

### (1) 使用命令查看当前系统的内核版本

```
pengmeidong@pengmeidong-virtual-machine:~$ uname -a
Linux pengmeidong-virtual-machine 4.15.0-112-generic #113~16.04.1-Ubuntu SMP Fri Jul 10 04:37:08 UTC
2020 x86_64 x86_64 x86_64 GNU/Linux
pengmeidong@pengmeidong-virtual-machine:~$ _
```

### (2) 更新&准备编译环境

```
The following packages will be upgraded:
accountsservice apport apport-gtk apt apt-transport-https apt-utils aptdaemon aptdaemon-data
base-files bind9-host ca-certificates distro-info-data dnsmasq-base dnsutils dpkg dpkg-dev
file-roller firefox ghostscript ghostscript-x gir1.2-packagekitglib-1.0 grub-common grub-pc
grub-pc-bin grub2-common gstreamer1.0-plugins-good gstreamer1.0-pulseaudio imagemagick
imagemagick-6.q16 imagemagick-common initramfs-tools initramfs-tools-bin initramfs-tools-core
intel-microcode krb5-locales libaccountsservice0 libapt-inst2.0 libapt-pkg5.0 libbind9-140
libc-bin libc-dev-bin libc6 libc6-dbg libc6-dev libcaca0 libcurl3 libcurl3-gnutls
libdns-export162 libdns162 libdpkg-perl libexif12 libfreetype6 libglib2.0-0 libglib2.0-bin
libglib2.0-data libgnutls-openssl127 libgnutls30 libgs9 libgs9-common libgssapi-krb5-2
libgstreamer-plugins-good1.0-0 libhogweed4 libisc-export160 libisc160 libisccc140 libisccfg140
libjasper1 libk5crypto3 libkrb5-3 libkrb5support0 libldap-2.4-2 libldb1 liblwres141
libmagiccore-6.q16-2 libmagiccore-6.q16-2-extra libmagicwand-6.q16-2 libnettle6 libnss3
libnss3-nssdb libopenexr22 libp11-kit0 libpackagekit-glib2-16 libpam-modules libpam-modules-bin
libpam-runtime libpam-systemd libpam0g libperl5.22 libpoppler-glib8 libpoppler58
libproxy1-plugin-gsettings libproxy1-plugin-networkmanager libproxy1v5 libpulse-mainloop-glib0
libpulse0 libpulsedsp libpython2.7 libpython2.7-minimal libpython2.7-stdlib libpython3.5
libpython3.5-minimal libpython3.5-stdlib libraptor2-0 libsane libsane-common libseccomp2
libsmclient libsndfile1 libsnmp-base libsnmp30 libssl1.0.0 libsystemd0 libtiff5 libudev1
libvncclient1 libwbclient0 libx11-6 libx11-data libx11-xcb1 linux-generic-hwe-16.04
linux-headers-generic-hwe-16.04 linux-image-generic-hwe-16.04 linux-libc-dev locales
multiarch-support openssl p11-kit p11-kit-modules perl perl-base perl-modules-5.22 poppler-utils
pulseaudio pulseaudio-module-bluetooth pulseaudio-module-x11 pulseaudio-utils python-apt-common
python2.7 python2.7-minimal python3-apport python3-apt python3-aptdaemon
python3-aptdaemon.gtk3widgets python3-aptdaemon.pkcompat python3-cryptography
python3-distupgrade python3-lxml python3-pil python3-problem-report python3-pyparsing
python3-software-properties python3-urllib3 python3-xdg python3.5 python3.5-minimal samba-libs
sane-utils sbsigntool snapd software-properties-common software-properties-gtk sudo systemd
systemd-sysv tar tzdata ubuntu-advantage-tools ubuntu-core-launcher ubuntu-desktop
ubuntu-minimal ubuntu-release-upgrader-core ubuntu-release-upgrader-gtk ubuntu-standard udev
unattended-upgrades unzip update-notifier update-notifier-common vim-common vim-tiny vino
wireless-regdb wpasupplicant xdg-utils xserver-common xserver-xorg-core-hwe-16.04
xserver-xorg-legacy-hwe-16.04 xterm
188 upgraded, 9 newly installed, 0 to remove and 0 not upgraded.
Need to get 235 MB of archives.
After this operation, 355 MB of additional disk space will be used.
Do you want to continue? [Y/n]
```

用力更新中……

```

imagemagick-6.q16 imagemagick-common initramfs-tools initramfs-tools-bin initramfs-tools-core
intel-microcode krb5-locales libaccountsservice0 libapt-inst2.0 libapt-pkg5.0 libbind9-140
libc-bin libc-dev-bin libc6 libc6-dbg libc6-dev libcaca0 libcurl3 libcurl3-gnutls
libdns-export162 libdns162 libdpkg-perl libexif12 libfreetype6 libglib2.0-0 libglib2.0-bin
libglib2.0-data libgnutls-openssl127 libgnutls30 libgs9 libgs9-common libgssapi-krb5-2
libgstreamer-plugins-good1.0-0 libhogweed4 libisc-export160 libisc160 libisccc140 libisccfg140
libjasper1 libk5crypto3 libkrb5-3 libkrb5support0 libldap-2.4-2 libldb1 liblures141
libmagickcore-6.q16-2 libmagickcore-6.q16-2-extra libmagickwand-6.q16-2 libnettle6 libnss3
libnss3-nssdb libopenexr22 libp11-kit0 libpackagekit-glib2-16 libpam-modules libpam-modules-bin
libpam-runtime libpam-systemd libpam0g libperl5.22 libpoppler-glib8 libpoppler58
libproxy1-plugin-gsettings libproxy1-plugin-networkmanager libproxy1v5 libpulse-mainloop-glib0
libpulse0 libpulsedsp libpython2.7 libpython2.7-minimal libpython2.7-stdlib libpython3.5
libpython3.5-minimal libpython3.5-stdlib libraptor2-0 libsane libsane-common libseccomp2
libsmclient libsndfile1 libsnmp-base libsnmp30 libssl1.0.0 libsystemd0 libtiff5 libudev1
libvncclient1 libwbclient0 libx11-6 libx11-data libx11-xcb1 linux-generic-hwe-16.04
linux-headers-generic-hwe-16.04 linux-image-generic-hwe-16.04 linux-libc-dev locales
multiarch-support openssl p11-kit p11-kit-modules perl perl-base perl-modules-5.22 poppler-utils
pulseaudio pulseaudio-module-bluetooth pulseaudio-module-x11 pulseaudio-utils python-apt-common
python2.7 python2.7-minimal python3-apt python3-apt python3-aptdaemon
python3-aptdaemon.gtk3widgets python3-aptdaemon.pkcompat python3-cryptography
python3-distupgrade python3-lxml python3-pil python3-problem-report python3-pyparsing
python3-software-properties python3-urllib3 python3-xdg python3.5 python3.5-minimal samba-libs
sane-utils sbsigntool snapd software-properties-common software-properties-gtk sudo systemd
systemd-sysv tar tzdata ubuntu-advantage-tools ubuntu-core-launcher ubuntu-desktop
ubuntu-minimal ubuntu-release-upgrader-core ubuntu-release-upgrader-gtk ubuntu-standard udev
unattended-upgrades unzip update-notifier update-notifier-common vim-common vim-tiny vino
wireless-regdb wpasupplicant xdg-utils xserver-common xserver-xorg-core-hwe-16.04
xserver-xorg-legacy-hwe-16.04 xterm
188 upgraded, 9 newly installed, 0 to remove and 0 not upgraded.
Need to get 235 MB of archives.
After this operation, 355 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://cn.archive.ubuntu.com/ubuntu xenial-updates/main amd64 base-files amd64 9.4ubuntu4.13 [
61.8 kB]
Get:2 http://cn.archive.ubuntu.com/ubuntu xenial-updates/main amd64 libc6-dbg amd64 2.23-0ubuntu11.3
[3,686 kB]
1% [2 libc6-dbg 2,019 kB/3,686 kB 55%] 225 kB/s 17min 18s

