苏 州 大 学 实 验 报 告

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课程名称		操作系统课程实践				成绩	
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实验名称　　　　　　　　实验 6　　　Linux 内核编译

一. 实验目的

1. 学习重新编译 Linux 内核的方法。
2. 理解 Linux 标准内核和发行版本内核的区别。

二. 实验内容

　　　　在 Linux 系统中下载同一发行版本的版本号较高的内核，编译之后运行自己编译的内核，并使用 uname -r 命令查看是否运行成功。

　　　　由于不同版本的内核在编译过程中可能出现不同的问题，本书推荐的内核版本为 4.16.10。从第 7 章开始的进阶实验篇，都可以选用该版本的内核。

三. 操作方法和实验步骤

（1）查看内核版本

　　　　使用 uname -r 命令查看内核版本。

（2）下载内核

　　　　既可以通过 Linux 官方网站下载内核，也可以通过国内的某些网站进行下载。

　　　　推荐内核版本：linux-4.16.10。下载后的压缩包：linux-4.16.10.tar.gz。

（3）解压

　　　　将压缩包解压到/usr/src 目录下，使用如下命令：

```
# tar xf linux-4.16.10.tar.gz -C /usr/src
```

　　　　解压完成后跳转至/usr/src 目录，利用 ls 命令查看是否解压成功。

（4）配置内核

```
# make menuconfig
```

　　　　执行以上命令后，便可以图形化配置哪些功能需要直接编译进内核，哪些功能需要编译成模块，哪些功能不需要编译。随后保存对应的配置文件。

　　　　对于每个配置选项，可以通过<Select>来对其进行选择：<*>或[*]表示将该功能编译进内核；[ ]表示不将该功能编译进内核；[M]表示将该功能编译成可以在需要时动态插入内核的模块。

　　　　说明：从此处开始，如果出现缺包错误，那么需要按照错误提示安装所需要的包。例如，ncurses 库可使用命令 apt-get install ncurses-devel 安装所需要的包。

（5）编译内核

```
# make -jn
```

　　　　利用 make 命令开始编译内核。为了提高编译速度，可以使用-j 选项进行多线程处理。在一台双核的机器上，可以使用 make -j4 使 make 最多允许 4 条编译命令同时执行，从而更有效地利用 CPU 资源。在一台 4 核的机器上，可以使用 make -j8 使 make 最多允许 8 条编译命令同时执行。

　　　　同样，如果出现缺包错误，那么需要安装所缺的包，比如 openssl（apt-get install openssl）和 libssl-

dev（apt-get install libssl-dev）。

（6）编译和安装模块

```
# make modules
# make modules_install
```

同样，可以使用-j选项进行多线程处理。例如：

```
# make modules -j8
```

（7）安装内核

```
# make install
```
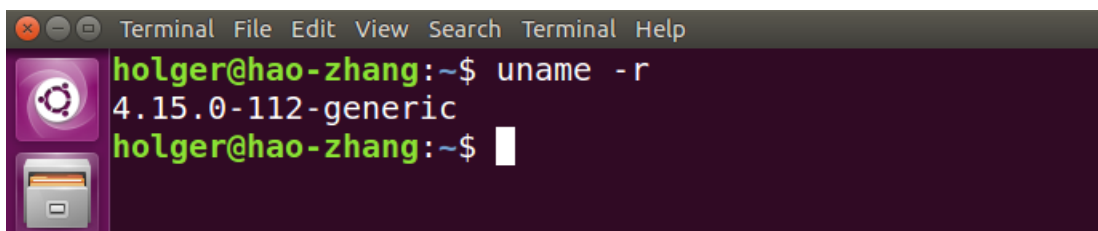
（8）重新启动，检查新内核

```
# reboot
```

