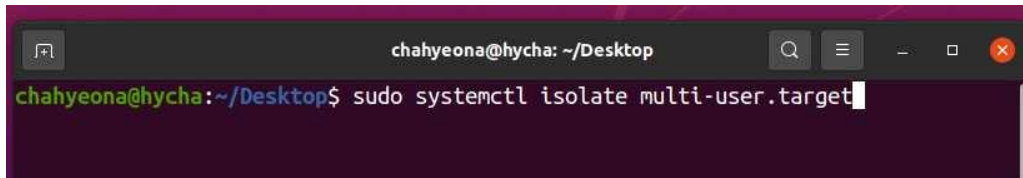


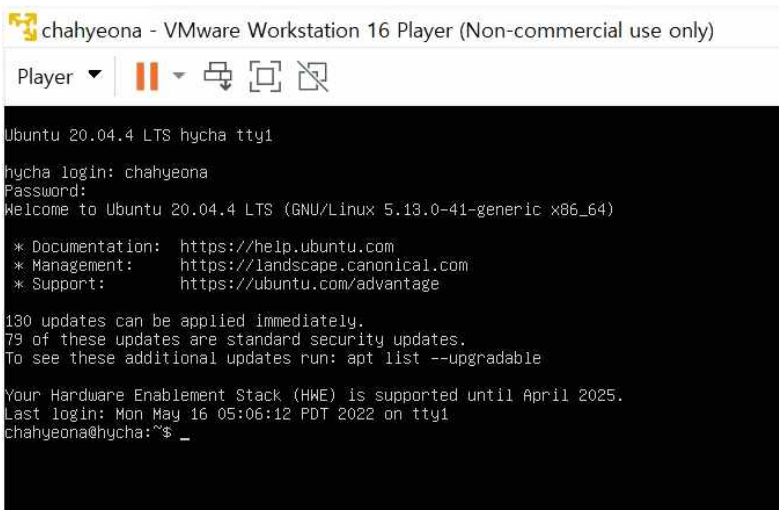
## 과제 #6. 시스템 호출 제작

2020039009\_차현아

1. 아래 명령어로 CLI모드로 전환하여 부팅 시 로그인 메시지 보여주기



```
chahyeona@hycha: ~/Desktop
chahyeona@hycha:~/Desktop$ sudo systemctl isolate multi-user.target
```



```
chahyeona - VMware Workstation 16 Player (Non-commercial use only)
Player
Ubuntu 20.04.4 LTS hycha tty1
hycha login: chahyeona
Password:
Welcome to Ubuntu 20.04.4 LTS (GNU/Linux 5.13.0-41-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

130 updates can be applied immediately.
79 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable

Your Hardware Enablement Stack (HWE) is supported until April 2025.
Last login: Mon May 16 05:06:12 PDT 2022 on tty1
chahyeona@hycha:~$ _
```

2. wget으로 커널 다운받고, /usr/src/로 해당 커널 복사



```
chahyeona@hycha:~/Desktop$ cd ~
chahyeona@hycha:~$ wget https://www.kernel.org/pub/linux/kernel/v5.x/linux-5.13.12.tar.xz
--2022-05-16 05:13:40-- https://www.kernel.org/pub/linux/kernel/v5.x/linux-5.13.12.tar.xz
linux-5.13.12.tar.xz
chahyeona@hycha:~$ cp linux-5.13.12.tar.xz /usr/src/
```

3. 압축풀기



```
chahyeona@hycha:~$ sudo -s
root@hycha:/home/chahyeona# cd /
root@hycha:/# cd usr/src/
root@hycha:/usr/src# ls
linux-5.13.12.tar.xz      linux-hwe-5.13-headers-5.13.0-30
linux-headers-5.13.0-30-generic  linux-hwe-5.13-headers-5.13.0-41
linux-headers-5.13.0-41-generic
root@hycha:/usr/src# tar -xf linux-5.13.12.tar.xz
```

#### 4. 컴파일에 필요한 라이브러리 설치

```
root@hycha:/usr/src# sudo apt-get update
Hit:1 http://security.ubuntu.com/ubuntu focal-security InRelease
Hit:2 http://us.archive.ubuntu.com/ubuntu focal InRelease
Hit:3 http://us.archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:4 http://us.archive.ubuntu.com/ubuntu focal-backports InRelease
Reading package lists... Done
root@hycha:/usr/src# sudo apt-get install build-essential libncurses5 libncurses
5-dev bin86 kernel-package libssl-dev bison flex libelf-dev gcc-arm-linux-gnueab
i g++-arm-linux-gnueabi -y
```

#### 5. 현재 커널 환경 설정 복사, menuconfig

```
root@hycha:/usr/src/linux-5.13.12
root@hycha:/usr/src/linux-5.13.12# cp /boot/config-5.13.0-41-generic ./config
root@hycha:/usr/src/linux-5.13.12# sudo make menuconfig
```