```

```

Preparing to unpack .../libtinfo-dev_6.0+20160213-1ubuntu1_amd64.deb ...
Unpacking libtinfo-dev:amd64 (6.0+20160213-1ubuntu1) ...
Selecting previously unselected package libncurses5-dev:amd64.
Preparing to unpack .../libncurses5-dev_6.0+20160213-1ubuntu1_amd64.deb ...
Unpacking libncurses5-dev:amd64 (6.0+20160213-1ubuntu1) ...
Selecting previously unselected package zlib1g-dev:amd64.
Preparing to unpack .../zlib1g-dev_1%3a1.2.8.dfsg-2ubuntu4.3_amd64.deb ...
Unpacking zlib1g-dev:amd64 (1:1.2.8.dfsg-2ubuntu4.3) ...
Selecting previously unselected package libssl-dev:amd64.
Preparing to unpack .../libssl-dev_1.0.2g-1ubuntu4.20_amd64.deb ...
Unpacking libssl-dev:amd64 (1.0.2g-1ubuntu4.20) ...
Selecting previously unselected package libssl-doc.
Preparing to unpack .../libssl-doc_1.0.2g-1ubuntu4.20_all.deb ...
Unpacking libssl-doc (1.0.2g-1ubuntu4.20) ...
Processing triggers for install-info (6.1.0.dfsg.1-5) ...
Processing triggers for man-db (2.7.5-1) ...
Processing triggers for libc-bin (2.23-0ubuntu11.3) ...
Processing triggers for doc-base (0.10.7) ...
Processing 1 added doc-base file...
Setting up libsigsegv2:amd64 (2.10-4) ...
Setting up m4 (1.4.17-5) ...
Setting up libfl-dev:amd64 (2.6.0-11) ...
Setting up flex (2.6.0-11) ...
Setting up grub2 (2.02~beta2-36ubuntu3.32) ...
Setting up libbison-dev:amd64 (2:3.0.4.dfsg-1) ...
Setting up bison (2:3.0.4.dfsg-1) ...
update-alternatives: using /usr/bin/bison.yacc to provide /usr/bin/yacc (yacc) in auto mode
Setting up libelf-dev:amd64 (0.165-3ubuntu1.2) ...
Setting up libtinfo-dev:amd64 (6.0+20160213-1ubuntu1) ...
Setting up libncurses5-dev:amd64 (6.0+20160213-1ubuntu1) ...
Setting up zlib1g-dev:amd64 (1:1.2.8.dfsg-2ubuntu4.3) ...
Setting up libssl-dev:amd64 (1.0.2g-1ubuntu4.20) ...
Setting up libssl-doc (1.0.2g-1ubuntu4.20) ...
Processing triggers for libc-bin (2.23-0ubuntu11.3) ...
pengmeidong@pengmeidong-virtual-machine:~$

```

(3) 'sudo apt install curl'安装 curl 下载并解压源码, 操作如图 E5-3 所示

(这里最后才发现忘记截图了, 最后 ls -l 证明一下成功的了)

```
pengmeidong@pengmeidong-virtual-machine:~$ ls -l
total 64
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Desktop
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Documents
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Downloads
-rw-r--r--  1 pengmeidong pengmeidong 8980 9月 25 15:35 examples.desktop
drwxrwxr-x 27 pengmeidong pengmeidong 4096 9月 25 20:24 linux-4.19.6
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Music
-rwxrwxr-x  1 pengmeidong pengmeidong 8608 9月 25 20:26 ourcall
-rw-rw-r--  1 pengmeidong pengmeidong 187 9月 25 20:18 ourcall.c
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Pictures
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Public
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Templates
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Videos
```

这里学长说最好去图形界面打开终端, 可以上下滑动方便查看历史记录

### 3、内核编译过程

#### (1) 配置内核

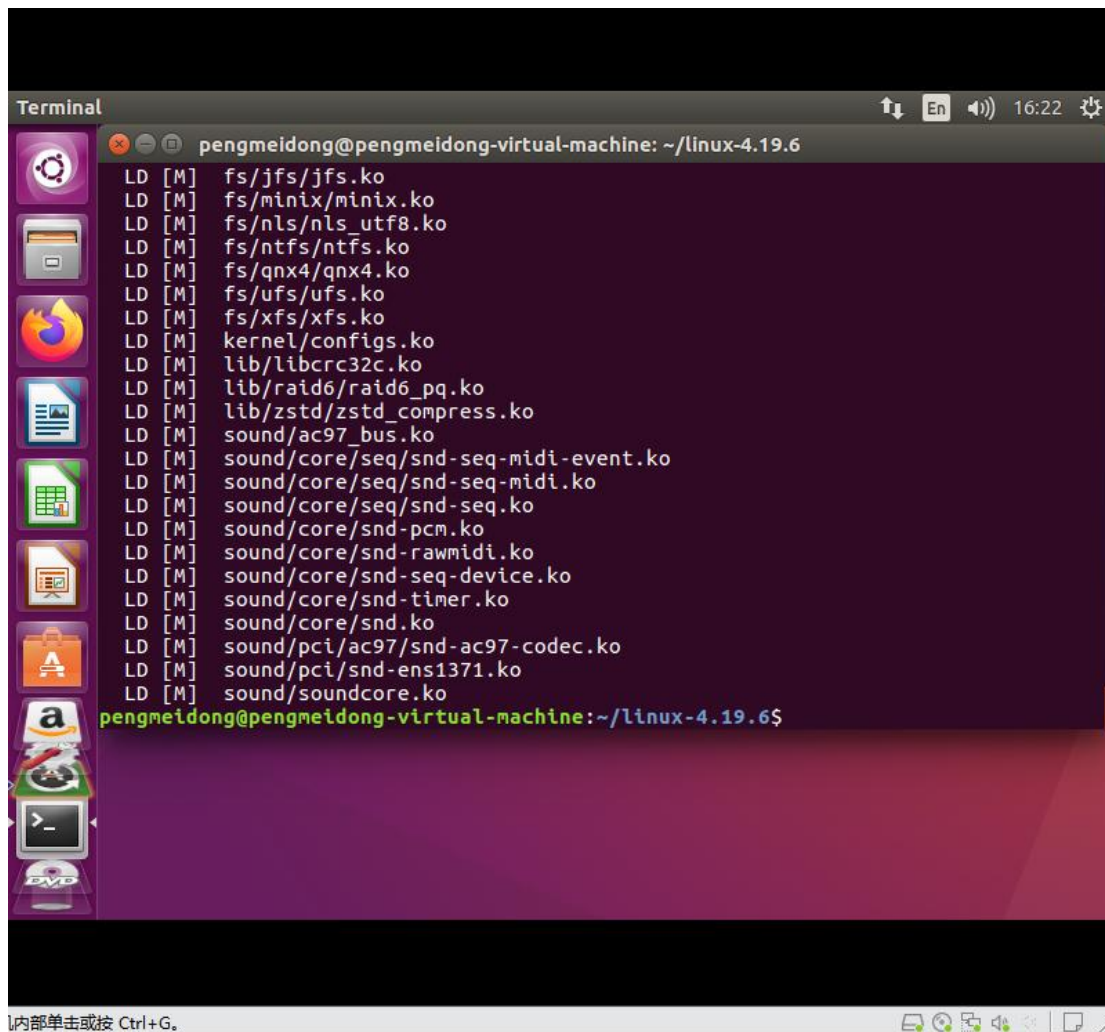
```
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6
Intel/SiS/nVidia/AMD MC97 Modem (SND_INTEL8X0M) [N/m/?] n
Korg 1212 IO (SND_KORG1212) [N/m/?] n
Digigram Lola (SND_LOLA) [N/m/?] n
Digigram LX6464ES (SND_LX6464ES) [N/m/?] n
ESS Allegro/Maestro3 (SND_MAESTRO3) [N/m/?] n
Digigram miXart (SND_MIXART) [N/m/?] n
NeoMagic NM256AV/ZX (SND_NM256) [N/m/?] n
Digigram PCXHR (SND_PCXHR) [N/m/?] n
Conexant Riptide (SND_RIPTIDE) [N/m/?] n
RME Digi32, 32/8, 32 PRO (SND_RME32) [N/m/?] n
RME Digi96, 96/8, 96/8 PRO (SND_RME96) [N/m/?] n
RME Digi9652 (Hammerfall) (SND_RME9652) [N/m/?] n
Studio Evolution SE6X (SND_SE6X) [N/m/?] (NEW)
S3 SonicVibes (SND_SONICVIBES) [N/m/?] n
Trident 4D-Wave DX/NX; SiS 7018 (SND_TRIDENT) [N/m/?] n
VIA 82C686A/B, 8233/8235 AC97 Controller (SND_VIA82XX) [N/m/?] n
VIA 82C686A/B, 8233 based Modems (SND_VIA82XX_MODEM) [N/m/?] n
Asus Virtuoso 66/100/200 (Xonar) (SND_VIRTUOSO) [N/m/?] n
Digigram VX222 (SND_VX222) [N/m/?] n
Yamaha YMF724/740/744/754 (SND_YMFPCI) [N/m/?] n
#
# configuration written to .config
#
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6$
```