重启 Linux 以开启新的内核。注意：有可能出现短暂死机的情况，可以多等待一些时间。

使用以下命令可以再次查看内核版本，并检查内核是否安装成功。

```
# uname -r
```

四. 实验结果和分析

（1）查看内核版本：uname -r 命令执行的结果为 4.15.0-112-generic：

此时的内核版本为 4.15.0。

（2）下载内核：通过上海交通大学镜像站下载 4.16.10 版本的内核源码。

使用如下命令下载：

```
$ wget http://ftp.sjtu.edu.cn/sites/ftp.kernel.org/pub/linux/kernel/v4.x/linux-4.16.10.tar.gz
```

下载后的压缩包：linux-4.16.10.tar.gz。

（3）解压

将压缩包解压到/usr/src 目录下，使用如下命令：

```
# tar -xzf linux-4.16.10.tar.gz -C /usr/src
```

解压完成后跳转至/usr/src 目录，利用 ls 命令查看是否解压成功：

教务处制

（4）配置内核

```
# cd /usr/src/linux-4.16.10
# make menuconfig
```

```
root@hao-zhang:/usr/src# cd /usr/src/linux-4.16.10/
root@hao-zhang:/usr/src/linux-4.16.10# make menuconfig
  HOSTCC  scripts/basic/fixdep
 *** Unable to find the ncurses libraries or the
 *** required header files.
 521 MB Volume menuconfig' requires the ncurses libraries.
 ***
 *** Install ncurses (ncurses-devel or libncurses-dev
 *** depending on your distribution) and try again.
 ***
scripts/kconfig/Makefile:206: recipe for target 'scripts/kconfig/dochecklxdialog' failed
make[1]: *** [scripts/kconfig/dochecklxdialog] Error 1
Makefile:514: recipe for target 'menuconfig' failed
make: *** [menuconfig] Error 2
root@hao-zhang:/usr/src/linux-4.16.10#
```

出现错误：缺少 ncurses，使用 apt 安装 ncurses。

（根据提示信息，通过安装 libncurses-dev 包来安装 ncurses）

```
root@hao-zhang:/usr/src/linux-4.16.10# apt install ncurses-devel -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
E: Unable to locate package ncurses-devel
root@hao-zhang:/usr/src/linux-4.16.10# apt install libncurses-dev -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
Note, selecting 'libncurses5-dev' instead of 'libncurses-dev'
The following additional packages will be installed:
  libtinfo-dev
Suggested packages:
  ncurses-doc
The following NEW packages will be installed:
  libncurses5-dev libtinfo-dev
0 upgraded, 2 newly installed, 0 to remove and 186 not upgraded.
Need to get 252 kB of archives.
After this operation, 1,461 kB of additional disk space will be used.
Get:1 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 libtinfo-dev amd64 6.0+20160213-1ubuntu1 [77.4 kB]
Get:2 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 libncurses5-dev amd64 6.0+20160213-1ubuntu1 [175 kB]
Fetched 252 kB in 2s (95.6 kB/s)
Selecting previously unselected package libtinfo-dev:amd64.
(Reading database ... 184123 files and directories currently installed.)
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) ...
Processing triggers for man-db (2.7.5-1) ...
Setting up libtinfo-dev:amd64 (6.0+20160213-1ubuntu1) ...
Setting up libncurses5-dev:amd64 (6.0+20160213-1ubuntu1) ...
root@hao-zhang:/usr/src/linux-4.16.10#
```

重新执行 make menuconfig 命令，发现报错：缺少 bison 这个包，同样使用 apt 安装。

```
root@hao-zhang:/usr/src/linux-4.16.10# make menuconfig
  HOSTCC  scripts/kconfig/mconf.o
  YACC    scripts/kconfig/zconf.tab.c
/bin/sh: 1: bison: not found
scripts/Makefile.lib:217: recipe for target 'scripts/kconfig/zconf.tab.c' failed
make[1]: *** [scripts/kconfig/zconf.tab.c] Error 127
Makefile:514: recipe for target 'menuconfig' failed
make: *** [menuconfig] Error 2
```

```
root@hao-zhang:/usr/src/linux-4.16.10# apt install bison -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  libbison-dev libsigsegv2 m4
Suggested packages:
  bison-doc
The following NEW packages will be installed:
  bison libbison-dev libsigsegv2 m4
0 upgraded, 4 newly installed, 0 to remove and 186 not upgraded.
```

