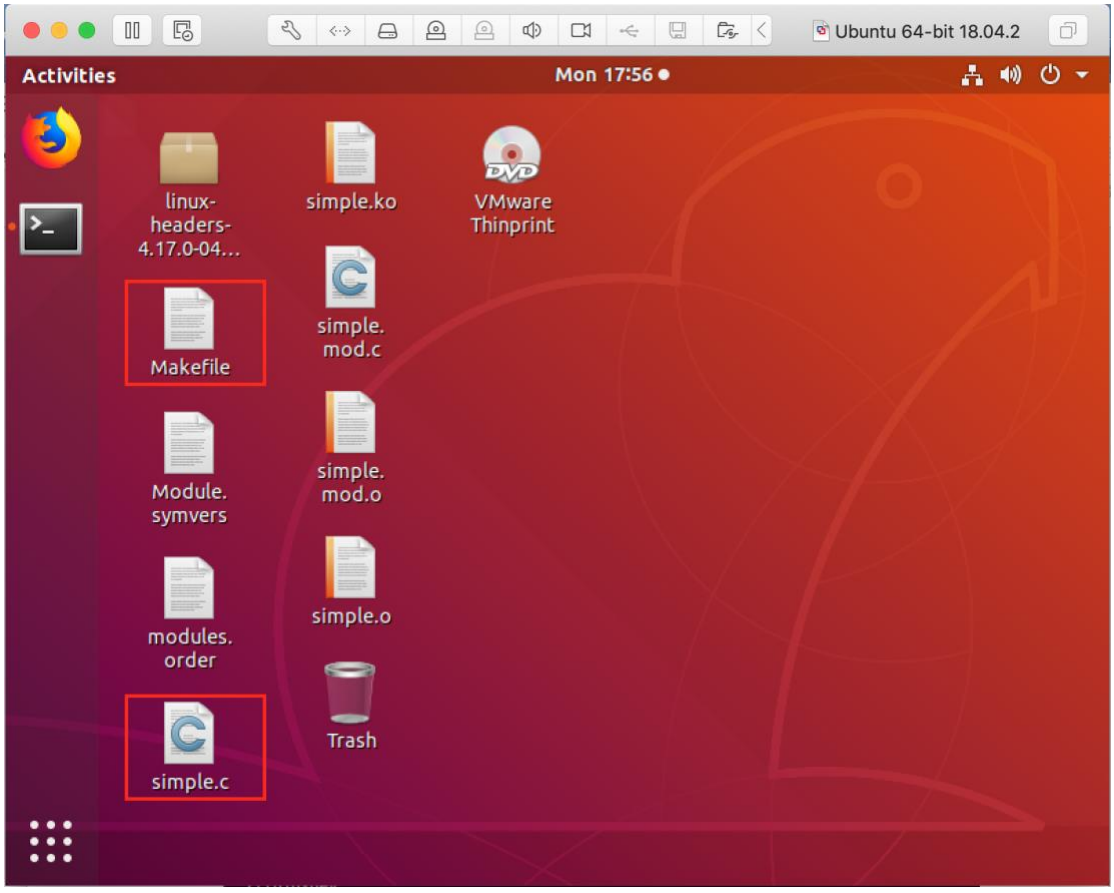
PART 1

1. 下载并安装 VMware Fusion

2. 安装 Ubuntu 虚拟机。准备好 simple.c 文件和 makefile，并拷贝至 ubuntu。



3. 安装 linux

```
xiaxi@ubuntu:~/Desktop$ sudo apt-get install linux-source
```

```
xiaxi@ubuntu:~/Desktop$ sudo apt-get install linux-headers-$(uname -r)
```

4. Make 编译

```
xiaxi@ubuntu:~/Desktop$ make
make -C /lib/modules/4.18.0-16-generic/build/ M=/home/xiaxi/Desktop modules
make[1]: Entering directory '/usr/src/linux-headers-4.18.0-16-generic'
Makefile:970: "Cannot use CONFIG_STACK_VALIDATION=y, please install libelf-dev,
 libelf-devel or elfutils-libelf-devel"
  CC [M]  /home/xiaxi/Desktop/simple.o
  Building modules, stage 2.
  MODPOST 1 modules
  CC      /home/xiaxi/Desktop/simple.mod.o
  LD [M]  /home/xiaxi/Desktop/simple.ko
make[1]: Leaving directory '/usr/src/linux-headers-4.18.0-16-generic'
xiaxi@ubuntu:~/Desktop$ sudo apt-get install libelf-dev
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  zlib1g-dev
The following NEW packages will be installed:
  libelf-dev zlib1g-dev
0 upgraded, 2 newly installed, 0 to remove and 24 not upgraded.
Need to get 233 kB of archives.
After this operation, 829 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:2 http://us.archive.ubuntu.com/ubuntu bionic/main amd64 libelf-dev amd64 0.
170-0.4 [57.2 kB]
Get:1 http://us.archive.ubuntu.com/ubuntu bionic/main amd64 zlib1g-dev amd64 1:
1.2.11.dfsg-0ubuntu2 [176 kB]
Fetched 233 kB in 21s (10.9 kB/s)
```

