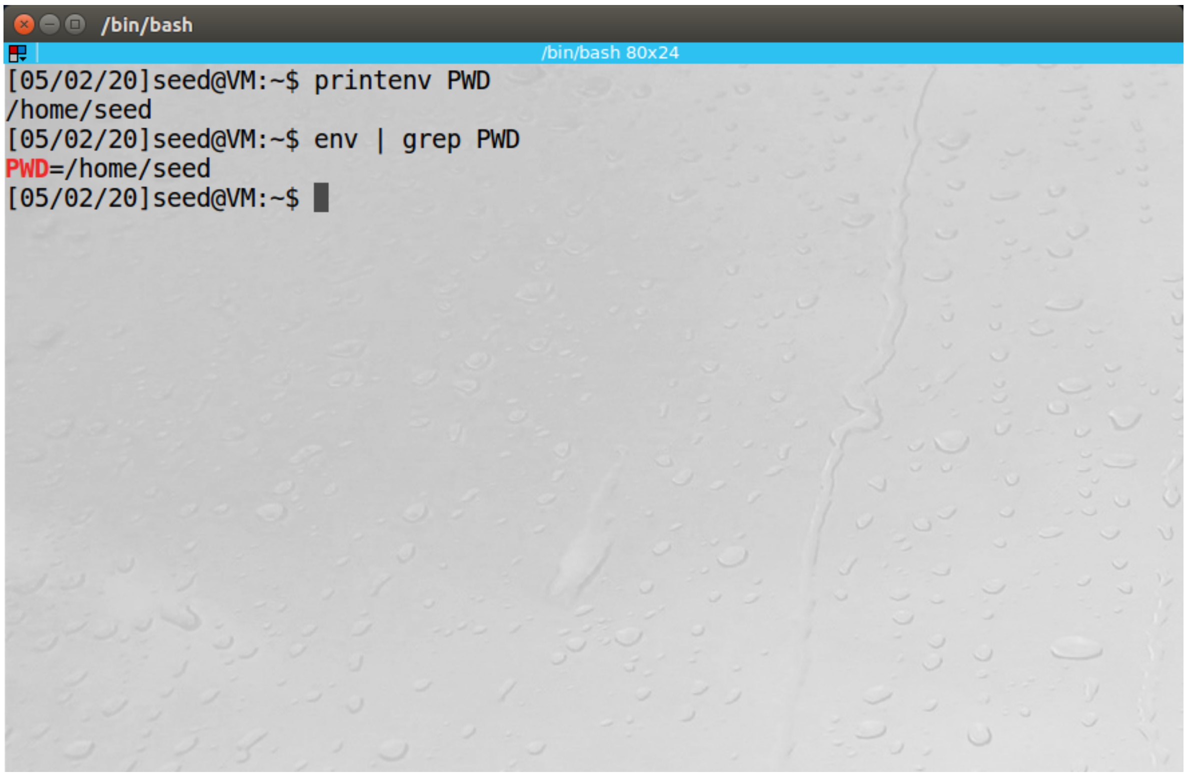
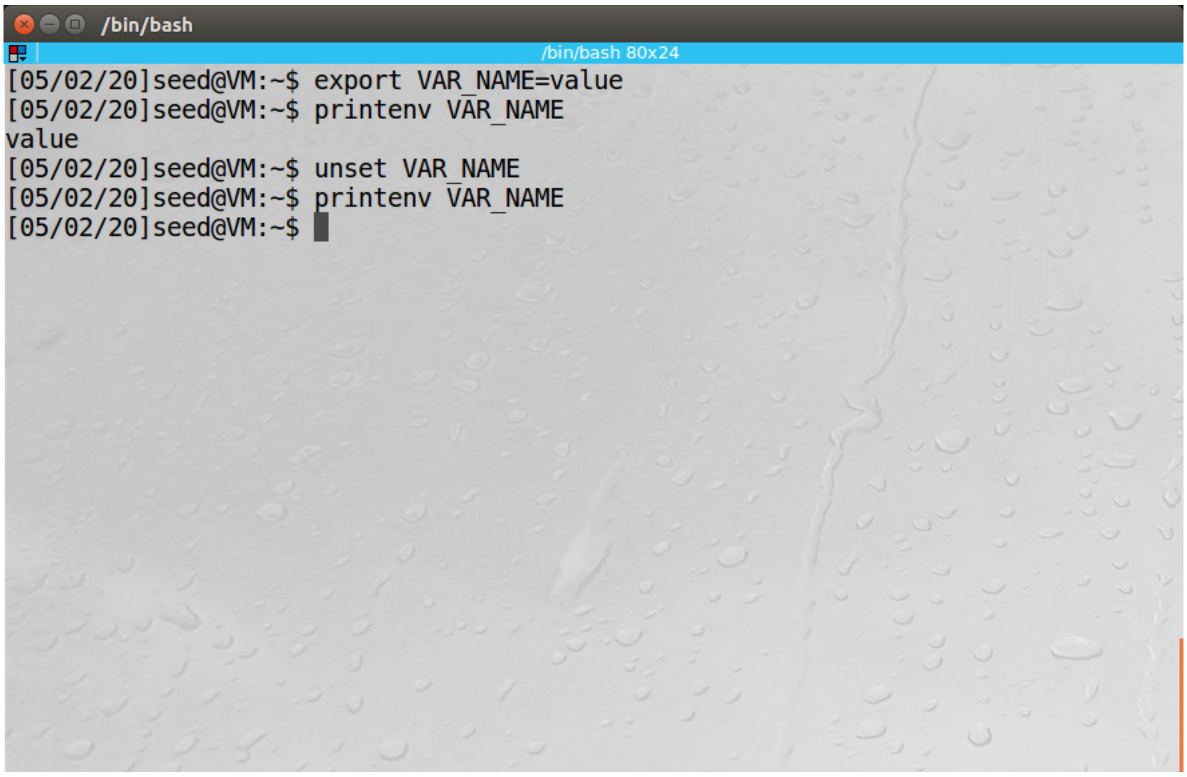
Task 1