教务处制

```
Need to get 806 kB of archives.
After this operation, 2,204 kB of additional disk space will be used.
Get:1 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 libsigsegv2 amd64 2.10-4 [14.1 kB]
Get:2 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 m4 amd64 1.4.17-5 [195 kB]
Get:3 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 libbison-dev amd64 2:3.0.4.dfsg-1 [338 kB]
Get:4 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 bison amd64 2:3.0.4.dfsg-1 [259 kB]
Fetched 806 kB in 4s (181 kB/s)
Selecting previously unselected package libsigsegv2:amd64.
(Reading database ... 184172 files and directories currently installed.)
Preparing to unpack .../libsigsegv2_2.10-4_amd64.deb ...
Unpacking libsigsegv2:amd64 (2.10-4) ...
Selecting previously unselected package m4.
Preparing to unpack .../archives/m4_1.4.17-5_amd64.deb ...
Unpacking m4 (1.4.17-5) ...
Selecting previously unselected package libbison-dev:amd64.
Preparing to unpack .../libbison-dev_2%3a3.0.4.dfsg-1_amd64.deb ...
Unpacking libbison-dev:amd64 (2:3.0.4.dfsg-1) ...
Selecting previously unselected package bison.
Preparing to unpack .../bison_2%3a3.0.4.dfsg-1_amd64.deb ...
Unpacking bison (2:3.0.4.dfsg-1) ...
Processing triggers for install-info (6.1.0.dfsg.1-5) ...