#### (2) 编译内核



```
Terminal
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6

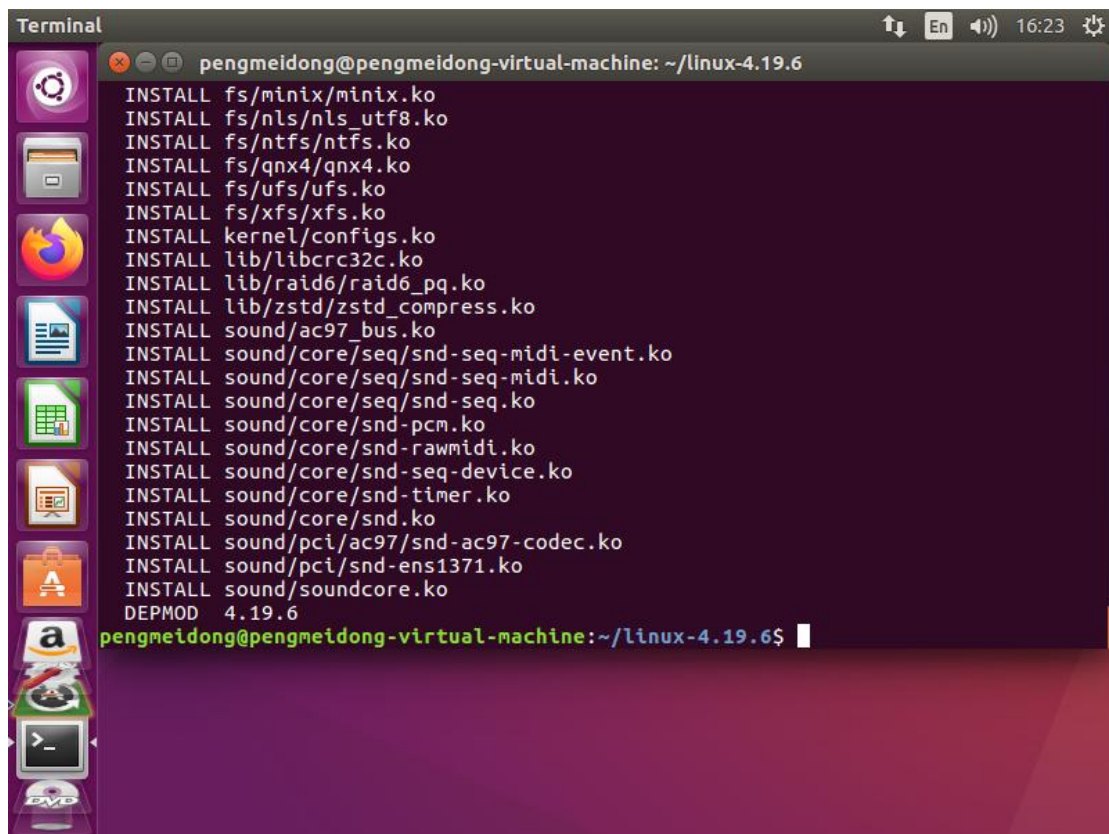
###
### Now generating an X.509 key pair to be used for signing modules.
###
### If this takes a long time, you might wish to run rngd in the
### background to keep the supply of entropy topped up. It
### needs to be run as root, and uses a hardware random
### number generator if one is available.
###
Generating a 4096 bit RSA private key
..... AR      arch/x86/entry/built-in.a
..... CC      mm/filemap.o
.....++
.....++
writing new private key to 'certs/signing_key.pem'
-----
###
### Key pair generated.
###
EXTRACT_CERTS  certs/signing_key.pem
AS      certs/system_certificates.o
AR      certs/built-in.a
CC      arch/x86/events/amd/ibs.o
CC      arch/x86/events/intel/core.o
```



The image shows a terminal window titled "Terminal" with a dark background. The prompt is "pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6". The output shows a list of kernel modules being loaded, each preceded by "LD [M]". The modules listed are: fs/jfs/jfs.ko, fs/minix/minix.ko, fs/nls/nls\_utf8.ko, fs/ntfs/ntfs.ko, fs/qnx4/qnx4.ko, fs/ufs/ufs.ko, fs/xfs/xfs.ko, kernel/configs.ko, lib/libcrc32c.ko, lib/raid6/raid6\_pq.ko, lib/zstd/zstd\_compress.ko, sound/ac97\_bus.ko, sound/core/seq/snd-seq-midi-event.ko, sound/core/seq/snd-seq-midi.ko, sound/core/seq/snd-seq.ko, sound/core/snd-pcm.ko, sound/core/snd-rawmidi.ko, sound/core/snd-seq-device.ko, sound/core/snd-timer.ko, sound/core/snd.ko, sound/pci/ac97/snd-ac97-codec.ko, sound/pci/snd-ens1371.ko, and sound/soundcore.ko. The prompt at the bottom is "pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6\$".