1.1 command "printenv PWD" / "env | grep PWD"



```
[05/02/20]seed@VM:~$ printenv PWD
/home/seed
[05/02/20]seed@VM:~$ env | grep PWD
PWD=/home/seed
[05/02/20]seed@VM:~$ 
```

1.2 command "export" & "unset"



```
[05/02/20]seed@VM:~$ export VAR_NAME=value
[05/02/20]seed@VM:~$ printenv VAR_NAME
value
[05/02/20]seed@VM:~$ unset VAR_NAME
[05/02/20]seed@VM:~$ printenv VAR_NAME
[05/02/20]seed@VM:~$ 
```

Task 2

2.1 program

```c
#include<unistd.h>
#include<stdio.h>
#include<stdlib.h>

extern char **environ;

void printenv()
{
    int i = 0;
    while(environ[i] != NULL) {
        printf("%s\n", environ[i]);
        i++;
    }
}

void main()
{
    pid_t childPid;

    switch(childPid = fork()) {
        case 0:    // child process
            printenv();
            exit(0);
        default:   // parent process
            // printenv();
            exit(0);
    }
}
```

2.2 compare the difference

```
[05/03/20]seed@VM:~/HW$ task2>child
[05/03/20]seed@VM:~/HW$ task2_p>parent
[05/03/20]seed@VM:~/HW$ ls
child  parent  task2  task2.c  task2_p
[05/03/20]seed@VM:~/HW$ diff child parent
71c71
< _=./task2
---
> _=./task2_p
```

2.3 conclusion

The parent's environment variables are inherited by the child process.