根据提示“Cannot use…”,缺少库文件。

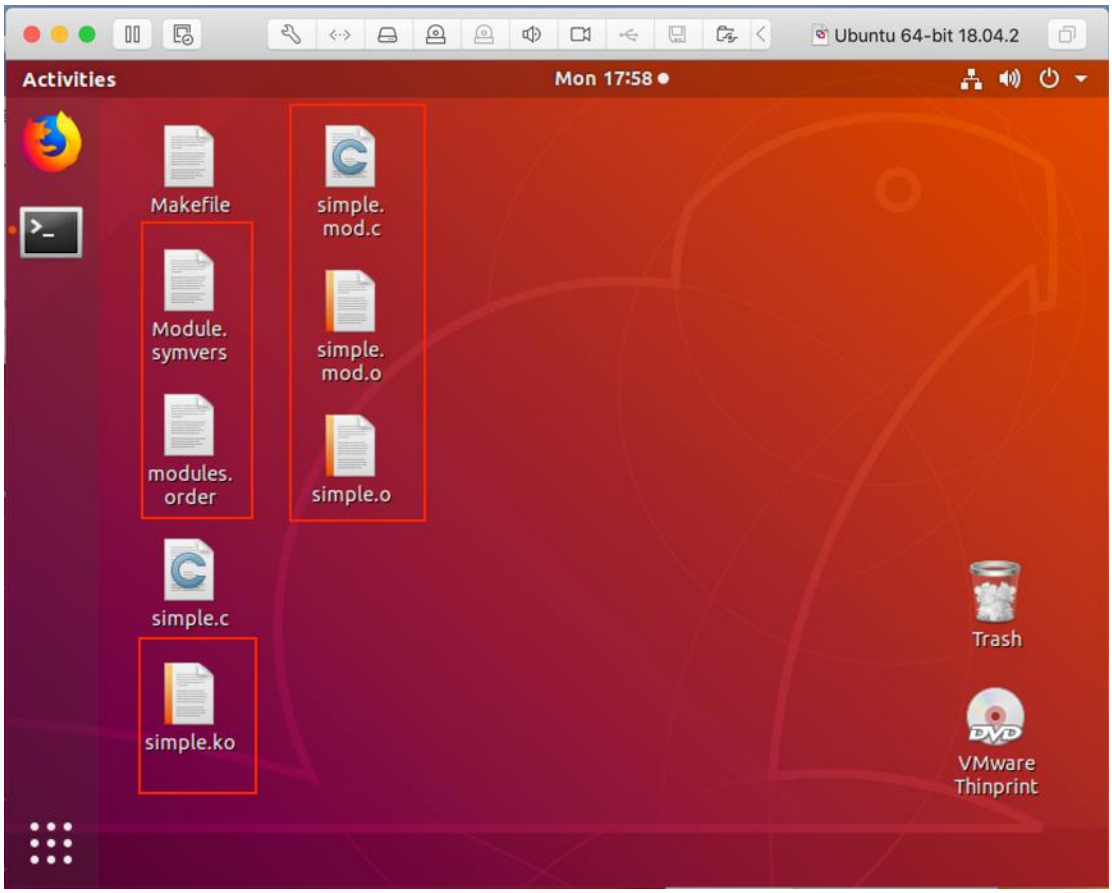
于是安装库文件，再次编译

```
1.2.11.dfsg-0ubuntu2 [176 kB]
Fetched 233 kB in 21s (10.9 kB/s)
Selecting previously unselected package zlib1g-dev:amd64.
(Reading database ... 181322 files and directories currently installed.)
Preparing to unpack .../zlib1g-dev_1%3a1.2.11.dfsg-0ubuntu2_amd64.deb ...
Unpacking zlib1g-dev:amd64 (1:1.2.11.dfsg-0ubuntu2) ...
Selecting previously unselected package libelf-dev:amd64.
Preparing to unpack .../libelf-dev_0.170-0.4_amd64.deb ...
Unpacking libelf-dev:amd64 (0.170-0.4) ...
Processing triggers for man-db (2.8.3-2ubuntu0.1) ...
Setting up zlib1g-dev:amd64 (1:1.2.11.dfsg-0ubuntu2) ...
Setting up libelf-dev:amd64 (0.170-0.4) ...
xiaxi@ubuntu:~/Desktop$ make
make -C /lib/modules/4.18.0-16-generic/build/ M=/home/xiaxi/Desktop modules
make[1]: Entering directory '/usr/src/linux-headers-4.18.0-16-generic'
  Building modules, stage 2.
  MODPOST 1 modules
make[1]: Leaving directory '/usr/src/linux-headers-4.18.0-16-generic'
```