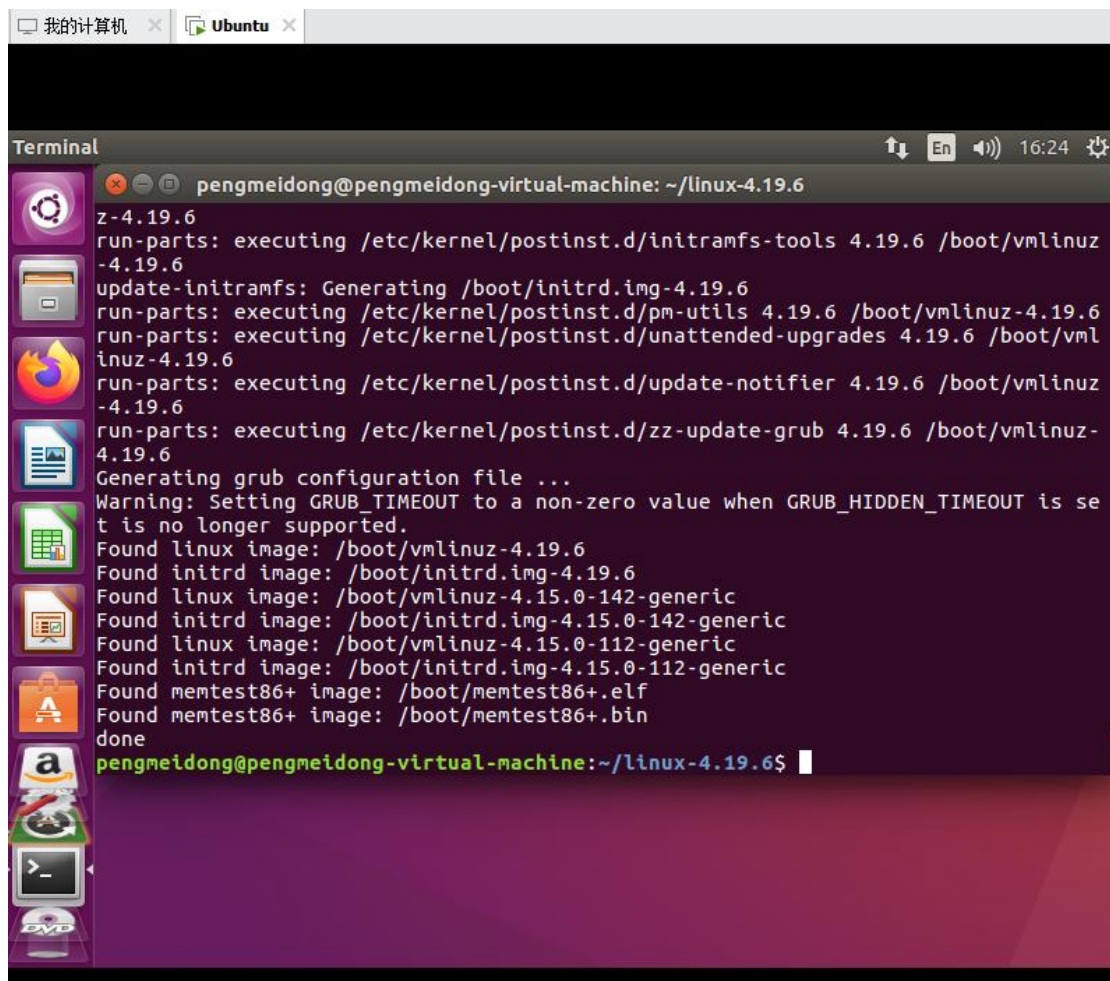
```
LD [M] fs/jfs/jfs.ko
LD [M] fs/minix/minix.ko
LD [M] fs/nls/nls_utf8.ko
LD [M] fs/ntfs/ntfs.ko
LD [M] fs/qnx4/qnx4.ko
LD [M] fs/ufs/ufs.ko
LD [M] fs/xfs/xfs.ko
LD [M] kernel/configs.ko
LD [M] lib/libcrc32c.ko
LD [M] lib/raid6/raid6_pq.ko
LD [M] lib/zstd/zstd_compress.ko
LD [M] sound/ac97_bus.ko
LD [M] sound/core/seq/snd-seq-midi-event.ko
LD [M] sound/core/seq/snd-seq-midi.ko
LD [M] sound/core/seq/snd-seq.ko
LD [M] sound/core/snd-pcm.ko
LD [M] sound/core/snd-rawmidi.ko
LD [M] sound/core/snd-seq-device.ko
LD [M] sound/core/snd-timer.ko
LD [M] sound/core/snd.ko
LD [M] sound/pci/ac97/snd-ac97-codec.ko
LD [M] sound/pci/snd-ens1371.ko
LD [M] sound/soundcore.ko
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6$
```

(3) 安装内核模块

A terminal window titled "Terminal" with a dark background and a light-colored text. The window shows the installation progress of the Linux 4.19.6 kernel. The prompt is "pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6". The output shows a list of files being installed, including various kernel modules and libraries. The installation is complete, and the prompt has changed to "pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6\$".

```
Terminal
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6
INSTALL fs/minix/minix.ko
INSTALL fs/nls/nls_utf8.ko
INSTALL fs/ntfs/ntfs.ko
INSTALL fs/qnx4/qnx4.ko
INSTALL fs/ufs/ufs.ko
INSTALL fs/xfs/xfs.ko
INSTALL kernel/configs.ko
INSTALL lib/libcrc32c.ko
INSTALL lib/raid6/raid6_pq.ko
INSTALL lib/zstd/zstd_compress.ko
INSTALL sound/ac97_bus.ko
INSTALL sound/core/seq/snd-seq-midi-event.ko
INSTALL sound/core/seq/snd-seq-midi.ko
INSTALL sound/core/seq/snd-seq.ko
INSTALL sound/core/snd-pcm.ko
INSTALL sound/core/snd-rawmidi.ko
INSTALL sound/core/snd-seq-device.ko
INSTALL sound/core/snd-timer.ko
INSTALL sound/core/snd.ko
INSTALL sound/pci/ac97/snd-ac97-codec.ko
INSTALL sound/pci/snd-ens1371.ko
INSTALL sound/soundcore.ko
DEPMOD 4.19.6
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6$
```

(4) 安装内核



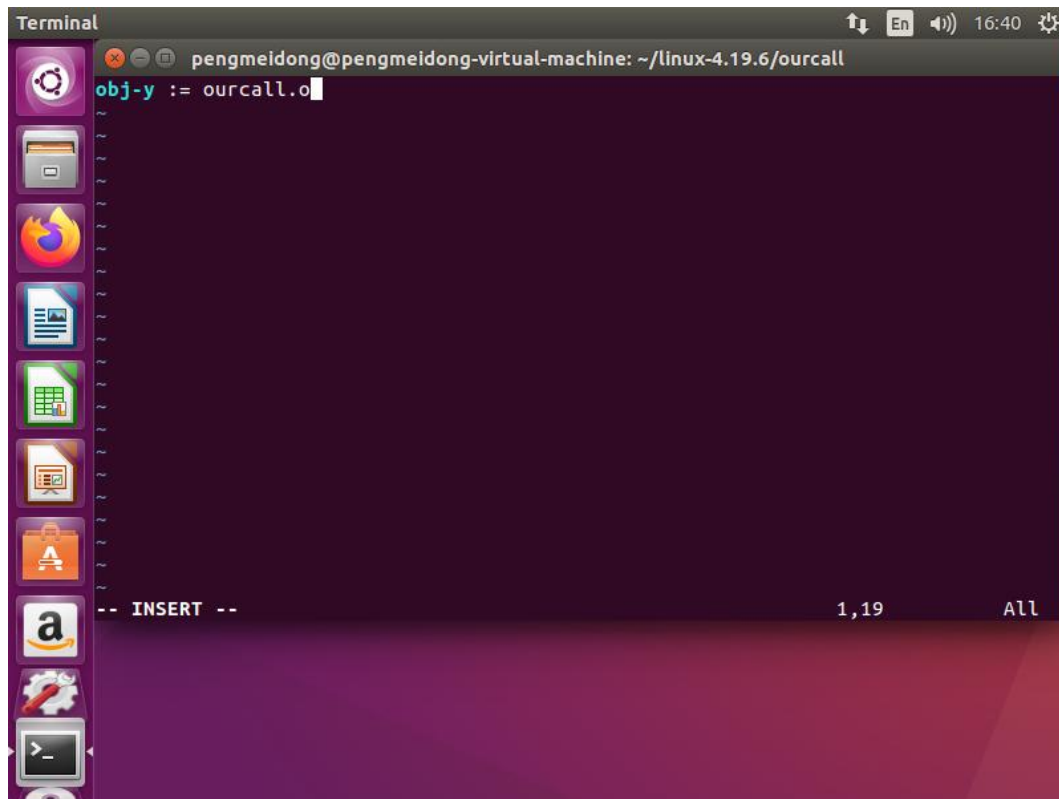
(5) 查看安装之后的内核版本。重启系统，选择新的内核，通过 `uname -a` 命令可以查看目前正在运行的系统内核版本