Task 3

3.1 command & result

```
[05/03/20]seed@VM:~/HW/Lab1$ gedit task3.c
[05/03/20]seed@VM:~/HW/Lab1$ gcc task3.c -o task3
[05/03/20]seed@VM:~/HW/Lab1$ task3 > task3_1
[05/03/20]seed@VM:~/HW/Lab1$ gedit task3.c
[05/03/20]seed@VM:~/HW/Lab1$ gcc task3.c -o task3
```

```
[05/03/20]seed@VM:~/HW/Lab1$ task3 > task3_2
[05/03/20]seed@VM:~/HW/Lab1$ diff task3_1 task3_2
0a1,72
> XDG_VTNR=7
> ORBIT_SOCKETDIR=/tmp/orbit-seed
> XDG_SESSION_ID=c1
> XDG_GREETER_DATA_DIR=/var/lib/lightdm-data/seed
> TERMINATOR_UUID=urn:uuid:e37c4fcb-e251-430f-a4a9-bb8b861b106a
> IBUS_DISABLE_SNOOPER=1
> CLUTTER_IM_MODULE=xim
> ANDROID_HOME=/home/seed/android/android-sdk-linux
> GPG_AGENT_INFO=/home/seed/.gnupg/S.gpg-agent:0:1
> TERM=xterm
> SHELL=/bin/bash
> DERBY_HOME=/usr/lib/jvm/java-8-oracle/db
> QT_LINUX_ACCESSIBILITY_ALWAYS_ON=1
>
LD_PRELOAD=/home/seed/lib/boost/libboost_program_options.so.1.64.0:/home/se
ed/lib/boost/libboost_filesystem.so.1.64.0:/home/seed/lib/boost/libboost_sy
stem.so.1.64.0
> WINDOWID=60817412
> UPSTART_SESSION=unix:abstract=/com/ubuntu/upstart-session/1000/1322
> GNOME_KEYRING_CONTROL=
> GTK_MODULES=gail:atk-bridge:unity-gtk-module
> USER=seed
>
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33;
01:cd=40;33;01:or=40;31;01:mi=00:su=37;41:sg=30;43:ca=30;41:tw=30;42:ow=34;
42:st=37;44:ex=01;32:*.tar=01;31:*.tgz=01;31:*.arc=01;31:*.arj=01;31:*.taz=
01;31:*.lha=01;31:*.lz4=01;31:*.lzh=01;31:*.lzma=01;31:*.tlz=01;31:*.txz=01
;31:*.tzo=01;31:*.t7z=01;31:*.zip=01;31:*.z=01;31:*.Z=01;31:*.dz=01;31:*.gz
=01;31:*.lrz=01;31:*.lz=01;31:*.lzo=01;31:*.xz=01;31:*.bz2=01;31:*.bz=01;31
:*.tbz=01;31:*.tbz2=01;31:*.tz=01;31:*.deb=01;31:*.rpm=01;31:*.jar=01;31:*.
war=01;31:*.ear=01;31:*.sar=01;31:*.rar=01;31:*.alz=01;31:*.ace=01;31:*.zoo
=01;31:*.cpio=01;31:*.7z=01;31:*.rz=01;31:*.cab=01;31:*.jpg=01;35:*.jpeg=01
;35:*.gif=01;35:*.bmp=01;35:*.pbm=01;35:*.pgm=01;35:*.ppm=01;35:*.tga=01;35
:*.xbm=01;35:*.xpm=01;35:*.tif=01;35:*.tiff=01;35:*.png=01;35:*.svg=01;35:*
.svgz=01;35:*.mng=01;35:*.pcx=01;35:*.mov=01;35:*.mpg=01;35:*.mpeg=01;35:*.
m2v=01;35:*.mkv=01;35:*.webm=01;35:*.ogm=01;35:*.mp4=01;35:*.m4v=01;35:*.mp
4v=01;35:*.vob=01;35:*.qt=01;35:*.nuv=01;35:*.wmv=01;35:*.asf=01;35:*.rm=01
;35:*.rmvb=01;35:*.flc=01;35:*.avi=01;35:*.fli=01;35:*.flv=01;35:*.gl=01;35
:*.dl=01;35:*.xcf=01;35:*.xwd=01;35:*.yuv=01;35:*.cgm=01;35:*.emf=01;35:*.o
gv=01;35:*.ogx=01;35:*.aac=00;36:*.au=00;36:*.flac=00;36:*.m4a=00;36:*.mid=
00;36:*.midi=00;36:*.mka=00;36:*.mp3=00;36:*.mpc=00;36:*.ogg=00;36:*.ra=00;
36:*.wav=00;36:*.oga=00;36:*.opus=00;36:*.spx=00;36:*.xspf=00;36:
> QT_ACCESSIBILITY=1
>
LD_LIBRARY_PATH=/home/seed/source/boost_1_64_0/stage/lib:/home/seed/source/
boost_1_64_0/stage/lib:
> XDG_SESSION_PATH=/org/freedesktop/DisplayManager/Session0
> XDG_SEAT_PATH=/org/freedesktop/DisplayManager/Seat0
> SSH_AUTH_SOCK=/run/user/1000/keyring/ssh
> DEFAULTS_PATH=/usr/share/gconf/ubuntu.default.path
> XDG_CONFIG_DIRS=/etc/xdg/xdg-ubuntu:/usr/share/upstart/xdg:/etc/xdg
> DESKTOP_SESSION=ubuntu
```

```
> 
PATH=/home/seed/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin
:/bin:/usr/games:/usr/local/games:.:/snap/bin:/usr/lib/jvm/java-8-
oracle/bin:/usr/lib/jvm/java-8-oracle/db/bin:/usr/lib/jvm/java-8-
oracle/jre/bin:/home/seed/android/android-sdk-
linux/tools:/home/seed/android/android-sdk-linux/platform-
tools:/home/seed/android/android-ndk/android-ndk-r8d:/home/seed/.local/bin
> QT_IM_MODULE=ibus
> QT_QPA_PLATFORMTHEME=appmenu-qt5
> XDG_SESSION_TYPE=x11
> PWD=/home/seed/HW/Lab1
> JOB=gnome-session
> XMODIFIERS=@im=ibus
> JAVA_HOME=/usr/lib/jvm/java-8-oracle
> GNOME_KEYRING_PID=
> LANG=en_US.UTF-8
> GDM_LANG=en_US
> MANDATORY_PATH=/usr/share/gconf/ubuntu.mandatory.path
> COMPIZ_CONFIG_PROFILE=ubuntu
> IM_CONFIG_PHASE=1
> GDMSESSION=ubuntu
> SESSIONTYPE=gnome-session
> GTK2_MODULES=overlay-scrollbar
> SHLVL=1
> HOME=/home/seed
> XDG_SEAT=seat0
> LANGUAGE=en_US
> LIBGL_ALWAYS_SOFTWARE=1
> GNOME_DESKTOP_SESSION_ID=this-is-deprecated
> UPSTART_INSTANCE=
> XDG_SESSION_DESKTOP=ubuntu
> UPSTART_EVENTS=started starting
> LOGNAME=seed
> DBUS_SESSION_BUS_ADDRESS=unix:abstract=/tmp/dbus-wNiWhHELqD
> J2SDKDIR=/usr/lib/jvm/java-8-oracle
> 
XDG_DATA_DIRS=/usr/share/ubuntu:/usr/share/gnome:/usr/local/share/:/usr/sha
re/:/var/lib/snapd/desktop
> QT4_IM_MODULE=xim
> LESSOPEN=| /usr/bin/lesspipe %s
> INSTANCE=Unity
> UPSTART_JOB=unity-settings-daemon
> XDG_RUNTIME_DIR=/run/user/1000
> DISPLAY=:0
> XDG_CURRENT_DESKTOP=Unity
> GTK_IM_MODULE=ibus
> J2REDIR=/usr/lib/jvm/java-8-oracle/jre
> LESSCLOSE=/usr/bin/lesspipe %s %s
> XAUTHORITY=/home/seed/.Xauthority
> COLORTERM=gnome-terminal
> _=./task3
> OLDPWD=/home/seed/HW
```

