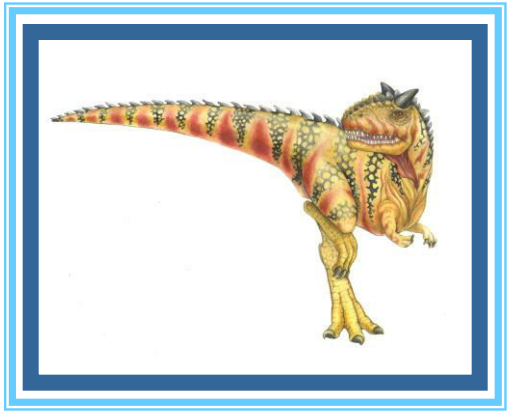
# Project 1 Tutorial

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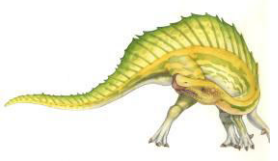
# Common commands

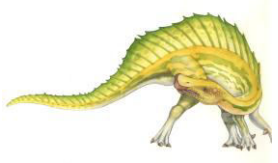
- cd: change directory
- make: compile the source code using the accompany Makefile
- sudo: using the root permission
- rm: remove files
- ls: list the files in the current directory
- ……

- The 10 Most Important Linux Commands
- 50 Most Frequently Used UNIX / Linux Commands (With Examples)



# Part I

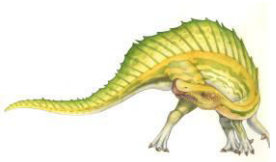
- Create, load, unload a kernel module



# Listing Kernel Modules

- lsmod: list all kernel modules that are currently loaded

```
zhisheng@zhisheng-ubuntu: ~
File  Edit  View  Terminal  Help
zhisheng@zhisheng-ubuntu:~$ lsmod
Module                  Size  Used by
binfmt_misc             6523  1
snd_intel8x0           25652  2
snd_ac97_codec        100646  1 snd_intel8x0
ac97_bus                1002  1 snd_ac97_codec
snd_pcm_oss            35308  0
snd_mixer_oss          13746  1 snd_pcm_oss
snd_pcm                70918  3 snd_intel8x0,snd_ac97_codec,snd_pcm_oss
snd_seq_dummy           1338  0
snd_seq_oss            26722  0
snd_seq_midi            4557  0
snd_rawmidi            19056  1 snd_seq_midi
snd_seq_midi_event      6003  2 snd_seq_oss,snd_seq_midi
snd_seq                47295  6 snd_seq_dummy,snd_seq_oss,snd_seq_midi,snd_seq_m
idi_event
snd_timer              19130  2 snd_pcm,snd_seq
snd_seq_device          5700  5 snd_seq_dummy,snd_seq_oss,snd_seq_midi,snd_rawmi
di,snd_seq
ppdev                   5259  0
fbcon                  35102  71
tileblit                1999  1 fbcon
font                    7557  1 fbcon
bitblit                 4707  1 fbcon
```



# A Simple Kernel Module

simple.c (~/Desktop/4320) - gedit

File Edit View Search Tools Documents Help

Open Save Undo

simple.c

```
#include <linux/init.h>
#include <linux/module.h>
#include <linux/kernel.h>
/* This function is called when the module is loaded. */
int simple_init(void)
{
printk(KERN_INFO "Loading Module\n");
return 0;
}
/* This function is called when the module is removed. */
void simple_exit(void) {
printk(KERN_INFO "Removing Module\n");
}
/* Macros for registering module entry and exit points. */
module_init( simple_init );
module_exit( simple_exit );
MODULE_LICENSE("GPL");
MODULE_DESCRIPTION("Simple Module");
MODULE_AUTHOR("SGG");
```

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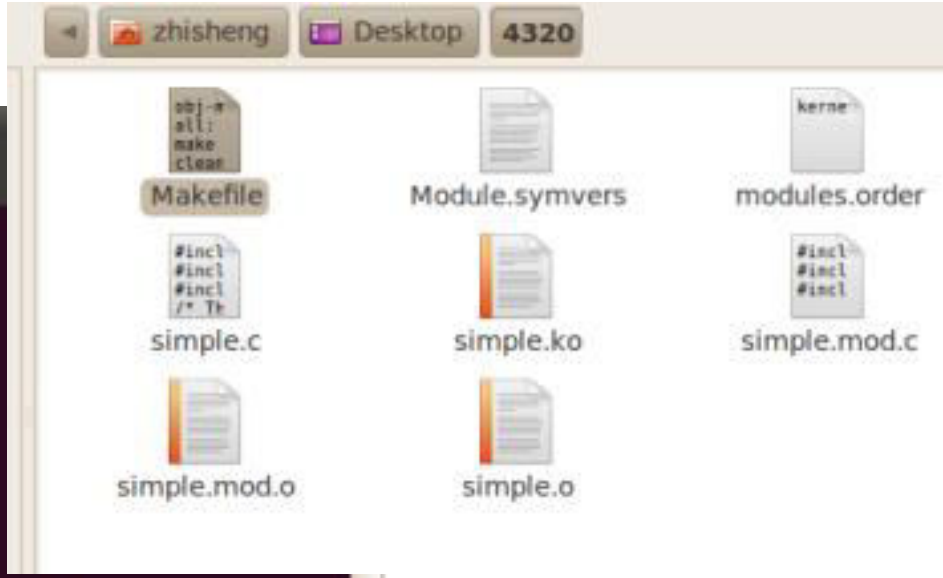
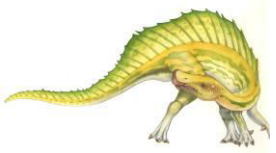
# Compile the Source Code