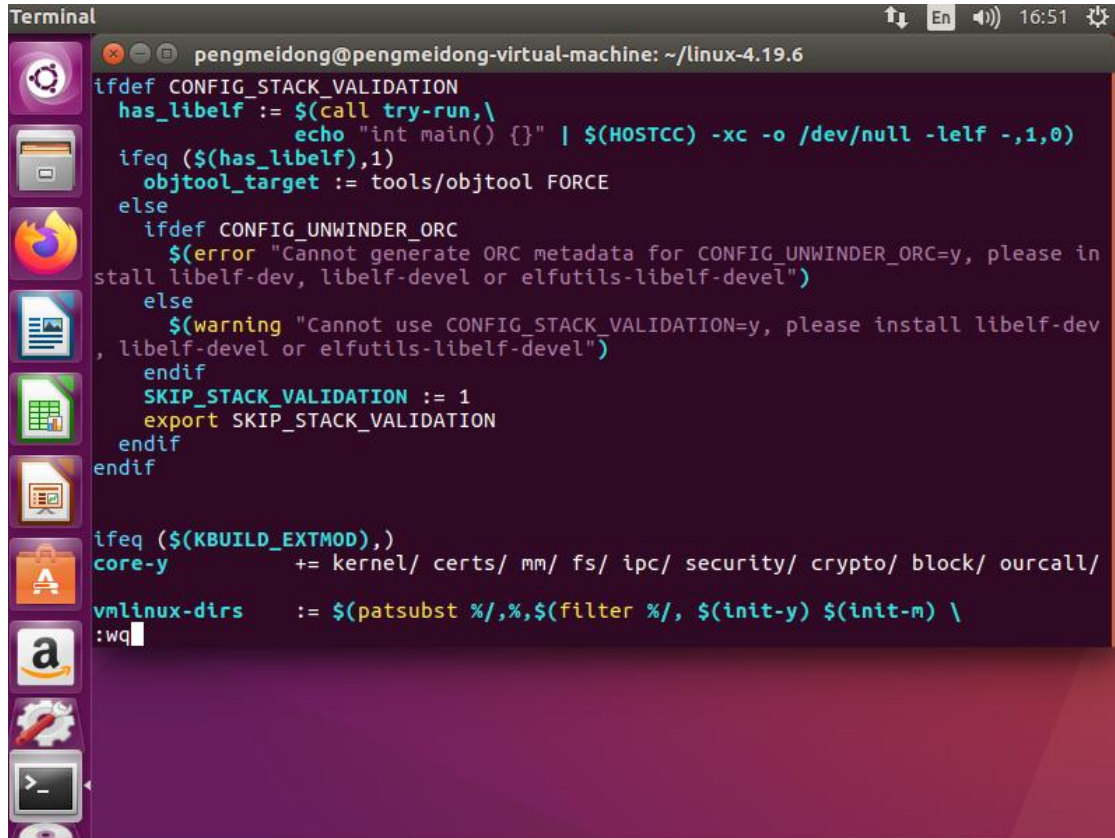
(2) 添加 Makefile

```
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6$ cd ourcall
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6/ourcall$ vim Makefile
```



(3) 添加 ourcall 目录，修改源代码根目录下的 Makefile

```
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6/ourcall$ cd ..
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6$ vim Makefile
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6$
```

A terminal window titled "Terminal" showing the output of a kernel configuration script. The prompt is "pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6". The script defines CONFIG\_STACK\_VALIDATION, checks for libelf, sets objtool\_target, and handles CONFIG\_UNWINDER\_ORC. It also sets SKIP\_STACK\_VALIDATION and defines core-y and vmlinux-dirs.

```
Terminal
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6
ifndef CONFIG_STACK_VALIDATION
    has_libelf := $(call try-run,\
        echo "int main() {}" | $(HOSTCC) -xc -o /dev/null -lelf -,1,0)
    ifeq ($(has_libelf),1)
        objtool_target := tools/objtool FORCE
    else
        ifdef CONFIG_UNWINDER_ORC
            $(error "Cannot generate ORC metadata for CONFIG_UNWINDER_ORC=y, please in
stall libelf-dev, libelf-devel or elfutils-libelf-devel")
        else
            $(warning "Cannot use CONFIG_STACK_VALIDATION=y, please install libelf-dev
, libelf-devel or elfutils-libelf-devel")
        endif
        SKIP_STACK_VALIDATION := 1
        export SKIP_STACK_VALIDATION
    endif
endif

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

vmlinux-dirs := $(patsubst %/,%, $(filter %/, $(init-y) $(init-m) \
:wq
```

(4) 修改 syscalls 头文件

```
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6$ vim include/linux/syscal
ls.h
```

```
Terminal
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6
    flags |= O_LARGEFILE;
    return do_sys_open(AT_FDCWD, filename, flags, mode);
}
extern long do_sys_truncate(const char __user *pathname, loff_t length);
static inline long ksys_truncate(const char __user *pathname, loff_t length)
{
    return do_sys_truncate(pathname, length);
}
static inline unsigned int ksys_personality(unsigned int personality)
{
    unsigned int old = current->personality;
    if (personality != 0xffffffff)
        set_personality(personality);
    return old;
}
asmlinkage long sys_ourcall(void);
-- INSERT --
1297,1 99%
```

(5) 添加系统调用号

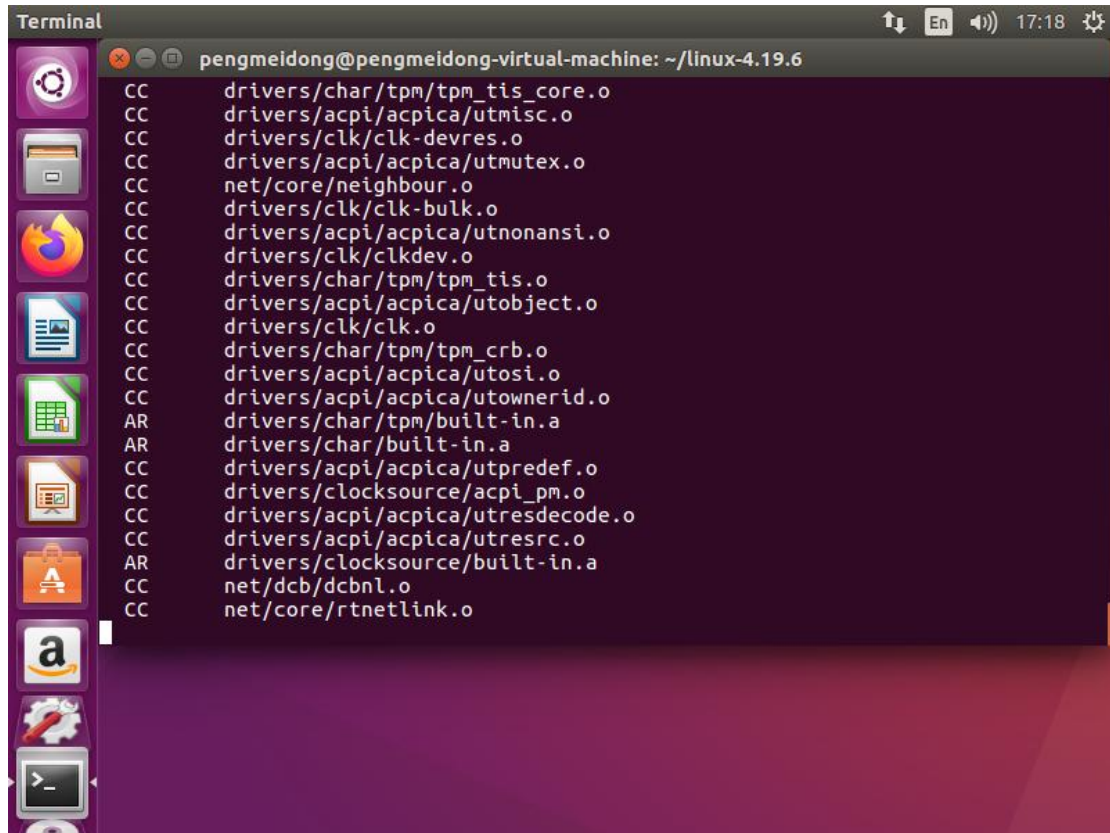
在系统调用表 syscall\_64.tbl 中添加 ourcall 系统调用号

```
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6$ vim arch/x86/entry/syscalls/syscall_64.tbl
Terminal
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6
322    64    execveat    __x64_sys_execveat/ptregs
323    common userfaultfd __x64_sys_userfaultfd
324    common membarrier  __x64_sys_membarrier
325    common mlock2    __x64_sys_mlock2
326    common copy_file_range __x64_sys_copy_file_range
327    64    preadv2    __x64_sys_preadv2
328    64    pwritev2   __x64_sys_pwritev2
329    common pkey_mprotect __x64_sys_pkey_mprotect
330    common pkey_alloc __x64_sys_pkey_alloc
331    common pkey_free  __x64_sys_pkey_free
332    common statx     __x64_sys_statx
333    common io_pgetevents __x64_sys_io_pgetevents
334    common rseq      __x64_sys_rseq
335    common ourcall    __x64_sys_ourcall
#
# x32-specific system call numbers start at 512 to avoid cache impact
# for native 64-bit operation. The __x32_compat_sys stubs are created
# on-the-fly for compat_sys_*(*) compatibility system calls if X86_X32
# is defined.
#
512    x32    rt_sigaction __x32_compat_sys_rt_sigaction
513    x32    rt_sigreturn sys32_x32_rt_sigreturn
-- INSERT --
347,1 90%
```