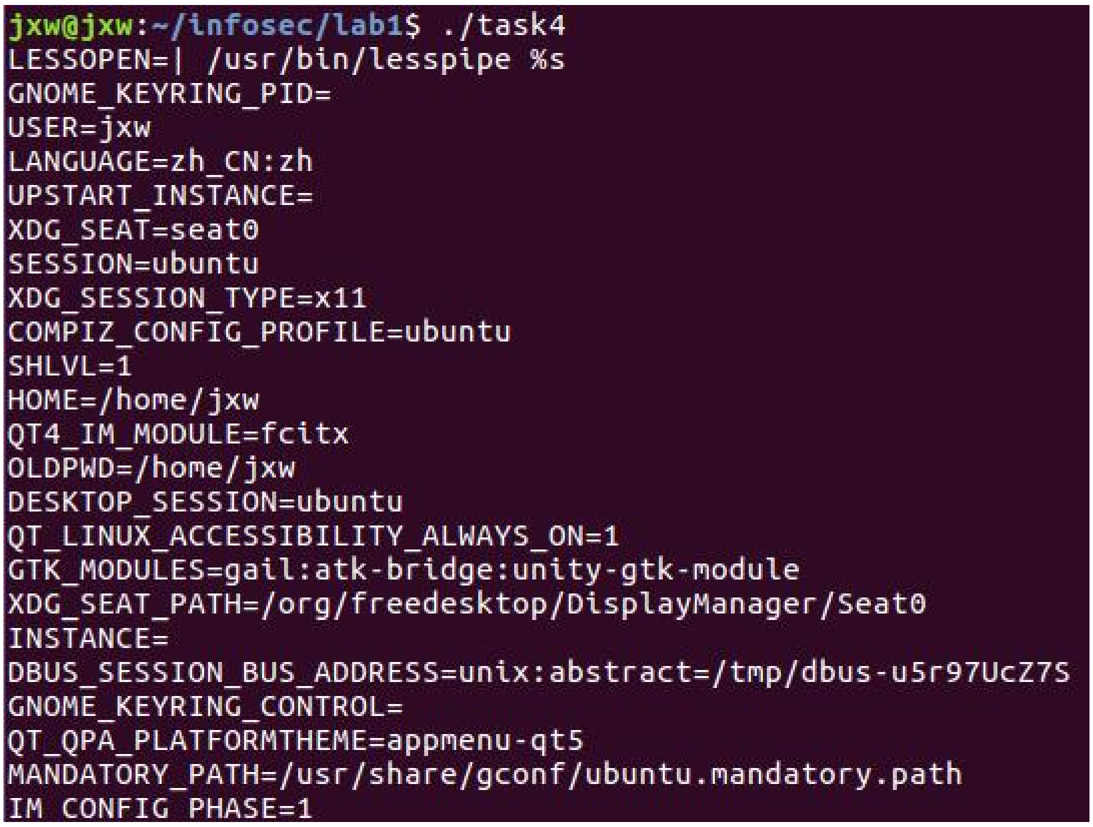
3.2 conclusion

Environment variables are not automatically inherited by the new program.

Task 4

```c
#include <stdio.h>
#include <stdlib.h>
int main()
{
        system("/usr/bin/env");
        return 0;
}
```

仅截取部分结果



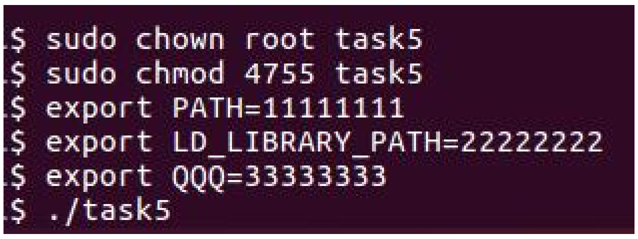
```
jxw@jxw:~/infosec/lab1$ ./task4
LESSOPEN=| /usr/bin/lesspipe %s
GNOME_KEYRING_PID=
USER=jxw
LANGUAGE=zh_CN:zh
UPSTART_INSTANCE=
XDG_SEAT=seat0
SESSION=ubuntu
XDG_SESSION_TYPE=x11
COMPIZ_CONFIG_PROFILE=ubuntu
SHLVL=1
HOME=/home/jxw
QT4_IM_MODULE=fcitx
OLDPWD=/home/jxw
DESKTOP_SESSION=ubuntu
QT_LINUX_ACCESSIBILITY_ALWAYS_ON=1
GTK_MODULES=gail:atk-bridge:unity-gtk-module
XDG_SEAT_PATH=/org/freedesktop/DisplayManager/Seat0
INSTANCE=
DBUS_SESSION_BUS_ADDRESS=unix:abstract=/tmp/dbus-u5r97UcZ7S
GNOME_KEYRING_CONTROL=
QT_QPA_PLATFORMTHEME=appmenu-qt5
MANDATORY_PATH=/usr/share/gconf/ubuntu.mandatory.path
IM_CONFIG_PHASE=1
```

Task 5

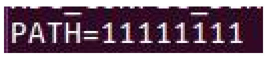
Step 1. Write the following program that can print out all the environment variables in the current process.

```c
#include <stdio.h>
#include <stdlib.h>

extern char **environ;

void main()
{
        int i = 0;
        while(environ[i] != NULL)
        {
                printf("%s\n",environ[i]);
                i++;
        }
}
```

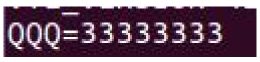
Step 2&3. Compile the above program, change its ownership to root, and make it a Set-UID program. In your shell, use theexportcommand to set the following environment variables.



```
$ sudo chown root task5
$ sudo chmod 4755 task5
$ export PATH=11111111
$ export LD_LIBRARY_PATH=22222222
$ export QQQ=33333333
$ ./task5
```