Processing triggers for man-db (2.7.5-1) ...
Setting up libsigsegv2:amd64 (2.10-4) ...
Setting up m4 (1.4.17-5) ...
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
Processing triggers for libc-bin (2.23-0ubuntu11.2) ...
root@hao-zhang:/usr/src/linux-4.16.10#
```
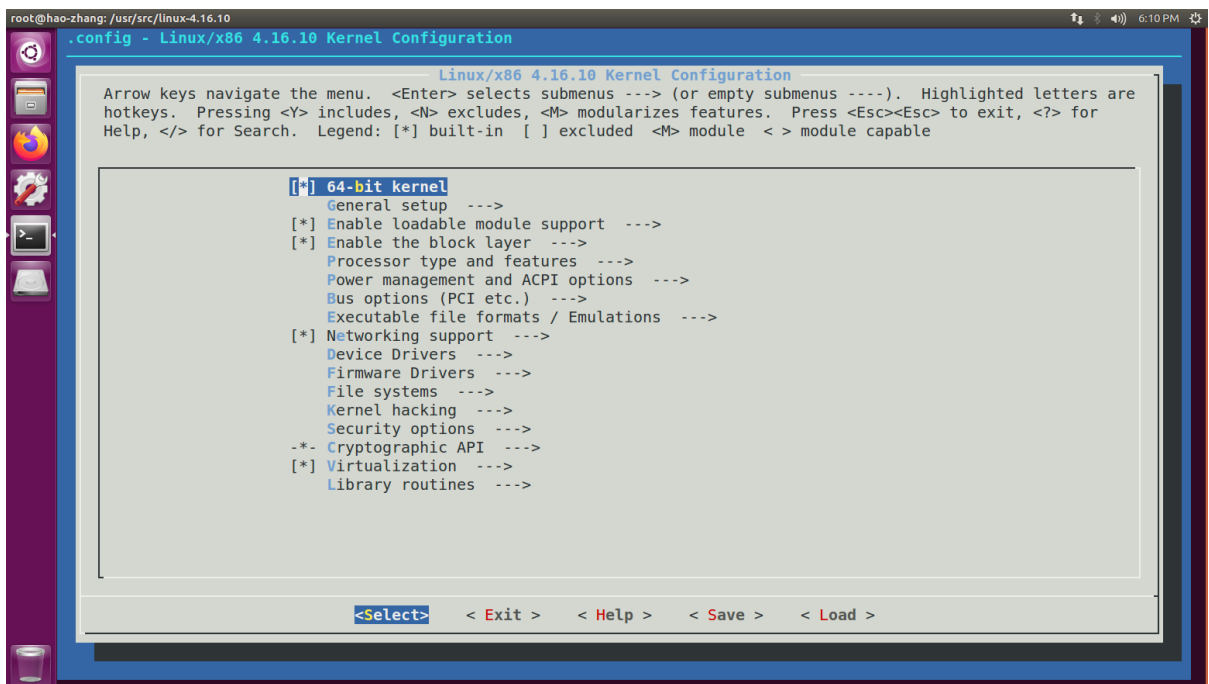
再次执行 make menuconfig 命令，缺少 flex，使用 apt 安装 flex。

```
root@hao-zhang:/usr/src/linux-4.16.10# make menuconfig
  YACC    scripts/kconfig/zconf.tab.c
  LEX     scripts/kconfig/zconf.lex.c
/bin/sh: 1: flex: not found
scripts/Makefile.lib:202: recipe for target 'scripts/kconfig/zconf.lex.c' failed
make[1]: *** [scripts/kconfig/zconf.lex.c] Error 127
Makefile:514: recipe for target 'menuconfig' failed
make: *** [menuconfig] Error 2
root@hao-zhang:/usr/src/linux-4.16.10# apt install flex -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  libfl-dev
The following NEW packages will be installed:
  flex libfl-dev
0 upgraded, 2 newly installed, 0 to remove and 186 not upgraded.
Need to get 302 kB of archives.
After this operation, 897 kB of additional disk space will be used.
Get:1 http://us.archive.ubuntu.com/ubuntu xenial/main amd64 libfl-dev amd64 2.6.0-11 [12.5 kB]
```
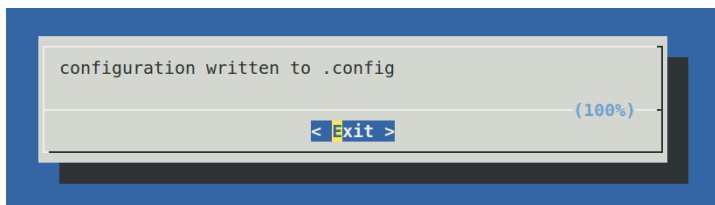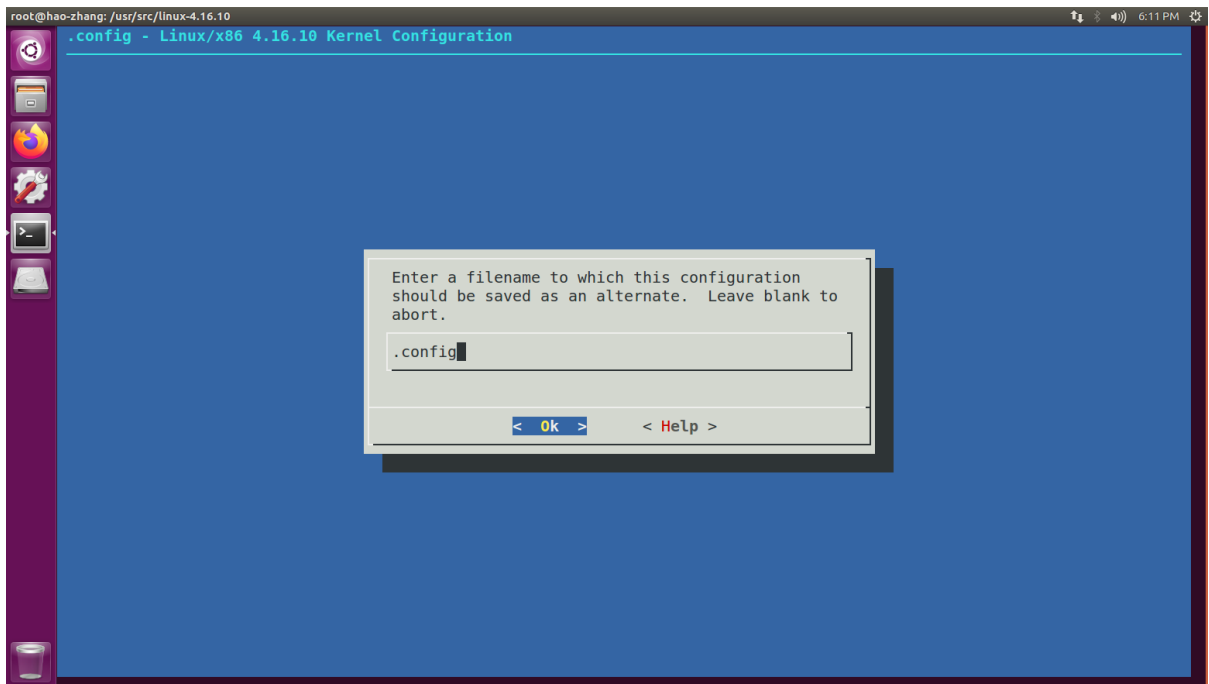
继续尝试执行 make menuconfig