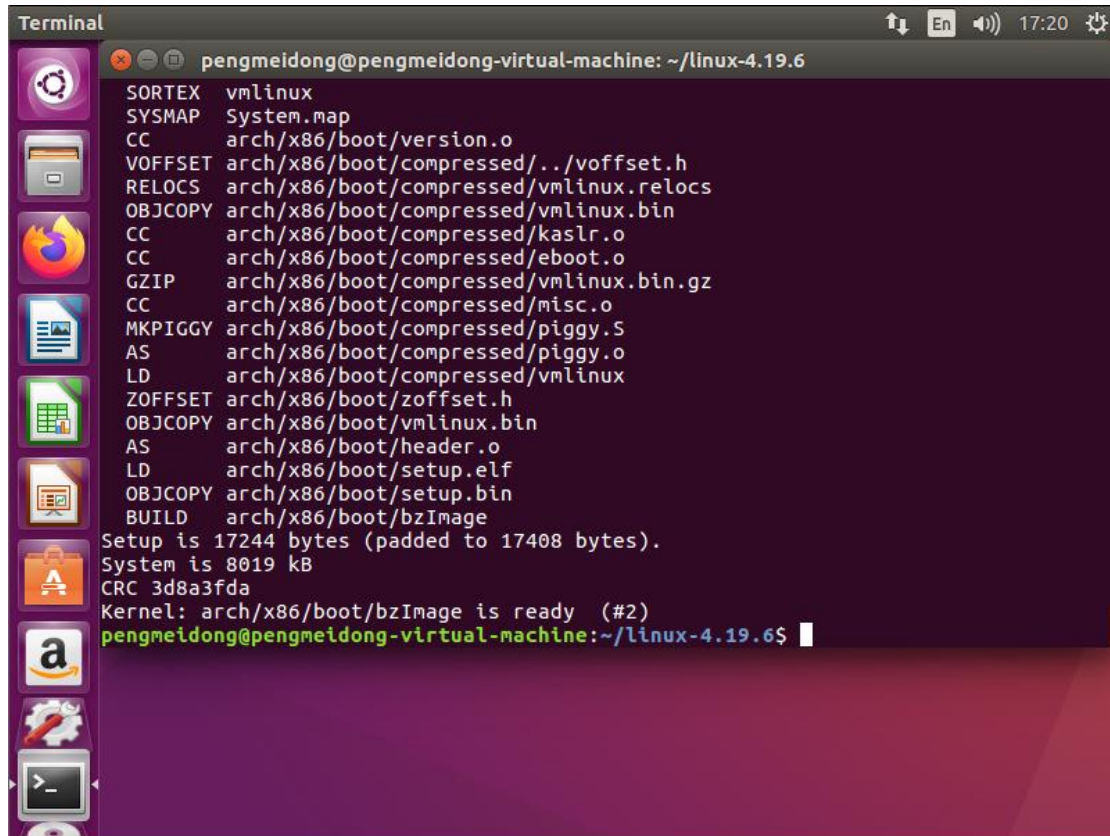
(6) 重新编译内核

```
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6$ make bzImage -j $(nproc)
```



Terminal window showing the compilation of kernel modules for the bzImage target. The output lists various modules being compiled (CC) or archived (AR).

```
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6
CC      drivers/char/tpm/tpm_tis_core.o
CC      drivers/acpi/acpica/utmisc.o
CC      drivers/clk/clk-devres.o
CC      drivers/acpi/acpica/utmutex.o
CC      net/core/neighbour.o
CC      drivers/clk/clk-bulk.o
CC      drivers/acpi/acpica/utnonansi.o
CC      drivers/clk/clkdev.o
CC      drivers/char/tpm/tpm_tis.o
CC      drivers/acpi/acpica/utobject.o
CC      drivers/clk/clk.o
CC      drivers/char/tpm/tpm_crb.o
CC      drivers/acpi/acpica/utosi.o
CC      drivers/acpi/acpica/utownerid.o
AR      drivers/char/tpm/built-in.a
AR      drivers/char/built-in.a
CC      drivers/acpi/acpica/utpredef.o
CC      drivers/clocksource/acpi_pm.o
CC      drivers/acpi/acpica/utresdecode.o
CC      drivers/acpi/acpica/utresrc.o
AR      drivers/clocksource/built-in.a
CC      net/dcb/dcbnl.o
CC      net/core/rtnetlink.o
```