生成文件：

Module.symvers
modules.order
simple.ko
simple.mod.c
simple.mod.o

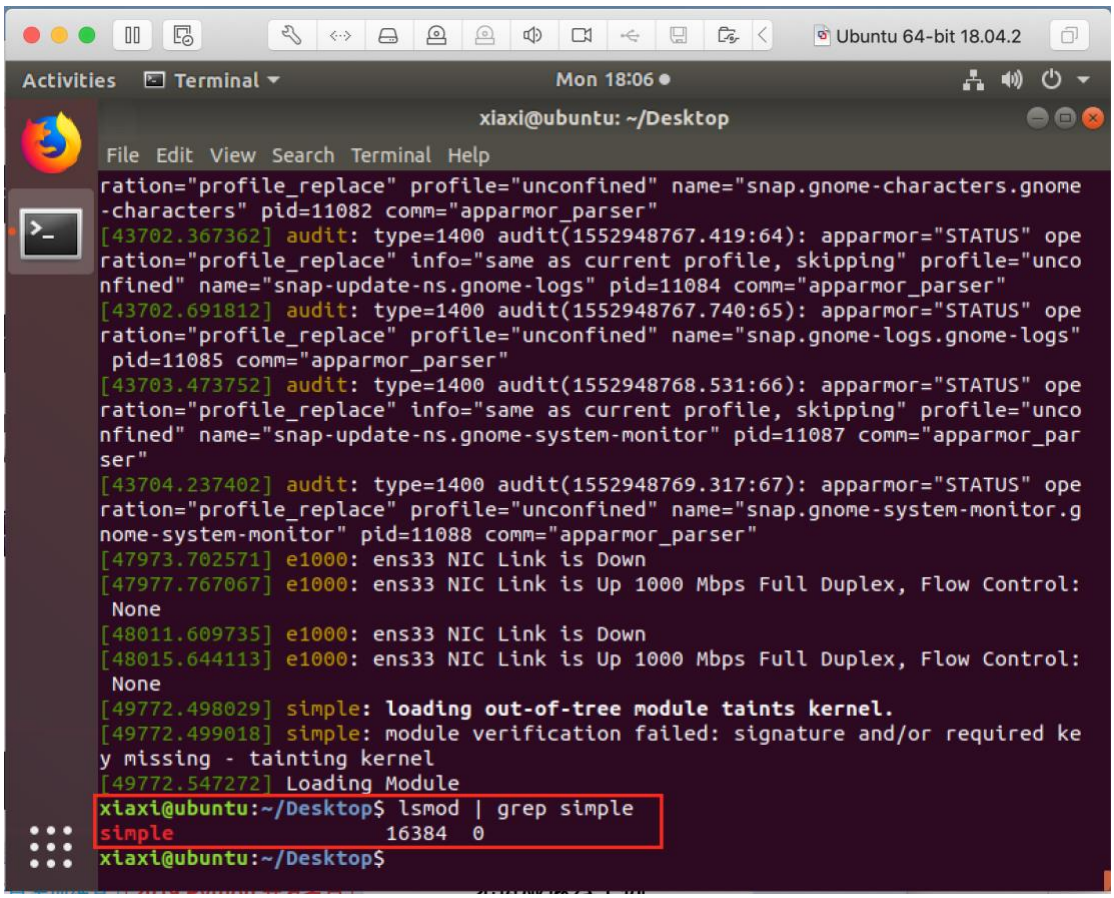
simple.o



5. 插入模块，并运行

```
xiaxi@ubuntu:~/Desktop$ sudo insmod simple.ko
xiaxi@ubuntu:~/Desktop$ dmesg
[    0.000000] Linux version 4.18.0-16-generic (buildd@lcy01-amd64-006) (gcc ve
rsion 7.3.0 (Ubuntu 7.3.0-16ubuntu3)) #17~18.04.1-Ubuntu SMP Tue Feb 12 13:35:5
1 UTC 2019 (Ubuntu 4.18.0-16.17~18.04.1-generic 4.18.20)
[    0.000000] Command line: BOOT_IMAGE=/boot/vmlinuz-4.18.0-16-generic root=UU
ID=88e3be6c-fba1-48bb-a5f2-c98e66d3d5ca ro find_preseed=/preseed.cfg auto nopro
mpt priority=critical locale=en_US quiet
[    0.000000] KERNEL supported cpus:
[    0.000000]   Intel GenuineIntel
[    0.000000]   AMD AuthenticAMD
[    0.000000]   Centaur CentaurHauls
[    0.000000] Disabled fast string operations
[    0.000000] x86/fpu: Supporting XSAVE feature 0x001: 'x87 floating point reg
isters'
[    0.000000] x86/fpu: Supporting XSAVE feature 0x002: 'SSE registers'