PATH和自定义的环境变量QQQ被传入子进程，LD_LIBRARY_PATH未找到 

```
PATH=11111111
```

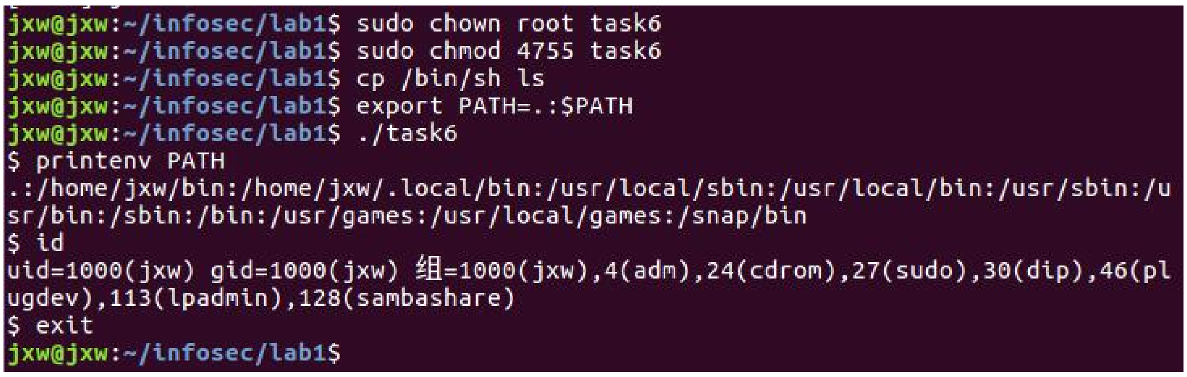


```
QQQ=33333333
```

Task 6

```c
#include <stdlib.h>
#include <unistd.h>
int main()
{
        system("ls");
        return 0;
}

```

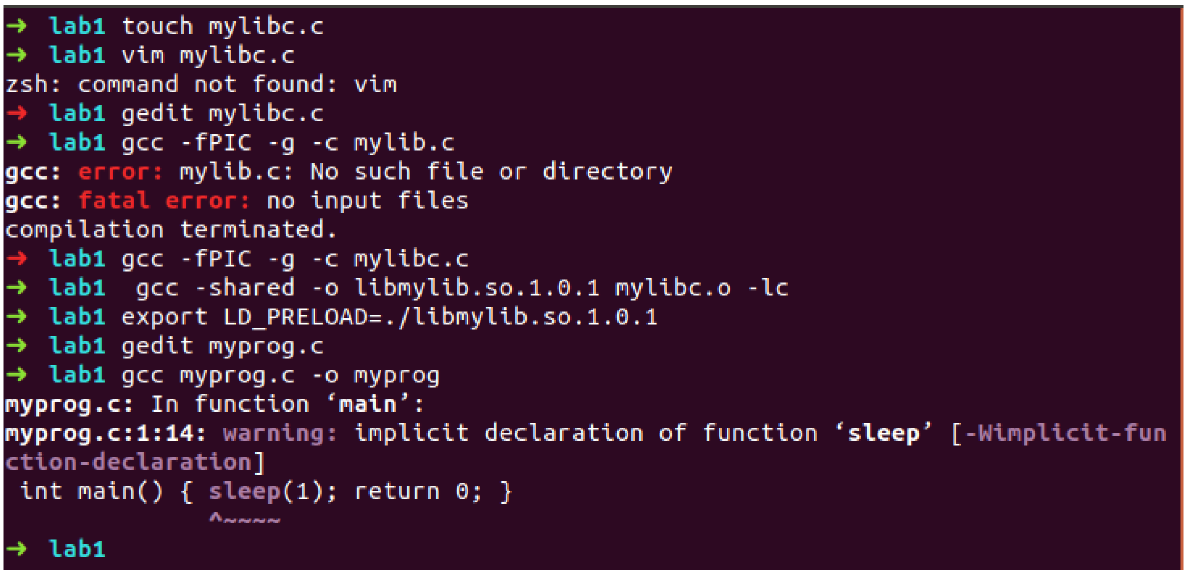
先将编译出的task6设为root和SET-UID 随后将`/bin/sh`复制到当前目录，重命名为ls 修改环境变量`PATH`，在最前方加入当前目录 运行task6，在运行到`system("ls");`的时候，根据PATH将默认从当前目录寻找文件`ls`，即复制后的`/bin/sh` 随后会创建子进程的shell，在子进程中查看uid，发现并没有变成root 说明16.04对此有一定的保护措施



```
jxw@jxw:~/infosec/lab1$ sudo chown root task6
jxw@jxw:~/infosec/lab1$ sudo chmod 4755 task6
jxw@jxw:~/infosec/lab1$ cp /bin/sh ls
jxw@jxw:~/infosec/lab1$ export PATH=.:$PATH
jxw@jxw:~/infosec/lab1$ ./task6
$ printenv PATH
.:/home/jxw/bin:/home/jxw/.local/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/u
sr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin
$ id
uid=1000(jxw) gid=1000(jxw) 组=1000(jxw),4(adm),24(cdrom),27(sudo),30(dip),46(pl
ugdev),113(lpadmin),128(sambashare)
$ exit
jxw@jxw:~/infosec/lab1$
```

Task 7

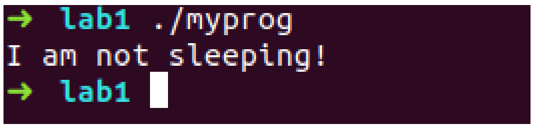
step1



```
➜  lab1 touch mylibc.c
➜  lab1 vim mylibc.c
zsh: command not found: vim
➜  lab1 gedit mylibc.c
➜  lab1 gcc -fPIC -g -c mylib.c
gcc: error: mylib.c: No such file or directory
gcc: fatal error: no input files
compilation terminated.
➜  lab1 gcc -fPIC -g -c mylibc.c
➜  lab1  gcc -shared -o libmylib.so.1.0.1 mylibc.o -lc
➜  lab1 export LD_PRELOAD=./libmylib.so.1.0.1
➜  lab1 gedit myprog.c
➜  lab1 gcc myprog.c -o myprog
myprog.c: In function ‘main’:
myprog.c:1:14: warning: implicit declaration of function ‘sleep’ [-Wimplicit-fun
ction-declaration]
 int main() { sleep(1); return 0; }
              ^~~~~
➜  lab1
```