图形化配置哪些功能需要直接编译进内核，哪些功能需要编译成模块，哪些功能不需要编译。

教务处制

随后保存对应的配置文件。

```
root@hao-zhang: /usr/src/linux-4.16.10                                    ↑↓ ⚙ ◀)) 6:11 PM ⚙
.config - Linux/x86 4.16.10 Kernel Configuration

                    ┌──────────────────────────────────────────────────┐
                    │ Enter a filename to which this configuration     │
                    │ should be saved as an alternate.  Leave blank to │
                    │ abort.                                           │
                    │ .config                                          │
                    │                                                  │
                    │                                                  │
                    │           <  Ok  >        < Help >               │
                    └──────────────────────────────────────────────────┘
```

```
configuration written to .config

                                                    (100%)
              < Exit >
```

```
*** End of the configuration.
*** Execute 'make' to start the build or try 'make help'.

root@hao-zhang:/usr/src/linux-4.16.10#
```

（5）编译内核

```
    # make -j8
```

利用 make 命令开始编译内核。为了提高编译速度，使用-j 选项进行多线程处理。虚拟机分配了四个 CPU 核心，使用 make -j8 使使 make 最多允许 8 条编译命令同时执行。

```
root@hao-zhang:/usr/src/linux-4.16.10# make -j8
  HOSTCC  scripts/kconfig/conf.o
  HOSTLD  scripts/kconfig/conf
scripts/kconfig/conf  --silentoldconfig Kconfig
Makefile:976: "Cannot use CONFIG_STACK_VALIDATION=y, please install libelf-dev, libelf-devel or elfutils-libelf-devel"
  HOSTCC  scripts/basic/bin2c
  CHK     include/config/kernel.release
  SYSHDR  arch/x86/include/generated/asm/unistd_32_ia32.h
  SYSTBL  arch/x86/include/generated/asm/syscalls_32.h
  SYSTBL  arch/x86/include/generated/asm/syscalls_64.h
```

出现错误：缺少 openssl

```
  HOSTCC  scripts/sign-file
  HOSTCC  scripts/extract-cert
scripts/sign-file.c:25:30: fatal error: openssl/opensslv.h: No such file or directory
compilation terminated.
scripts/Makefile.host:90: recipe for target 'scripts/sign-file' failed
make[1]: *** [scripts/sign-file] Error 1
make[1]: *** Waiting for unfinished jobs....
scripts/extract-cert.c:21:25: fatal error: openssl/bio.h: No such file or directory
compilation terminated.
scripts/Makefile.host:90: recipe for target 'scripts/extract-cert' failed
make[1]: *** [scripts/extract-cert] Error 1
Makefile:566: recipe for target 'scripts' failed
make: *** [scripts] Error 2
make: *** Waiting for unfinished jobs....
root@hao-zhang:/usr/src/linux-4.16.10#
```