[    0.000000] x86/fpu: Supporting XSAVE feature 0x004: 'AVX registers'
[    0.000000] x86/fpu: xstate_offset[2]:  576, xstate_sizes[2]:  256
[    0.000000] x86/fpu: Enabled xstate features 0x7, context size is 832 bytes,
 using 'standard' format.
[    0.000000] BIOS-provided physical RAM map:
[    0.000000] BIOS-e820: [mem 0x0000000000000000-0x000000000009e7ff] usable
[    0.000000] BIOS-e820: [mem 0x000000000009e800-0x000000000009ffff] reserved
[    0.000000] BIOS-e820: [mem 0x00000000000dc000-0x00000000000fffff] reserved
[    0.000000] BIOS-e820: [mem 0x0000000000100000-0x000000007fedffff] usable
[    0.000000] BIOS-e820: [mem 0x000000007fee0000-0x000000007fefefff] ACPI data
[    0.000000] BIOS-e820: [mem 0x000000007feff000-0x000000007fefffff] ACPI NVS
```

6. 检测是否正确插入



7. 使用 rmmod 卸载模块

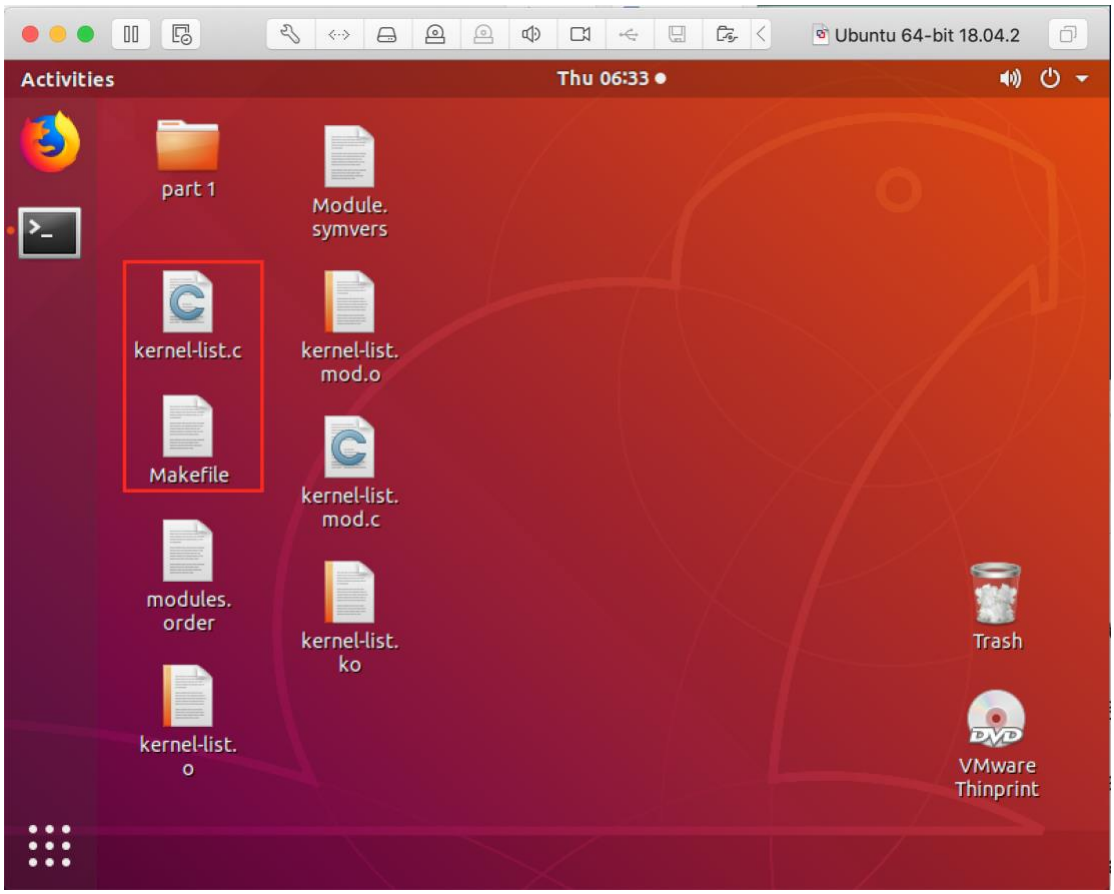
```
xiaxi@ubuntu:~/Desktop$ sudo rmmod simple
[sudo] password for xiaxi:
xiaxi@ubuntu:~/Desktop$
```