- simple.c and Makefile in folder “4230”
- make: compile the source code




```
zhisheng@zhisheng-ubuntu: ~/Desktop/4320
File  Edit  View  Terminal  Help
zhisheng@zhisheng-ubuntu:~$
zhisheng@zhisheng-ubuntu:~$
zhisheng@zhisheng-ubuntu:~$
zhisheng@zhisheng-ubuntu:~$
zhisheng@zhisheng-ubuntu:~$
zhisheng@zhisheng-ubuntu:~$
zhisheng@zhisheng-ubuntu:~$
zhisheng@zhisheng-ubuntu:~$
zhisheng@zhisheng-ubuntu:~$ cd ../zhisheng/Desktop/4320/
zhisheng@zhisheng-ubuntu:~/Desktop/4320$ make
make: Nothing to be done for `all'.
zhisheng@zhisheng-ubuntu:~/Desktop/4320$ make
make: *** No rule to make target `make', needed by `all'.  Stop.
zhisheng@zhisheng-ubuntu:~/Desktop/4320$ make
make -C /lib/modules/2.6.32-53-generic-pae/build M=/home/zhisheng/Desktop/4320 m
odules
make[1]: Entering directory `/usr/src/linux-headers-2.6.32-53-generic-pae'
  CC [M]  /home/zhisheng/Desktop/4320/simple.o
  Building modules, stage 2.
  MODPOST 1 modules
  CC      /home/zhisheng/Desktop/4320/simple.mod.o
  LD [M]  /home/zhisheng/Desktop/4320/simple.ko
make[1]: Leaving directory `/usr/src/linux-headers-2.6.32-53-generic-pae'
zhisheng@zhisheng-ubuntu:~/Desktop/4320$
```



# Load the Kernel Module

- sudo insmod: load a kernel module

```
zhisheng@zhisheng-ubuntu: ~/Desktop/4320
File  Edit  View  Terminal  Help
zhisheng@zhisheng-ubuntu:~/Desktop/4320$ sudo insmod simple.ko
[sudo] password for zhisheng:
zhisheng@zhisheng-ubuntu:~/Desktop/4320$ lsmod
Module                  Size  Used by
simple                   654  0
binfmt_misc             6523  1
snd_intel8x0           25652  2
snd_ac97_codec        100646  1 snd_intel8x0
ac97_bus                1002  1 snd_ac97_codec
snd_pcm_oss            35308  0
snd_mixer_oss          13746  1 snd_pcm_oss
snd_pcm                70918  3 snd_intel8x0,snd_ac97_codec,snd_pcm_oss
snd_seq_dummy           1338  0
snd_seq_oss            26722  0
snd_seq_midi            4557  0
snd_rawmidi            19056  1 snd_seq_midi
snd_seq_midi_event      6003  2 snd_seq_oss,snd_seq_midi
snd_seq                47295  6 snd_seq_dummy,snd_seq_oss,snd_seq_midi,snd_seq_m
idi_event
snd_timer              19130  2 snd_pcm,snd_seq
snd_seq_device          5700  5 snd_seq_dummy,snd_seq_oss,snd_seq_midi,snd_rawmi
di,snd_seq
ppdev                   5259  0
fbcon                  35102  71
```