教务处制

使用 apt install openssl 安装 openssl：

```
root@hao-zhang:/usr/src/linux-4.16.10# apt install openssl
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages will be upgraded:
  openssl
1 upgraded, 0 newly installed, 0 to remove and 185 not upgraded.
Need to get 0 B/492 kB of archives.
After this operation, 0 B of additional disk space will be used.
(Reading database ... 184384 files and directories currently installed.)
Preparing to unpack .../openssl_1.0.2g-1ubuntu4.20_amd64.deb ...
Unpacking openssl (1.0.2g-1ubuntu4.20) over (1.0.2g-1ubuntu4.16) ...
Processing triggers for man-db (2.7.5-1) ...
Setting up openssl (1.0.2g-1ubuntu4.20) ...
root@hao-zhang:/usr/src/linux-4.16.10#
```

重新编译内核：

```
root@hao-zhang:/usr/src/linux-4.16.10# make -j8
Makefile:976: "Cannot use CONFIG_STACK_VALIDATION=y, please install libelf-dev, libelf-devel or elfutils-libelf-devel"
  CHK     include/config/kernel.release
  CHK     include/generated/uapi/linux/version.h
  CHK     include/generated/utsrelease.h
  HOSTCC  scripts/sign-file
  HOSTCC  scripts/extract-cert
  HOSTCC  scripts/insert-sys-cert
  CHK     scripts/mod/devicetable-offsets.h
scripts/extract-cert.c:21:25: fatal error: openssl/bio.h: No such file or directory
compilation terminated.
scripts/Makefile.host:90: recipe for target 'scripts/extract-cert' failed
make[1]: *** [scripts/extract-cert] Error 1
make[1]: *** Waiting for unfinished jobs....
scripts/sign-file.c:25:30: fatal error: openssl/opensslv.h: No such file or directory
compilation terminated.
scripts/Makefile.host:90: recipe for target 'scripts/sign-file' failed
make[1]: *** [scripts/sign-file] Error 1
Makefile:566: recipe for target 'scripts' failed
make: *** [scripts] Error 2
root@hao-zhang:/usr/src/linux-4.16.10#
```

问题依然存在，尝试安装 libssl-dev，并安装提示中的 libelf-dev。（apt install libssl-dev libelf-dev）

```
root@hao-zhang:/usr/src/linux-4.16.10# apt install libssl-dev libelf-dev -y
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  libssl-doc libssl1.0.0 zlib1g-dev
The following NEW packages will be installed:
  libelf-dev libssl-dev libssl-doc zlib1g-dev
The following packages will be upgraded:
  libssl1.0.0
1 upgraded, 4 newly installed, 0 to remove and 184 not upgraded.
Need to get 2,646 kB/3,728 kB of archives.
After this operation, 10.9 MB of additional disk space will be used.
Get:1 http://us.archive.ubuntu.com/ubuntu xenial-updates/main amd64 libelf-dev amd64 0.165-3ubuntu1.2 [54.5 kB]
Get:2 http://us.archive.ubuntu.com/ubuntu xenial-updates/main amd64 zlib1g-dev amd64 1:1.2.8.dfsg-2ubuntu4.3 [167 kB]
Get:3 http://us.archive.ubuntu.com/ubuntu xenial-updates/main amd64 libssl-dev amd64 1.0.2g-1ubuntu4.20 [1,347 kB]
Get:4 http://us.archive.ubuntu.com/ubuntu xenial-updates/main amd64 libssl-doc all 1.0.2g-1ubuntu4.20 [1,077 kB]
Fetched 2,646 kB in 11s (232 kB/s)
Preconfiguring packages ...
(Reading database ... 184384 files and directories currently installed.)
```