8. 检查，模块已经卸载

```
xiaxi@ubuntu:~/Desktop$ lsmod | grep simple
xiaxi@ubuntu:~/Desktop$
```

PART 2

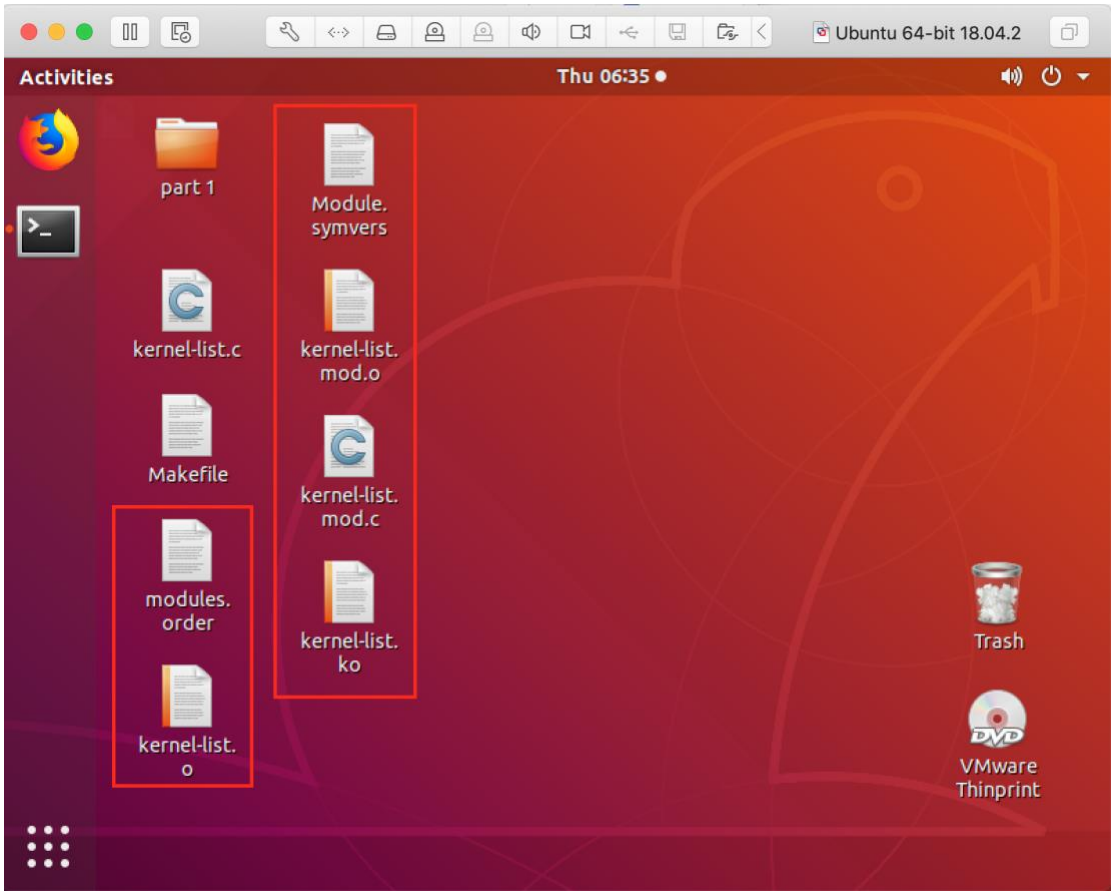
1. 准备好相关文件



2. Make 编译

```
xiaxi@ubuntu:~/Desktop$ make
```

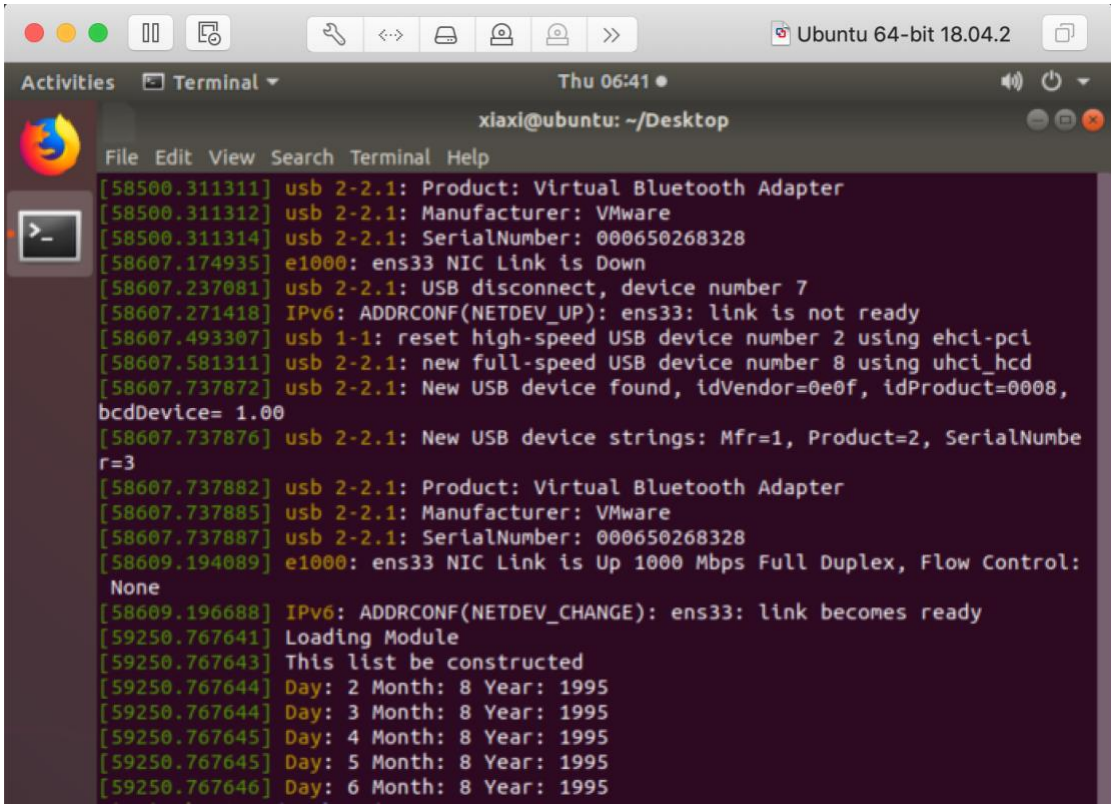
得到以下文件



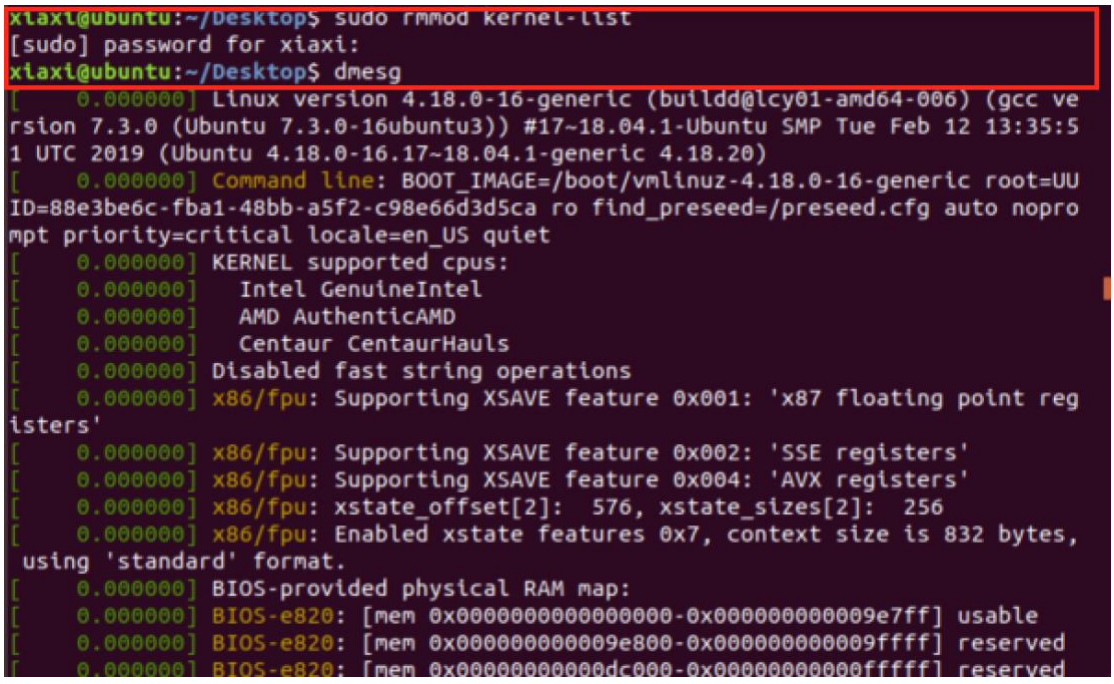
3. 插入模块

```
xiaxi@ubuntu:~/Desktop$ sudo insmod kernel-list.ko
xiaxi@ubuntu:~/Desktop$ dmesg
[    0.000000] Linux version 4.18.0-16-generic (buildd@lcy01-amd64-006) (gcc ve
rsion 7.3.0 (Ubuntu 7.3.0-16ubuntu3)) #17~18.04.1-Ubuntu SMP Tue Feb 12 13:35:5
1 UTC 2019 (Ubuntu 4.18.0-16.17~18.04.1-generic 4.18.20)
[    0.000000] Command line: BOOT_IMAGE=/boot/vmlinuz-4.18.0-16-generic root=UU