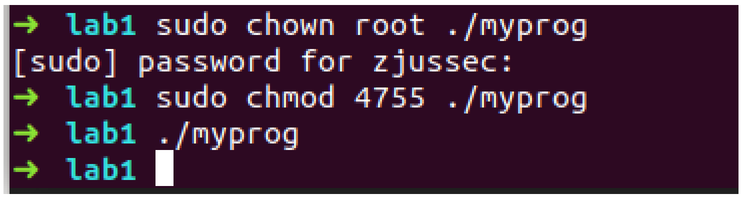
step2

- Make myprog a regular program, and run it as a normal user.



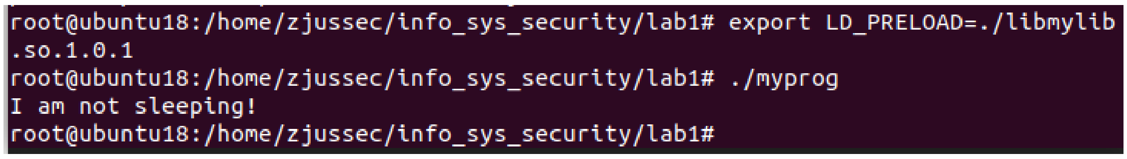
```
➜  lab1 ./myprog
I am not sleeping!
➜  lab1
```

- Make myprog a Set-UID root program, and run it as a normal user.



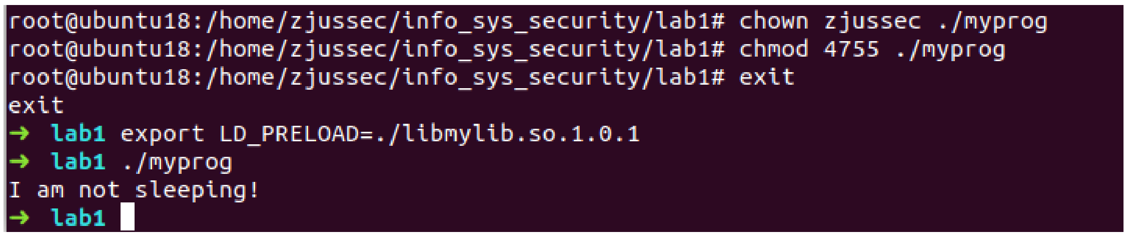
```
➜  lab1 sudo chown root ./myprog
[sudo] password for zjussec:
➜  lab1 sudo chmod 4755 ./myprog
➜  lab1 ./myprog
➜  lab1
```

- Make myprog a Set-UID root program, export the LD PRELOAD environment variable again in the root account and run it.



```
root@ubuntu18:/home/zjussec/info_sys_security/lab1# export LD_PRELOAD=./libmylib
.so.1.0.1
root@ubuntu18:/home/zjussec/info_sys_security/lab1# ./myprog
I am not sleeping!
root@ubuntu18:/home/zjussec/info_sys_security/lab1#
```

- Make myprog a Set-UID user1 program (i.e., the owner is user1, which is another user account), export the LD PRELOAD environment variable again in a different user’s account (not-root user) and run it.



```
root@ubuntu18:/home/zjussec/info_sys_security/lab1# chown zjussec ./myprog
root@ubuntu18:/home/zjussec/info_sys_security/lab1# chmod 4755 ./myprog
root@ubuntu18:/home/zjussec/info_sys_security/lab1# exit
exit
➜  lab1 export LD_PRELOAD=./libmylib.so.1.0.1
➜  lab1 ./myprog
I am not sleeping!
➜  lab1
```