再次编译：

```
  LD [M]  sound/synth/emux/snd-emux-synth.ko
  LD [M]  sound/synth/snd-util-mem.ko
  LD [M]  sound/usb/6fire/snd-usb-6fire.ko
  LD [M]  sound/usb/bcd2000/snd-bcd2000.ko
  LD [M]  sound/usb/caiaq/snd-usb-caiaq.ko
  LD [M]  sound/usb/hiface/snd-usb-hiface.ko
  LD [M]  sound/usb/line6/snd-usb-line6.ko
  LD [M]  sound/usb/line6/snd-usb-pod.ko
  LD [M]  sound/usb/line6/snd-usb-podhd.ko
  LD [M]  sound/usb/line6/snd-usb-toneport.ko
  LD [M]  sound/usb/line6/snd-usb-variax.ko
  LD [M]  sound/usb/misc/snd-ua101.ko
  LD [M]  sound/usb/snd-usb-audio.ko
  LD [M]  sound/usb/snd-usbmidi-lib.ko
  LD [M]  sound/usb/usx2y/snd-usb-us122l.ko
  LD [M]  sound/usb/usx2y/snd-usb-usx2y.ko
  LD [M]  sound/x86/snd-hdmi-lpe-audio.ko
  LD [M]  virt/lib/irqbypass.ko
root@hao-zhang:/usr/src/linux-4.16.10#
```

教务处制

这次编译成功。

（6）编译和安装模块

```
# make modules -j8

# make modules_install
```

```
root@hao-zhang:/usr/src/linux-4.16.10# make modules -j8
  CHK     include/config/kernel.release
  CHK     include/generated/uapi/linux/version.h
  DESCEND  objtool
  CHK     include/generated/utsrelease.h
  CHK     scripts/mod/devicetable-offsets.h
  CHK     include/generated/bounds.h
  CHK     include/generated/timeconst.h
  CHK     include/generated/asm-offsets.h
  CALL    scripts/checksyscalls.sh
  LD [M]  drivers/media/pci/saa7164/saa7164.o
  LD [M]  drivers/scsi/libsas/libsas.o
  LD [M]  drivers/video/fbdev/intelfb/intelfb.o
  LD [M]  drivers/usb/host/whci/whci-hcd.o
  Building modules, stage 2.
  MODPOST 5127 modules
  LD [M]  drivers/media/pci/saa7164/saa7164.ko
  LD [M]  drivers/scsi/libsas/libsas.ko
  LD [M]  drivers/usb/host/whci/whci-hcd.ko
  LD [M]  drivers/video/fbdev/intelfb/intelfb.ko
root@hao-zhang:/usr/src/linux-4.16.10#
```

```
  INSTALL sound/soundcore.ko
  INSTALL sound/synth/emux/snd-emux-synth.ko
  INSTALL sound/synth/snd-util-mem.ko
  INSTALL sound/usb/6fire/snd-usb-6fire.ko
  INSTALL sound/usb/bcd2000/snd-bcd2000.ko
  INSTALL sound/usb/caiaq/snd-usb-caiaq.ko
  INSTALL sound/usb/hiface/snd-usb-hiface.ko
  INSTALL sound/usb/line6/snd-usb-line6.ko
  INSTALL sound/usb/line6/snd-usb-pod.ko
  INSTALL sound/usb/line6/snd-usb-podhd.ko
  INSTALL sound/usb/line6/snd-usb-toneport.ko
  INSTALL sound/usb/line6/snd-usb-variax.ko
  INSTALL sound/usb/misc/snd-ua101.ko
  INSTALL sound/usb/snd-usb-audio.ko
  INSTALL sound/usb/snd-usbmidi-lib.ko
  INSTALL sound/usb/usx2y/snd-usb-us122l.ko
  INSTALL sound/usb/usx2y/snd-usb-usx2y.ko
  INSTALL sound/x86/snd-hdmi-lpe-audio.ko
  INSTALL virt/lib/irqbypass.ko
  DEPMOD  4.16.10
root@hao-zhang:/usr/src/linux-4.16.10#
```