#### 6. 코어 개수 확인 및 오류를 막기 위한 조치(해당 작업을 안해주면 오류가 났었음)

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

root@hycha:/usr/src/linux-5.13.12# grep -c processor /proc/cpuinfo
4
```

```
root@hycha:/usr/src/linux-5.13.12# sudo apt install dwarves
Reading package lists... Done
Building dependency tree
Reading state information... Done
```

```
root@hycha:/usr/src/linux-5.13.12# apt-get install zstd
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
```

```
Processing triggers for man-db (2.9.1-1) ...
root@hycha:/usr/src/linux-5.13.12# scripts/config --set-str SYSTEM_TRUSTED_KEYS ""
root@hycha:/usr/src/linux-5.13.12# scripts/config --disable SYSTEM_REVOCATION_KEYS
```

#### 7. sudo make-> sudo make modules\_install -> make install 순서로 컴파일

```
root@hycha:/usr/src/linux-5.13.12
root@hycha:/usr/src/linux-5.13.12# sudo make
```

```
SIGN /lib/modules/5.13.12/kernel/sound/xen/snd_xen_front.ko
INSTALL /lib/modules/5.13.12/kernel/sound/xen/snd_xen_front.ko
SIGN /lib/modules/5.13.12/kernel/sound/xen/snd_xen_front.ko
DEPMOD /lib/modules/5.13.12
root@hycha:/usr/src/linux-5.13.12# sudo make install
```

```
BTF [M] sound/xen/snd_xen_front.ko
GEN scripts/gdb/linux/constants.py
root@hycha:/usr/src/linux-5.13.12# sudo make modules_install
```

\* make에 엄청나게 많은 시간 소요

## 8. 재부팅 후 버전 확인 - 커널 설치 완료

```
chahyeona@hycha: ~/Desktop
chahyeona@hycha:~/Desktop$ uname -r
5.13.0-41-generic
chahyeona@hycha:~/Desktop$
```

->

```
chahyeona@hycha:~/Desktop$ uname -r
5.13.12
chahyeona@hycha:~/Desktop$
```

## 9. 시스템 콜 구현 파일 만들기

```
chahyeona@hycha:/usr/src/linux-5.13.12/kernel$ sudo vi mySysCall_hycha.c
chahyeona@hycha:/usr/src/linux-5.13.12/kernel$
```

## 10. 시스템 콜 구현(인자값이 20일 때 이름과 생년월일을 출력)

```
#include <linux/kernel.h>
#include <linux/syscalls.h>
#include <linux/time64.h>
#include <linux/ktime.h>
#include <linux/linkage.h>
#include <linux/timekeeping.h>

asmlinkage long sys_mySysCall_hycha(int num)
{
    struct tm my_date;
    unsigned long time;

    time=ktime_get_real_seconds();
    time64_to_tm(time, 32400, &my_date);

    if(num==20)
    {
        printk("chahyeona, 000320\n");
        printk("Today : %ldy %dm %dd %dh %dm %ds\n", my_date.tm_year + 1900, my_date.tm_mon + 1, my_date.tm_mday, my_date.tm_hour, my_date.tm_min, my_date.tm_sec);
    }
    else
    {
        printk("Incorrect Input!\n");
        printk("Today : %ldy %dm %dd %dh %dm %ds\n", my_date.tm_year + 1900, my_date.tm_mon + 1, my_date.tm_mday, my_date.tm_hour, my_date.tm_min, my_date.tm_sec);
    }
    return 0;
}

SYSCALL_DEFINE1(mySysCall_hycha, int, num)
{
    return sys_mySysCall_hycha(num);
}
```

11. 추가한 시스템콜을 시스템 콜 테이블에 등록(이때 등록한 번호를 반드시 기억)

```
chahyeona@hycha:/usr/src/linux-5.13.12/kernel$ cd ../
chahyeona@hycha:/usr/src/linux-5.13.12$ cd arch/x86/entry/syscalls/
chahyeona@hycha:/usr/src/linux-5.13.12/arch/x86/entry/syscalls$ ls
Makefile syscall_32.tbl syscall_64.tbl syscallhdr.sh syscalltbl.sh
chahyeona@hycha:/usr/src/linux-5.13.12/arch/x86/entry/syscalls$ sudo vi s
yscall_64.tbl
```

```
445     common    landlock_add_rule      sys_landlock_add_rule
446     common    landlock_restrict_self  sys_landlock_restrict_self
447     common    mySysCall_hycha         sys_mySysCall_hycha
#
# Due to a historical design error, certain syscalls are numbered differ
ntly
# in x32 as compared to native x86_64. These syscalls have numbers 512-5
47.
```

12. 추가한 시스템콜을 시스템 콜 헤더파일에 등록

```
mbus.h                zstd.h
mc146818rtc.h          zutil.h
mc6821.h
chahyeona@hycha:/usr/src/linux-5.13.12/include/linux$ sudo vi syscalls.h
chahyeona@hycha:/usr/src/linux-5.13.12/include/linux$
```