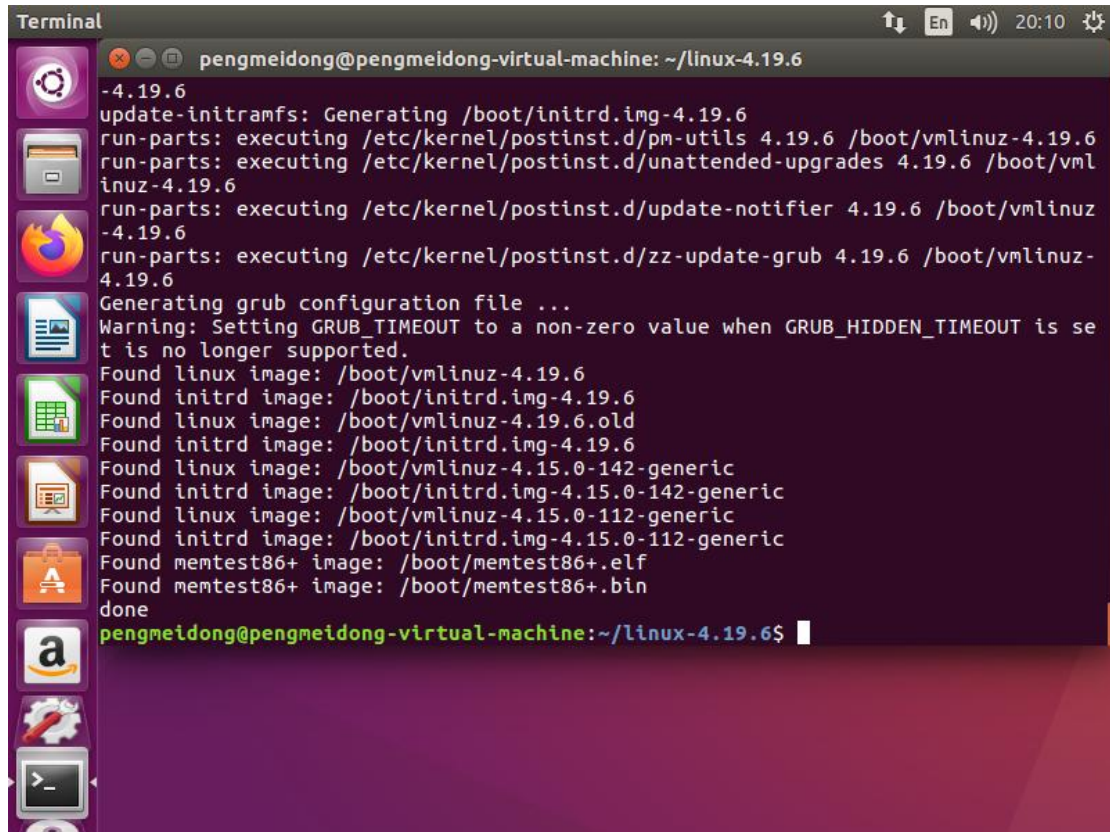


Terminal window showing the final steps of the kernel compilation. It lists the creation of various boot files and provides system size and CRC information.

```
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6
SORTEX  vmlinux
SYSMAP  System.map
CC      arch/x86/boot/version.o
VOFFSET arch/x86/boot/compressed/../voffset.h
RELOCS  arch/x86/boot/compressed/vmlinux.relocs
OBJCOPY arch/x86/boot/compressed/vmlinux.bin
CC      arch/x86/boot/compressed/kaslr.o
CC      arch/x86/boot/compressed/eboot.o
GZIP    arch/x86/boot/compressed/vmlinux.bin.gz
CC      arch/x86/boot/compressed/misc.o
MKPIGGY arch/x86/boot/compressed/piggy.S
AS      arch/x86/boot/compressed/piggy.o
LD      arch/x86/boot/compressed/vmlinux
ZOFFSET arch/x86/boot/zoffset.h
OBJCOPY arch/x86/boot/vmlinux.bin
AS      arch/x86/boot/header.o
LD      arch/x86/boot/setup.elf
OBJCOPY arch/x86/boot/setup.bin
BUILD  arch/x86/boot/bzImage
Setup is 17244 bytes (padded to 17408 bytes).
System is 8019 kB
CRC 3d8a3fda
Kernel: arch/x86/boot/bzImage is ready (#2)
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6$
```

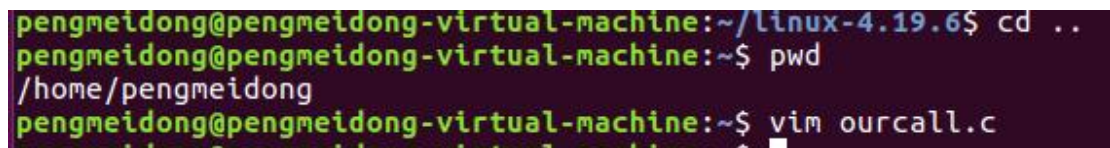


重新安装内核：make install 出错，改成 sudo make install

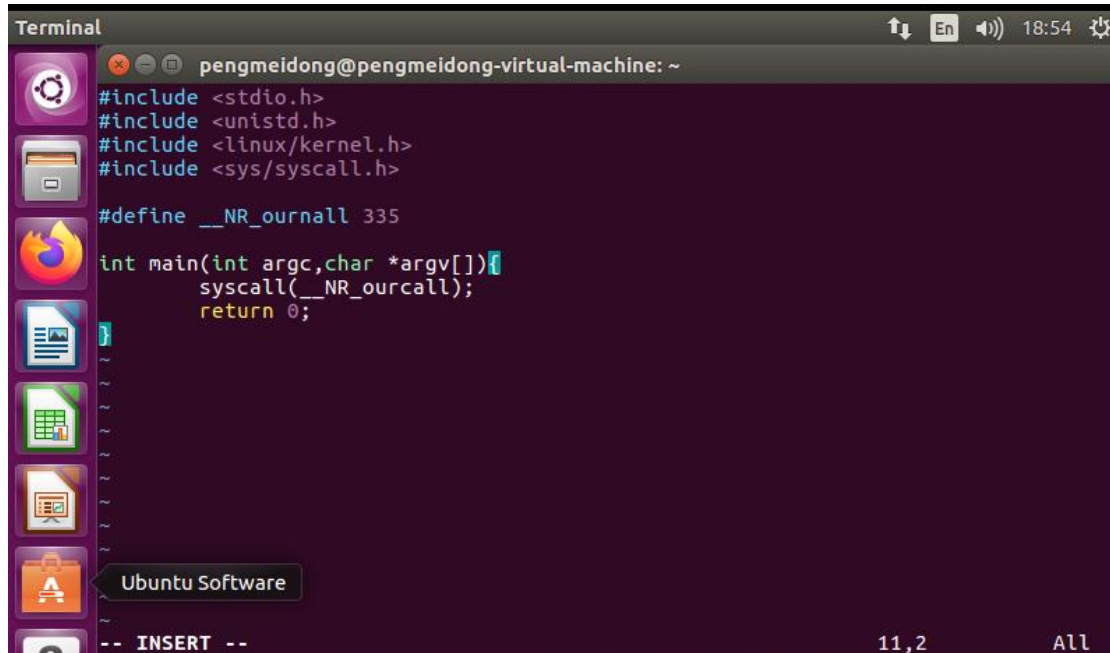


```
Terminal
pengmeidong@pengmeidong-virtual-machine: ~/linux-4.19.6
-4.19.6
update-initramfs: Generating /boot/initrd.img-4.19.6
run-parts: executing /etc/kernel/postinst.d/pm-utils 4.19.6 /boot/vmlinuz-4.19.6
run-parts: executing /etc/kernel/postinst.d/unattended-upgrades 4.19.6 /boot/vmlinuz-4.19.6
run-parts: executing /etc/kernel/postinst.d/update-notifier 4.19.6 /boot/vmlinuz-4.19.6
run-parts: executing /etc/kernel/postinst.d/zz-update-grub 4.19.6 /boot/vmlinuz-4.19.6
Generating grub configuration file ...
Warning: Setting GRUB_TIMEOUT to a non-zero value when GRUB_HIDDEN_TIMEOUT is set is no longer supported.
Found linux image: /boot/vmlinuz-4.19.6
Found initrd image: /boot/initrd.img-4.19.6
Found linux image: /boot/vmlinuz-4.19.6.old
Found initrd image: /boot/initrd.img-4.19.6
Found linux image: /boot/vmlinuz-4.15.0-142-generic
Found initrd image: /boot/initrd.img-4.15.0-142-generic
Found linux image: /boot/vmlinuz-4.15.0-112-generic
Found initrd image: /boot/initrd.img-4.15.0-112-generic
Found memtest86+ image: /boot/memtest86+.elf
Found memtest86+ image: /boot/memtest86+.bin
done
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6$
```

(7) 验证系统调用，通过 syscall() 函数发起系统调用，参数为自定义的系统调用号



```
pengmeidong@pengmeidong-virtual-machine:~/linux-4.19.6$ cd ..
pengmeidong@pengmeidong-virtual-machine:~$ pwd
/home/pengmeidong
pengmeidong@pengmeidong-virtual-machine:~$ vim ourcall.c
```



```
Terminal
pengmeidong@pengmeidong-virtual-machine: ~
#include <stdio.h>
#include <unistd.h>
#include <linux/kernel.h>
#include <sys/syscall.h>

#define __NR_ourcall 335

int main(int argc, char *argv[]) {
    syscall(__NR_ourcall);
    return 0;
}

Ubuntu Software
-- INSERT --
11,2 All
```