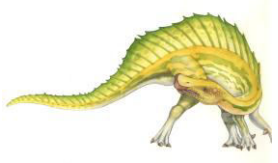
# Remove the Kernel Module

- sudo rmmod: remove a kernel module
- dmesg: check kernel log buffer

```
zhisheng@zhisheng-ubuntu: ~/Desktop/4320
File  Edit  View  Terminal  Help
[   27.150636] type=1505 audit(1516325807.227:9):  operation="profile_replace" p
id=689 name="/sbin/dhclient3"
[   27.154410] type=1505 audit(1516325807.231:10):  operation="profile_replace"
pid=689 name="/usr/lib/NetworkManager/nm-dhcp-client.action"
[   27.154681] type=1505 audit(1516325807.231:11):  operation="profile_replace"
pid=689 name="/usr/lib/connman/scripts/dhclient-script"
[   27.316506] type=1505 audit(1516325807.395:12):  operation="profile_load" pid
=690 name="/usr/bin/evince"
[   27.328529] type=1505 audit(1516325807.407:13):  operation="profile_load" pid
=690 name="/usr/bin/evince-previewer"
[   27.332047] type=1505 audit(1516325807.407:14):  operation="profile_load" pid
=690 name="/usr/bin/evince-thumbnailer"
[   27.433177] type=1505 audit(1516325807.511:15):  operation="profile_load" pid
=693 name="/usr/lib/cups/backend/cups-pdf"
[   27.433729] type=1505 audit(1516325807.511:16):  operation="profile_load" pid
=693 name="/usr/sbin/cupsd"
[   27.476501] type=1505 audit(1516325807.555:17):  operation="profile_load" pid
=694 name="/usr/sbin/tcpdump"
[   37.288133] eth0: no IPv6 routers present
[ 1605.095337] Clocksource tsc unstable (delta = 4687093270 ns)
[ 1605.118750] Switching to clocksource acpi_pm
[ 2114.592436] Loading Module
[ 2349.372386] Removing Module
zhisheng@zhisheng-ubuntu:~/Desktop/4320$
```

# Part II

- Kernel data structure
- An application of kernel module management



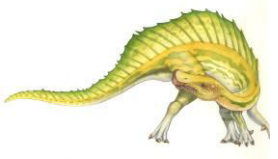
# Part II

- Kernel data structure include file: <linux/list.h>
- Define a linked list

```
struct birthday
{
    int month;
    int day;
    int year;

        struct list_head list;
};

/**
 * The following defines and initializes a list_head object named birthday_list
 */
static LIST_HEAD(birthday_list);
```



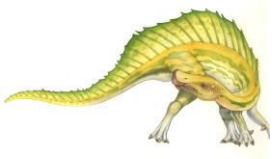
# Part II

- At module entry point, define each element in the list

```
int simple_init(void)
{
   /* the pointer for memory allocation */
   struct birthday *person;

      person_one = kmalloc(sizeof(*person_one), GFP_KERNEL);
      person_one->month = 8;
      person_one->day = 13;
      person_one->year = 1995;
   INIT_LIST_HEAD(&person_one->list);

      /* add the new node */
   list_add_tail(&person_one->list, &birthday_list);
```

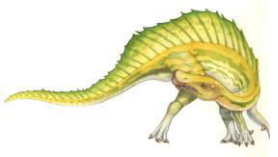


# Part II

- Traversing the Linked List

```
struct birthday *ptr;

list_for_each_entry(ptr, &birthday_list, list) {
   /* on each iteration ptr points */
   /* to the next birthday struct */
}
```

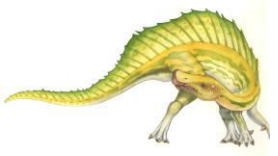


# Part II

- At module exit point, remove each element from the list

```
struct birthday *ptr, *next

list_for_each_entry_safe(ptr,next,&birthday_list,list) {
   /* on each iteration ptr points */
   /* to the next birthday struct */
   list_del(&ptr->list);
   kfree(ptr);
}
```



# Part II

- After compiling, loading, and removing the module, kernel log shows

```
zhisheng@zhisheng-ubuntu: ~/Desktop/4320/proj1
File  Edit  View  Terminal  Help
[   27.332047] type=1505 audit(1516325807.407:14):  operation="profile_load" pid
=690 name="/usr/bin/evince-thumbnailer"
[   27.433177] type=1505 audit(1516325807.511:15):  operation="profile_load" pid
=693 name="/usr/lib/cups/backend/cups-pdf"
[   27.433729] type=1505 audit(1516325807.511:16):  operation="profile_load" pid
=693 name="/usr/sbin/cupsd"
[   27.476501] type=1505 audit(1516325807.555:17):  operation="profile_load" pid
=694 name="/usr/sbin/tcpdump"
[   37.288133] eth0: no IPv6 routers present
[ 1605.095337] Clocksource tsc unstable (delta = 4687093270 ns)
[ 1605.118750] Switching to clocksource acpi_pm
[ 2114.592436] Loading Module
[ 2349.372386] Removing Module
[ 5235.577735] Loading Module
[ 5235.577746] Birthday: Month 10 Day 22 Year 1963
[ 5235.577753] Birthday: Month 8 Day 13 Year 1995
[ 5235.577761] Birthday: Month 9 Day 2 Year 1998
[ 5235.577767] Birthday: Month 8 Day 12 Year 1963
[ 5398.896154] Removing Module
[ 5398.896163] Removing 10 22 1963
[ 5398.896169] Removing 8 13 1995
[ 5398.896175] Removing 9 2 1998
[ 5398.896181] Removing 8 12 1963
zhisheng@zhisheng-ubuntu:~/Desktop/4320/proj1$
```