ID=88e3be6c-fba1-48bb-a5f2-c98e66d3d5ca ro find_preseed=/preseed.cfg auto nopro
mpt priority=critical locale=en_US quiet
[    0.000000] KERNEL supported cpus:
[    0.000000]   Intel GenuineIntel
[    0.000000]   AMD AuthenticAMD
[    0.000000]   Centaur CentaurHauls
[    0.000000] Disabled fast string operations
[    0.000000] x86/fpu: Supporting XSAVE feature 0x001: 'x87 floating point reg
isters'
[    0.000000] x86/fpu: Supporting XSAVE feature 0x002: 'SSE registers'
[    0.000000] x86/fpu: Supporting XSAVE feature 0x004: 'AVX registers'
[    0.000000] x86/fpu: xstate_offset[2]:  576, xstate_sizes[2]:  256
[    0.000000] x86/fpu: Enabled xstate features 0x7, context size is 832 bytes,
 using 'standard' format.
[    0.000000] BIOS-provided physical RAM map:
[    0.000000] BIOS-e820: [mem 0x0000000000000000-0x000000000009e7ff] usable
[    0.000000] BIOS-e820: [mem 0x000000000009e800-0x000000000009ffff] reserved
[    0.000000] BIOS-e820: [mem 0x00000000000dc000-0x00000000000fffff] reserved
[    0.000000] BIOS-e820: [mem 0x0000000000100000-0x000000007fedffff] usable
[    0.000000] BIOS-e820: [mem 0x000000007fee0000-0x000000007fefefff] ACPI data
[    0.000000] BIOS-e820: [mem 0x000000007feff000-0x000000007fefffff] ACPI NVS
[    0.000000] BIOS-e820: [mem 0x000000007ff00000-0x000000007fffffff] usable
```