（7）安装内核

```
# make install
```

```
root@hao-zhang:/usr/src/linux-4.16.10# make install
sh ./arch/x86/boot/install.sh 4.16.10 arch/x86/boot/bzImage \
       System.map "/boot"
run-parts: executing /etc/kernel/postinst.d/apt-auto-removal 4.16.10 /boot/vmlinuz-4.16.10
run-parts: executing /etc/kernel/postinst.d/initramfs-tools 4.16.10 /boot/vmlinuz-4.16.10
update-initramfs: Generating /boot/initrd.img-4.16.10
run-parts: executing /etc/kernel/postinst.d/pm-utils 4.16.10 /boot/vmlinuz-4.16.10
run-parts: executing /etc/kernel/postinst.d/unattended-upgrades 4.16.10 /boot/vmlinuz-4.16.10
run-parts: executing /etc/kernel/postinst.d/update-notifier 4.16.10 /boot/vmlinuz-4.16.10
run-parts: executing /etc/kernel/postinst.d/zz-update-grub 4.16.10 /boot/vmlinuz-4.16.10
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-4.16.10
Found initrd image: /boot/initrd.img-4.16.10
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
root@hao-zhang:/usr/src/linux-4.16.10#
```

教务处制

（8）重新启动，检查新内核

```
# reboot
```

成功启动，使用以下命令查看内核版本：

```
$ uname -r
```

```
holger@hao-zhang:~$ uname -r
4.16.10
holger@hao-zhang:~$
```

此时的内核版本为 4.16.10。

五. 讨论、心得

1. 通过本次实验，我了解了手动编译 Linux 内核的方法，理解了 Linux 标准内核和发行版本内核的区别。编译过程中遇到的问题可以根据报错信息来解决，同样可以使用搜索工具查找原因与解决办法。

2. 在编译过程中，系统会报缺少组件的错误，需要按照错误提示安装对应的包，也可以根据经验预先安装编译内核所需的包。

3. 编译前一定要注意留出足够的磁盘空间，否则会出现"磁盘空间不足"的错误。

4. 根据编译的流程，我总结了一个适用于内核版本为 4.16.10 的编译脚本如下：

```bash
###############################################################
# File Name: build_kernel_4.16.10.sh
# Author: Zhang Hao
# mail: HolgerZhang@outlook.com
# Created Time:  5/ 6 21:39:20 2022
# !!RUN THIS SCRIPT AS ROOT!!
###############################################################
#!/bin/bash

# Check kernel version
ver1=`uname -r | cut -d '.' -f1`
ver2=`uname -r | cut -d '.' -f2`
ver3=`uname -r | cut -d '.' -f3`
if [ $ver1 != 4 ]; then
    echo "Kernel version not matches!"
    exit
fi
if [ $ver2 = 16 ]; then
    if [ $ver3 -ge 10 ]; then
        echo "Kernel version not matches!"
        exit
    fi
elif [ $ver2 -gt 16 ]; then
    echo "Kernel version not matches!"
    exit
```

```
fi

# Install packages
apt update || exit
apt install wget build-essential libncurses-dev bison flex \
            openssl libssl-dev libelf-dev -y || exit

# Download linux-4.16.10
if [ -e /usr/src/linux-4.16.10/ ]; then
    rm -rf /usr/src/linux-4.16.10
fi
cd /tmp || exit
wget http://ftp.sjtu.edu.cn/sites/ftp.kernel.org/pub/linux/kernel\
    /v4.x/linux-4.16.10.tar.gz || exit
tar -xzf linux-4.16.10.tar.gz -C /usr/src || exit

# Config and build
cd /usr/src/linux-4.16.10 || exit
make menuconfig || exit
make -j || exit
make modules -j || exit
make modules_install || exit
make install || exit

echo "Kernel built finished! Please reboot."
```

教务处制