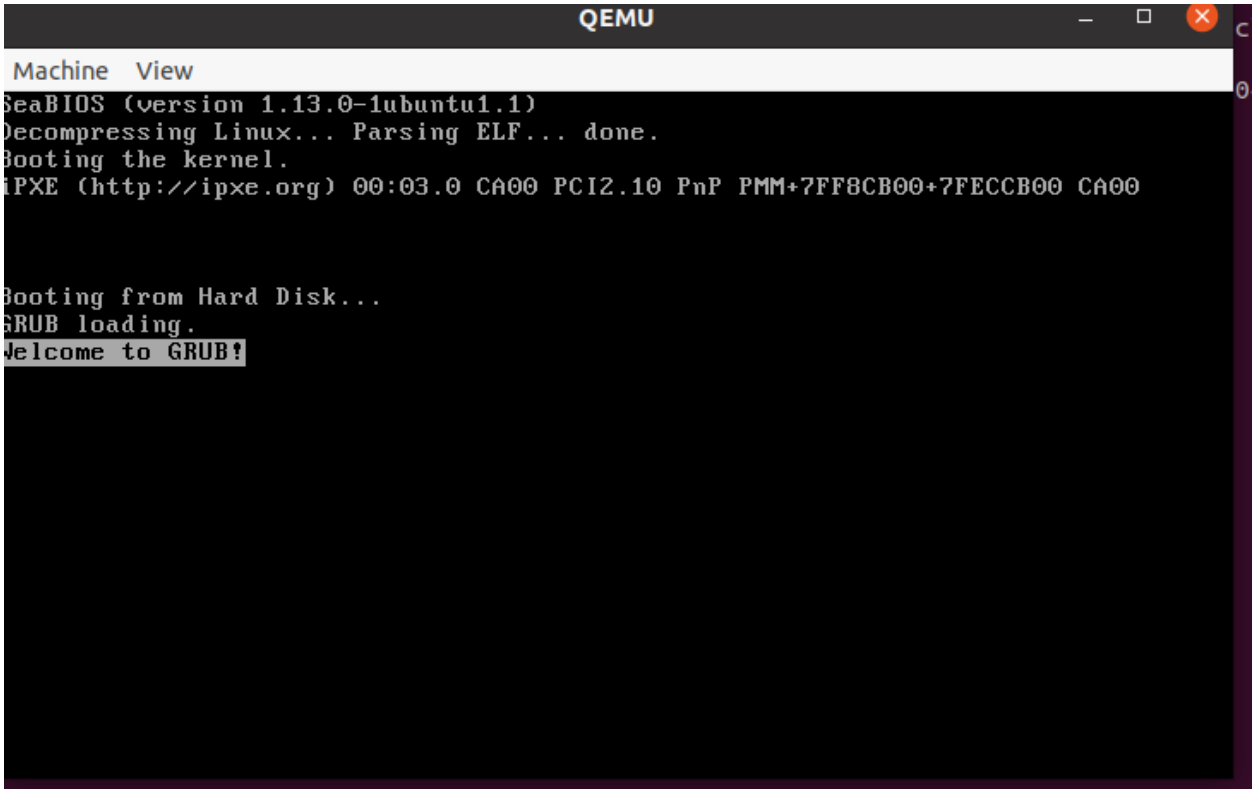
Create image off base image

```
kam:~/dev/school/operating_systems_678/lab3$ qemu-img create -f qcow2 -b ../lab2/eecs678_base.qcow ka
m.qcow
Formatting 'kam.qcow', fmt=qcow2 size=21474836480 backing_file=../lab2/eecs678_base.qcow cluster_size
=65536 lazy_refcounts=off refcount_bits=16
```