```
*/
#ifdef CONFIG_ARCH_HAS_SYSCALL_WRAPPER
asmlinkage long sys_mySysCall_hycha(int num);
asmlinkage long sys_io_setup(unsigned nr_reqs, aio_context_t
;
asmlinkage long sys_io_destroy(aio_context_t ctx);
```

13. 추가한 시스템콜을 Makefile에 등록

```
chahyeona@hycha:/usr/src/linux-5.13.12/include/linux$ cd ../../
chahyeona@hycha:/usr/src/linux-5.13.12$ cd kernel/
chahyeona@hycha:/usr/src/linux-5.13.12/kernel$ sudo vi Makefile
```

```
obj-y      = fork.o exec_domain.o panic.o \
            cpu.o exit.o softirq.o resource.o \
            sysctl.o capability.o ptrace.o user.o \
            signal.o sys.o umh.o workqueue.o pid.o task_work.o \
            extable.o params.o \
            kthread.o sys_ni.o nsproxy.o \
            notifier.o ksysfs.o cred.o reboot.o \
            async.o range.o smpboot.o ucount.o regset.o mySysCall_hycha.o

obj-$(CONFIG_USERMODE_DRIVER) += usermode_driver.o
```



14. sudo make-> sudo make modules\_install -> make install 순서로 컴파일

```
chahyeona@hycha:/usr/src/linux-5.13.12$ sudo make
```

\* modules\_install을 하지않으면,  
비지박스(initramfs)에 빠집니다\*

```
BT [M] sound/xen/snd_xen_frontend.ko
GEN scripts/gdb/linux/constants.py
chahyeona@hycha:/usr/src/linux-5.13.12$ sudo make modules_install
```

```
DEPMOD /lib/modules/5.13.12
chahyeona@hycha:/usr/src/linux-5.13.12$ sudo make install
```

- install이 완료된 모습(make에 엄청난 시간이 소요됨)

```
Found initrd image: /boot/initrd.img-5.13.12
Found linux image: /boot/vmlinuz-5.13.0-41-generic
Found initrd image: /boot/initrd.img-5.13.0-41-generic
Found linux image: /boot/vmlinuz-5.13.0-30-generic
Found initrd image: /boot/initrd.img-5.13.0-30-generic
Found memtest86+ image: /boot/memtest86+.elf
Found memtest86+ image: /boot/memtest86+.bin
done
chahyeona@hycha:/usr/src/linux-5.13.12$
```

15. mySysCall\_hycha 시스템 콜 실행을 위한 test.c 파일(앞에서 기억한 번호 447)

```
chahyeona@hycha: ~  
#include <stdio.h>  
#include <linux/kernel.h>  
#include <sys/syscall.h>  
#include <unistd.h>  
int main()  
{  
    long int a = syscall(447,20);  
    printf("System call sys_mySysCall_hycha returned %ld\n", a);  
    return 0;  
}
```

16. 시스템콜 함수에서 0을 리턴하도록 설계했으므로 정상적인 결과가 출력되었음

```
chahyeona@hycha:~$ gcc test.c  
chahyeona@hycha:~$ ./a.out  
System call sys_mySysCall_hycha returned 0  
chahyeona@hycha:~$
```

17. dmesg 명령을 통해 결과 확인

```
chahyeona@hycha:~$ gcc test.c  
chahyeona@hycha:~$ ./a.out  
System call sys_mySysCall_hycha returned 0  
chahyeona@hycha:~$ dmesg
```

18. 생일로 설정된 20을 인자로 넘겼을 때 출력 값

```
[ 66.374013] chahyeona, 000320
[ 66.374017] Today : 2022y 5m 18d 0h 48m 56s
chahyeona@hycha:~$
```

19. 생일이 아닌 다른 숫자를 넘겼을 때의 출력

```
[ 126.209106] Incorrect Input!
[ 126.209110] Today : 2022y 5m 18d 0h 49m 56s
chahyeona@hycha:~$
```

20. 최종 결과 화면

```
control: none
[ 14.254664] IPv6: ADDRCONF(NETDEV_CHANGE): ens33: link becomes ready
[ 16.646487] loop8: detected capacity change from 0 to 8
[ 19.712188] rfkill: input handler disabled
[ 41.834316] Bluetooth: RFCOMM TTY layer initialized
[ 41.834326] Bluetooth: RFCOMM socket layer initialized
[ 41.834334] Bluetooth: RFCOMM ver 1.11
[ 41.837445] rfkill: input handler enabled
[ 48.263045] rfkill: input handler disabled
[ 66.374013] chahyeona, 000320
[ 66.374017] Today : 2022y 5m 18d 0h 48m 56s
[ 126.209106] Incorrect Input!
[ 126.209110] Today : 2022y 5m 18d 0h 49m 56s
chahyeona@hycha:~$
```