(8) 编译

```

pengmeidong@pengmeidong-virtual-machine:~$ gcc ourcall.c -o ourcall
/usr/bin/ld: cannot open output file ourcall: Is a directory
collect2: error: ld returned 1 exit status
pengmeidong@pengmeidong-virtual-machine:~$ ls -l
total 56
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Desktop
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Documents
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Downloads
-rw-r--r--  1 pengmeidong pengmeidong 8980 9月 25 15:35 examples.desktop
drwxrwxr-x 27 pengmeidong pengmeidong 4096 9月 25 17:35 linux-4.19.6
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Music
drwxrwxr-x  2 pengmeidong pengmeidong 4096 9月 25 16:27 ourcall
-rw-rw-r--  1 pengmeidong pengmeidong  187 9月 25 19:47 ourcall.c
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Pictures
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Public
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Templates
drwxr-xr-x  2 pengmeidong pengmeidong 4096 9月 25 15:38 Videos
pengmeidong@pengmeidong-virtual-machine:~$ rm -rf ourcall
pengmeidong@pengmeidong-virtual-machine:~$ gcc ourcall.c -o ourcall
pengmeidong@pengmeidong-virtual-machine:~$ █

```

之前失误 mkdir 了一个 ourcall 空文件夹导致报错

参考: <https://blog.csdn.net/dyzhen/article/details/49072387>

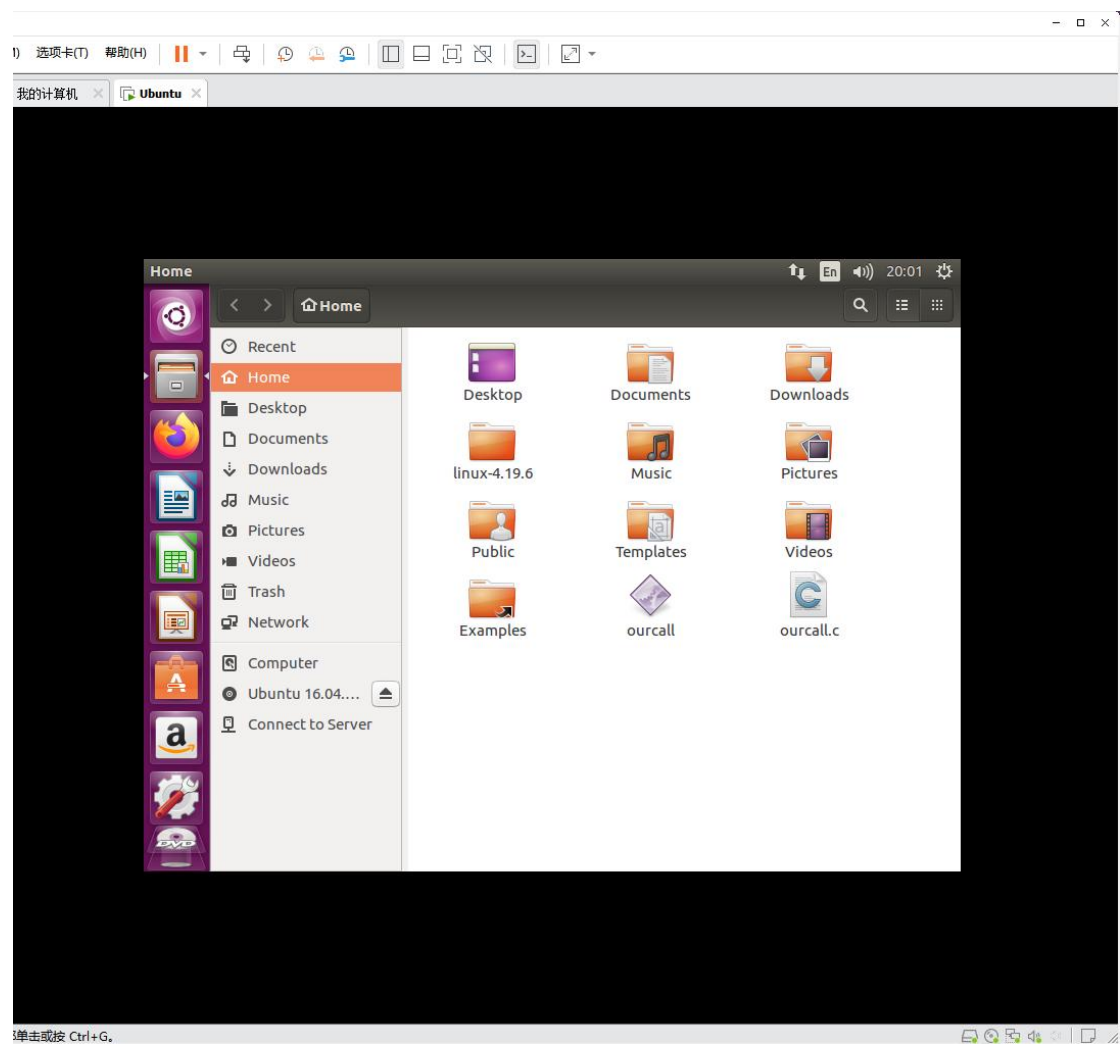
#### (9) 运行

```

pengmeidong@pengmeidong-virtual-machine:~$ ./ourcall
pengmeidong@pengmeidong-virtual-machine:~$ █

```

#### (10) 查看系统日志



单击或按 Ctrl+G。

(10) 查看系统日志

这里之前 `sudo make install` 重新安装完内核后需要重启一下，不然打印不成功日志

```

Terminal
pengmeidong@pengmeidong-virtual-machine: ~
-rwxrwxr-x 1 pengmeidong pengmeidong 8608 9月 25 20:18 ourcall
-rw-rw-r-- 1 pengmeidong pengmeidong 187 9月 25 20:18 ourcall.c
drwxr-xr-x 2 pengmeidong pengmeidong 4096 9月 25 15:38 Pictures
drwxr-xr-x 2 pengmeidong pengmeidong 4096 9月 25 15:38 Public
drwxr-xr-x 2 pengmeidong pengmeidong 4096 9月 25 15:38 Templates
drwxr-xr-x 2 pengmeidong pengmeidong 4096 9月 25 15:38 Videos
pengmeidong@pengmeidong-virtual-machine:~$ rm -rf ourcall
pengmeidong@pengmeidong-virtual-machine:~$ gcc ourcall.c -o ourcall
pengmeidong@pengmeidong-virtual-machine:~$ ./ourcall
pengmeidong@pengmeidong-virtual-machine:~$ dmesg | tail
[ 2.433858] audit: type=1400 audit(1664108772.092:10): apparmor="STATUS" operation="profile_load" profile="unconfined" name="/usr/lib/snapd/snap-confine//mount-namespace-capture-helper" pid=676 comm="apparmor_parser"
[ 2.680186] Adding 998396k swap on /dev/sda5. Priority:-2 extents:1 across:998396k FS
[ 2.927739] random: crng init done
[ 2.927740] random: 7 urandom warning(s) missed due to ratelimiting
[ 3.066044] IPv6: ADDRCONF(NETDEV_UP): ens33: link is not ready
[ 3.066390] pcnet32 0000:02:01.0 ens33: link up
[ 6.522888] ISO 9660 Extensions: Microsoft Joliet Level 3
[ 6.528679] ISO 9660 Extensions: RRIP_1991A
[ 44.348725] 210901216
[ 44.348725] pengmeidong
pengmeidong@pengmeidong-virtual-machine:~$

```

终于成功了！！耶耶耶耶耶耶耶耶耶耶耶！