Booting into image



Adding ‘kam’ as a user

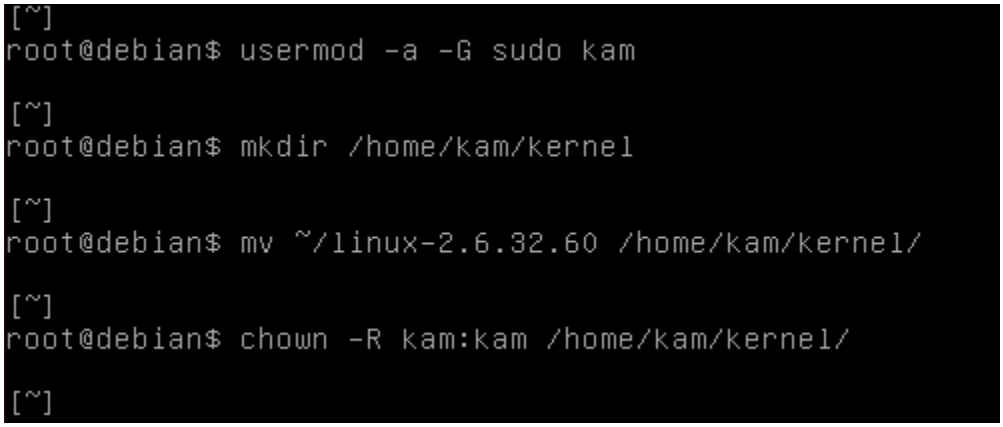
```
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.

[~]
root@debian$ adduser kam
Adding user `kam' ...
Adding new group `kam' (1000) ...
Adding new user `kam' (1000) with group `kam' ...
Creating home directory `/home/kam' ...
Copying files from `/etc/skel' ...
Enter new UNIX password:
Retype new UNIX password:
passwd: password updated successfully
Changing the user information for kam
Enter the new value, or press ENTER for the default
        Full Name []:
        Room Number []:
        Work Phone []:
        Home Phone []:
        Other []:
Is the information correct? [Y/n] Y

[~]
root@debian$ _
```

Editing /etc/sudoers to give myself admin superuser access

Adding myself to the sudo usergroup
Making the /home/kam/kernel dir and moving the linux image to it



apt-get install sudo

```
root@debian$ apt-get install sudo
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  sudo
0 upgraded, 1 newly installed, 0 to remove and 7 not upgraded.
Need to get 593 kB of archives.
After this operation, 942 kB of additional disk space will be used.
WARNING: The following packages cannot be authenticated!
  sudo
Install these packages without verification [y/N]? y
Get:1 http://archive.debian.org/debian/ squeeze/main sudo i386 1.7.4p4-2.squeeze
.4 [593 kB]
Fetched 593 kB in 1s (303 kB/s)
Selecting previously deselected package sudo.
(Reading database ... 23840 files and directories currently installed.)
Unpacking sudo (from .../sudo_1.7.4p4-2.squeeze.4_i386.deb) ...
Processing triggers for man-db ...
Setting up sudo (1.7.4p4-2.squeeze.4) ...

[~]
```

Installing libz-dev after switching users to ‘kam’

```
[sudo] password for kam:
Reading package lists... Done
Building dependency tree
Reading state information... Done
Note, selecting 'zlib1g-dev' instead of 'libz-dev'
The following NEW packages will be installed:
  zlib1g-dev
0 upgraded, 1 newly installed, 0 to remove and 7 not upgraded.
Need to get 186 kB of archives.
After this operation, 418 kB of additional disk space will be used.
WARNING: The following packages cannot be authenticated!
  zlib1g-dev
Install these packages without verification [y/N]? y
Get:1 http://archive.debian.org/debian/ squeeze/main zlib1g-dev i386 1:1.2.3.4.d
fsg-3 [186 kB]
Fetched 186 kB in 1s (169 kB/s)
Selecting previously deselected package zlib1g-dev.
(Reading database ... 23875 files and directories currently installed.)
Unpacking zlib1g-dev (from .../zlib1g-dev_1%3a1.2.3.4.dfsg-3_i386.deb) ...
Processing triggers for man-db ...
Setting up zlib1g-dev (1:1.2.3.4.dfsg-3) ...
kam@debian:/root$
```

Making hello directory in linux kernel

```
kam@debian:/root$ cd /home/kam/kernel/linux-2.6.32.60/
kam@debian:~/kernel/linux-2.6.32.60$ mkdir hello
kam@debian:~/kernel/linux-2.6.32.60$ cd hello
kam@debian:~/kernel/linux-2.6.32.60/hello$
```

Writing the syscall in hello.c within the hello directory

```
#include <linux/kernel.h>

asmlinkage long sys_hello(void)
{
        printk("Hello world!\n");
        return 100;
}
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
"hello.c" [New] 7L, 103C written                              6,12-19       All
```

Makefile in hello directory

```
obj-y := hello.o
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
"Makefile" [New] 1L, 17C written                            1,16          All
```

Altering the kernel makefile

```
ifeq ($(KBUILD_EXTMOD),)
core-y          += kernel/ mm/ fs/ ipc/ security/ crypto/ block/ hello/

vmlinux-dirs    := $(patsubst %/,%,$(filter %/, $(init-y) $(init-m) \
                     $(core-y) $(core-m) $(drivers-y) $(drivers-m) \
                     $(net-y) $(net-m) $(libs-y) $(libs-m)))

vmlinux-alldirs := $(sort $(vmlinux-dirs) $(patsubst %/,%,$(filter %/, \
                     $(init-n) $(init-) \
                     $(core-n) $(core-) $(drivers-n) $(drivers-) \
                     $(net-n)  $(net-)  $(libs-n)    $(libs-))))

init-y          := $(patsubst %/, %/built-in.o, $(init-y))
core-y          := $(patsubst %/, %/built-in.o, $(core-y))
"Makefile" 1598L, 55348C written                              650,63-71     40%
```