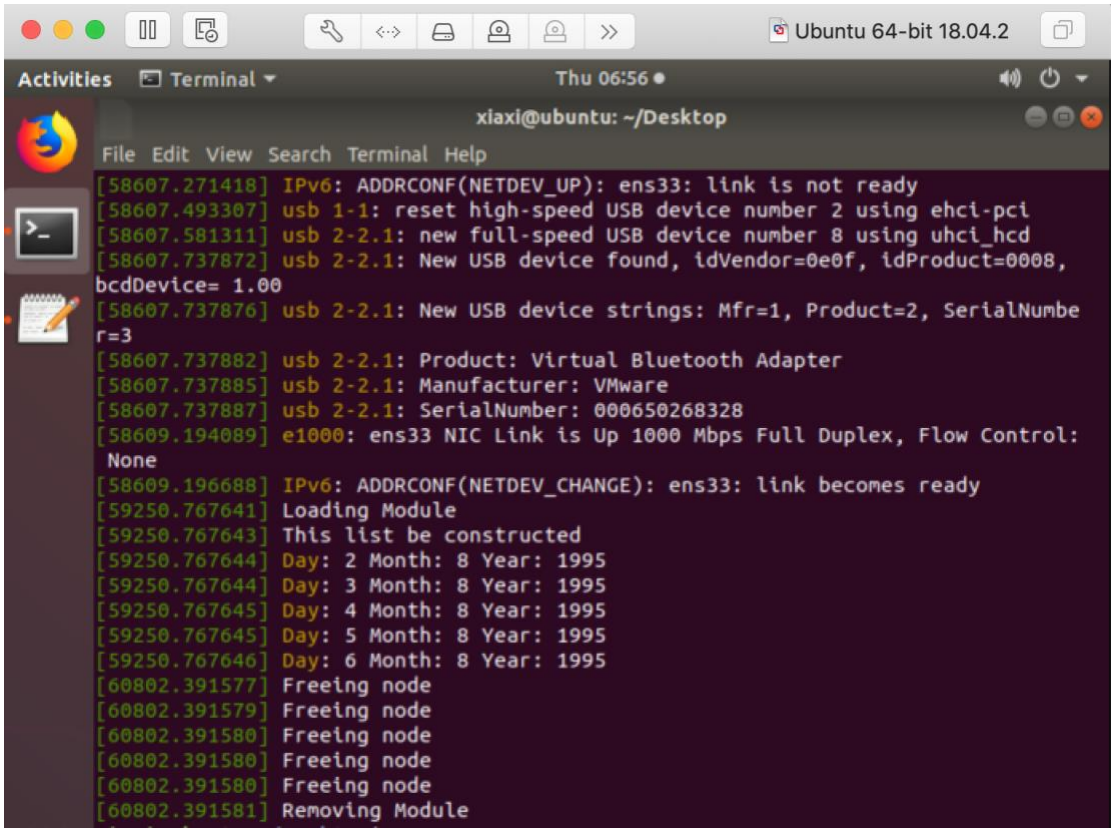
dmesg 查看



4. 删除模块



dmesg 查看


Ubuntu 64-bit 18.04.2
Activities
Terminal
Thu 06:56
xiaxi@ubuntu: ~/Desktop
File Edit View Search Terminal Help
[58607.271418] IPv6: ADDRCONF(NETDEV_UP): ens33: link is not ready
[58607.493307] usb 1-1: reset high-speed USB device number 2 using ehci-pci
[58607.581311] usb 2-2.1: new full-speed USB device number 8 using uhci_hcd
[58607.737872] usb 2-2.1: New USB device found, idVendor=0e0f, idProduct=0008, bcdDevice= 1.00
[58607.737876] usb 2-2.1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[58607.737882] usb 2-2.1: Product: Virtual Bluetooth Adapter
[58607.737885] usb 2-2.1: Manufacturer: VMware
[58607.737887] usb 2-2.1: SerialNumber: 000650268328
[58609.194089] e1000: ens33 NIC Link is Up 1000 Mbps Full Duplex, Flow Control: None
[58609.196688] IPv6: ADDRCONF(NETDEV_CHANGE): ens33: link becomes ready
[59250.767641] Loading Module
[59250.767643] This list be constructed
[59250.767644] Day: 2 Month: 8 Year: 1995
[59250.767644] Day: 3 Month: 8 Year: 1995
[59250.767645] Day: 4 Month: 8 Year: 1995
[59250.767645] Day: 5 Month: 8 Year: 1995
[59250.767646] Day: 6 Month: 8 Year: 1995
[60802.391577] Freeing node
[60802.391579] Freeing node
[60802.391580] Freeing node
[60802.391580] Freeing node
[60802.391580] Freeing node
[60802.391581] Removing Module