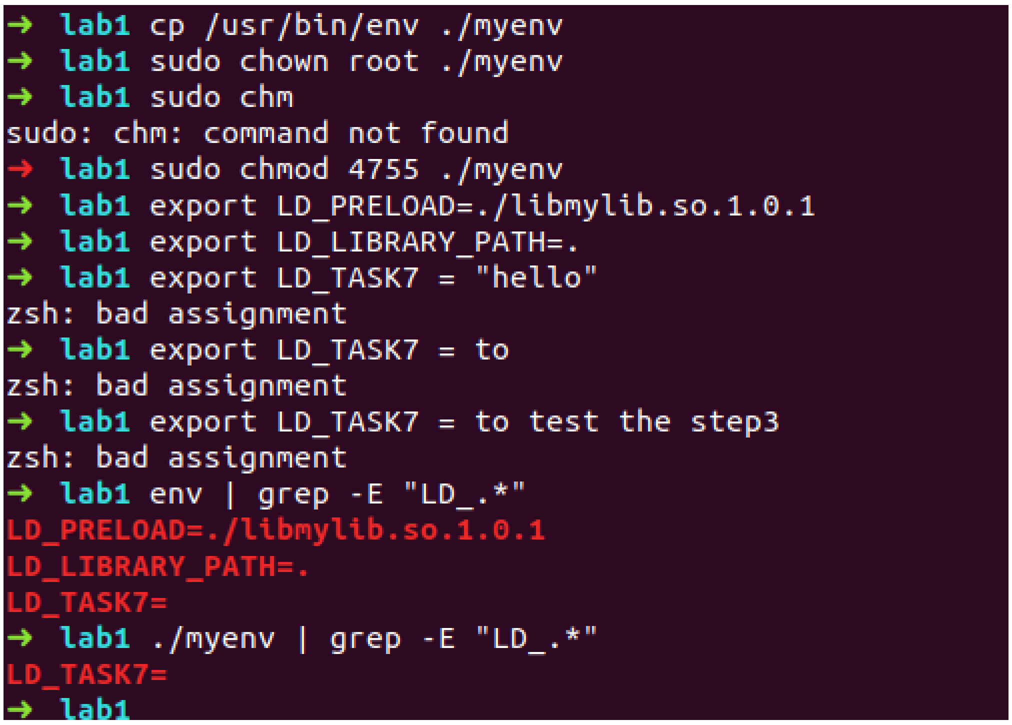
step 3

这个主要的问题在于动态链接器实施了一些对策，当一个进程的 RUID 和 EUID 不同的时候（上一步骤中第二个条件），动态链接器会并不会继承环境变量中的 LD_PRELOAD 和LD_LIBRARY_PATH 等变量。

设计实验如下：

1. 首先我们复制一份 env 程序 myenv 到我们自己的工作目录
2. 将 myenv 设置为 Set-UID 程序。

3. 在当前 shell 中 export 一些以 LD_.*的环境变量
4. 分别运行 env 和 myenv，查看输出结果

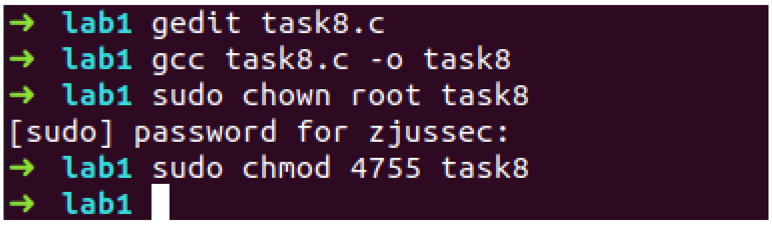


```
➜  lab1 cp /usr/bin/env ./myenv
➜  lab1 sudo chown root ./myenv
➜  lab1 sudo chm
sudo: chm: command not found
➜  lab1 sudo chmod 4755 ./myenv
➜  lab1 export LD_PRELOAD=./libmylib.so.1.0.1
➜  lab1 export LD_LIBRARY_PATH=.
➜  lab1 export LD_TASK7 = "hello"
zsh: bad assignment
➜  lab1 export LD_TASK7 = to
zsh: bad assignment
➜  lab1 export LD_TASK7 = to test the step3
zsh: bad assignment
➜  lab1 env | grep -E "LD_.*"
LD_PRELOAD=./libmylib.so.1.0.1
LD_LIBRARY_PATH=.
LD_TASK7=
➜  lab1 ./myenv | grep -E "LD_.*"
LD_TASK7=
➜  lab1
```

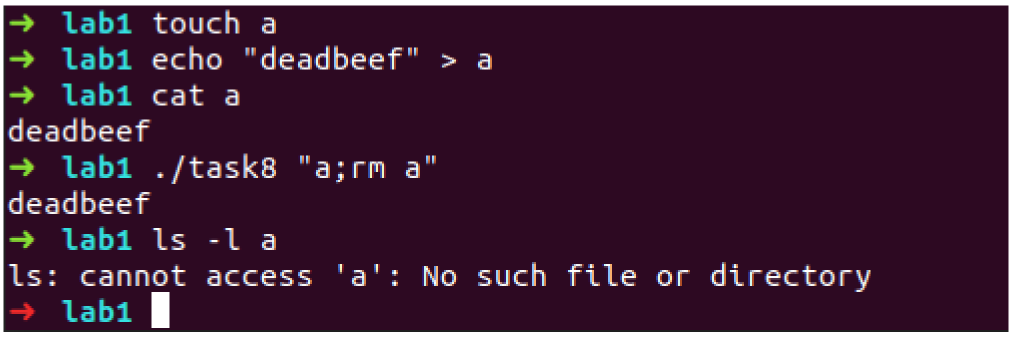
Task 8

step1

system() 函数实际执行会首先打开一个 shell 来执行后面的指令，那么只要我们让我们输入的内容 中包含一条指令就可以了。Linux 中一行中执行多条命令可以用“; ”隔开，这样无论前一条指 令运行的结果如何都会执行后面的指令。

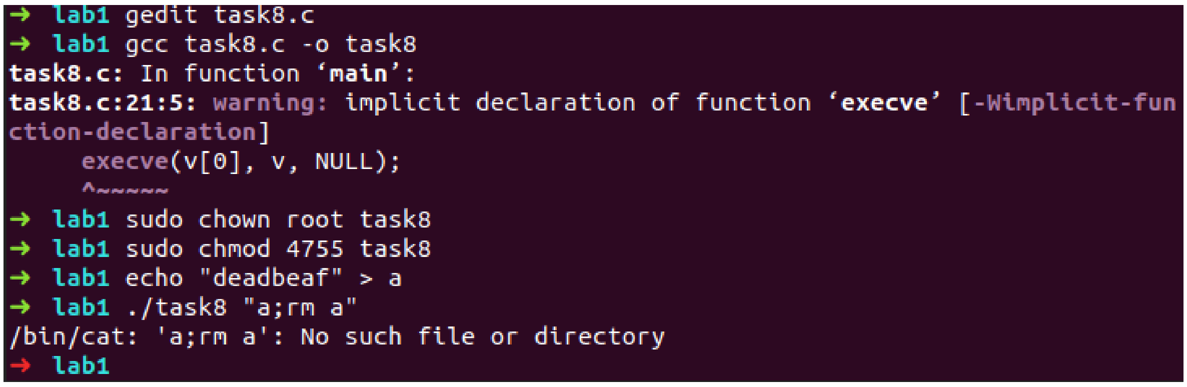


```
➜  lab1 gedit task8.c
➜  lab1 gcc task8.c -o task8
➜  lab1 sudo chown root task8
[sudo] password for zjussec:
➜  lab1 sudo chmod 4755 task8
➜  lab1
```