Adding the syscall to /arch/x86/kernel/syscall_table_32.S

```
        .long sys_rt_tgsigqueueinfo     /* 335 */
        .long sys_perf_event_open
        .long sys_sched_other_rr_getquantum
        .long sys_hello /* kam's syscall */
"syscall_table_32.S" 340L, 8397C written                      340,36-43     Bot
```

Defining syscall in /arch/x85/include/asm/unistd_32.h and incrementing NR_syscalls

```
#define __NR_perf_event_open    336
#define __NR_sched_other_rr_getquantum  337
#define __NR_hello              338

#ifdef __KERNEL__

#define NR_syscalls 339

#define __ARCH_WANT_IPC_PARSE_VERSION
```

Adding hello syscall to linux/include/syscalls.h

```
asmlinkage long sys_sched_other_rr_getquantum(void);

asmlinkage long sys_hello(void);

#endif
~
"syscalls.h" 893L, 38633C written                             893,1         Bot
```

Preparing build script

```
  1 #!/bin/sh
  2 rev=$1
  3 if [ -z "$rev" ]; then
  4         echo "Usage: build64 <revision>"
  5         exit 1
  6 fi
  7 make-kpkg -j 2 --rootcmd fakeroot --initrd --revision=$rev kernel_image 2>&1
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
"/usr/bin/kvm-kernel-build" 7L, 178C written                  7,14          All
```

Starting the kernel build

```
kam@debian:~/kernel/linux-2.6.32.60$ sudo kvm-kernel-build 1
exec make kpkg_version=12.036+nmu1 -f /usr/share/kernel-package/ruleset/minimal.
mk debian DEBIAN_REVISION=1  INITRD=YES  ROOT_CMD=fakeroot
_
```

After kernel build, dpkg -i [build] installs the image

```
[/home/kam/kernel]
root@debian$ dpkg -i linux-image-2.6.32.60_1_i386.deb
Selecting previously deselected package linux-image-2.6.32.60.
(Reading database ... 23905 files and directories currently installed.)
Unpacking linux-image-2.6.32.60 (from linux-image-2.6.32.60_1_i386.deb) ...
Done.
Setting up linux-image-2.6.32.60 (1) ...
Running depmod.
Examining /etc/kernel/postinst.d.
run-parts: executing /etc/kernel/postinst.d/initramfs-tools 2.6.32.60 /boot/vml
nuz-2.6.32.60
update-initramfs: Generating /boot/initrd.img-2.6.32.60
run-parts: executing /etc/kernel/postinst.d/zz-update-grub 2.6.32.60 /boot/vmli
uz-2.6.32.60
Generating grub.cfg ...
Found linux image: /boot/vmlinuz-2.6.32.60
Found initrd image: /boot/initrd.img-2.6.32.60
Found linux image: /boot/vmlinuz-2.6.32-5-686
Found initrd image: /boot/initrd.img-2.6.32-5-686
done

[/home/kam/kernel]
```

In new Linux image

```
kam@debian:~$ uname -a
Linux debian 2.6.32.60 #2 SMP Mon Mar 1 22:01:56 CST 2021 i686 GNU/Linux
kam@debian:~$ _
```

Wrote syscall test, compiled it, and tested it w/ good response

```
int main()
{
        long int syscall_val = syscall(338);
        printf("System call sys_hello returned %ld\n", syscall_val);
        return 0;
}
~
~
~
~
~
~
~
~
~
~
~
~
"test_syscall.c" [New] 11L, 217C written
kam@debian:~$ gcc test_syscall.c -o test_syscall
kam@debian:~$ ./test_syscall
System call sys_hello returned 100
kam@debian:~$
```

“Hello world!” printed in the kernel logs

```
System call sys_hello returned 100
kam@debian:~$ dmesg | tail -5
[   14.176685] loop: module loaded
[   16.742852] ADDRCONF(NETDEV_UP): eth0: link is not ready
[   16.745063] e1000: eth0 NIC Link is Up 1000 Mbps Full Duplex, Flow Control: R
X
[   16.748251] ADDRCONF(NETDEV_CHANGE): eth0: link becomes ready
[  202.256518] Hello world!
kam@debian:~$
```