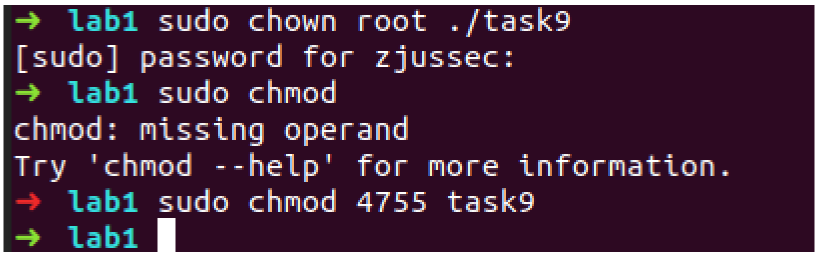
```
➜  lab1 touch a
➜  lab1 echo "deadbeef" > a
➜  lab1 cat a
deadbeef
➜  lab1 ./task8 "a;rm a"
deadbeef
➜  lab1 ls -l a
ls: cannot access 'a': No such file or directory
➜  lab1
```

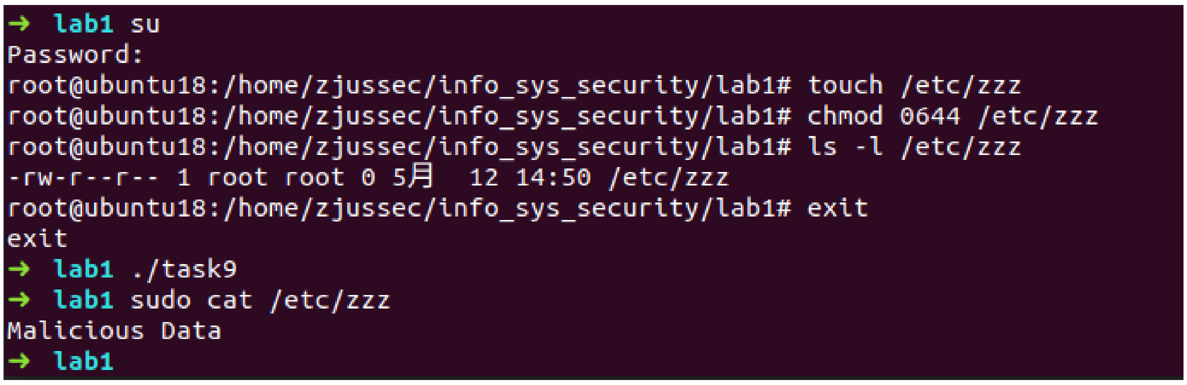
step2


```
➜  lab1 gedit task8.c
➜  lab1 gcc task8.c -o task8
task8.c: In function ‘main’:
task8.c:21:5: warning: implicit declaration of function ‘execve’ [-Wimplicit-fun
ction-declaration]
     execve(v[0], v, NULL);
     ^~~~~~
➜  lab1 sudo chown root task8
➜  lab1 sudo chmod 4755 task8
➜  lab1 echo "deadbeaf" > a
➜  lab1 ./task8 "a;rm a"
/bin/cat: 'a;rm a': No such file or directory
➜  lab1
```

可以看到输出显示的是找不到文件“a;rm a”，避免了 step1 中的攻击。 这主要是因为 exec 系列的命令并不会像 system 一样先打开一个 shell 在执行相应的指令。 exec 系列的指令在创建完子进程以后，会将目标指令进程的上下文替代子进程的上下文， 这样子进程就成为了一个专门执行某个命令的进程。

Task 9


```
➜  lab1 sudo chown root ./task9
[sudo] password for zjussec:
➜  lab1 sudo chmod
chmod: missing operand
Try 'chmod --help' for more information.
➜  lab1 sudo chmod 4755 task9
➜  lab1
```


```
➜  lab1 su
Password:
root@ubuntu18:/home/zjussec/info_sys_security/lab1# touch /etc/zzz
root@ubuntu18:/home/zjussec/info_sys_security/lab1# chmod 0644 /etc/zzz
root@ubuntu18:/home/zjussec/info_sys_security/lab1# ls -l /etc/zzz
-rw-r--r-- 1 root root 0 5月  12 14:50 /etc/zzz
root@ubuntu18:/home/zjussec/info_sys_security/lab1# exit
exit
➜  lab1 ./task9
➜  lab1 sudo cat /etc/zzz
Malicious Data
➜  lab1
```

可以看到文件`/etc/zzz` 中被写入了恶意数据。

原因： 文件指针 fd 被一个 root 所有的 Set-UID 程序打开，因此具有操作文件 的能力，而这个 fd 在使用 folk()创建子进程的时候被继承到子进程中，虽然之后通过 setuid() 来降低了权限，但是子进程还是可以通过这个 fd 来修改文件。