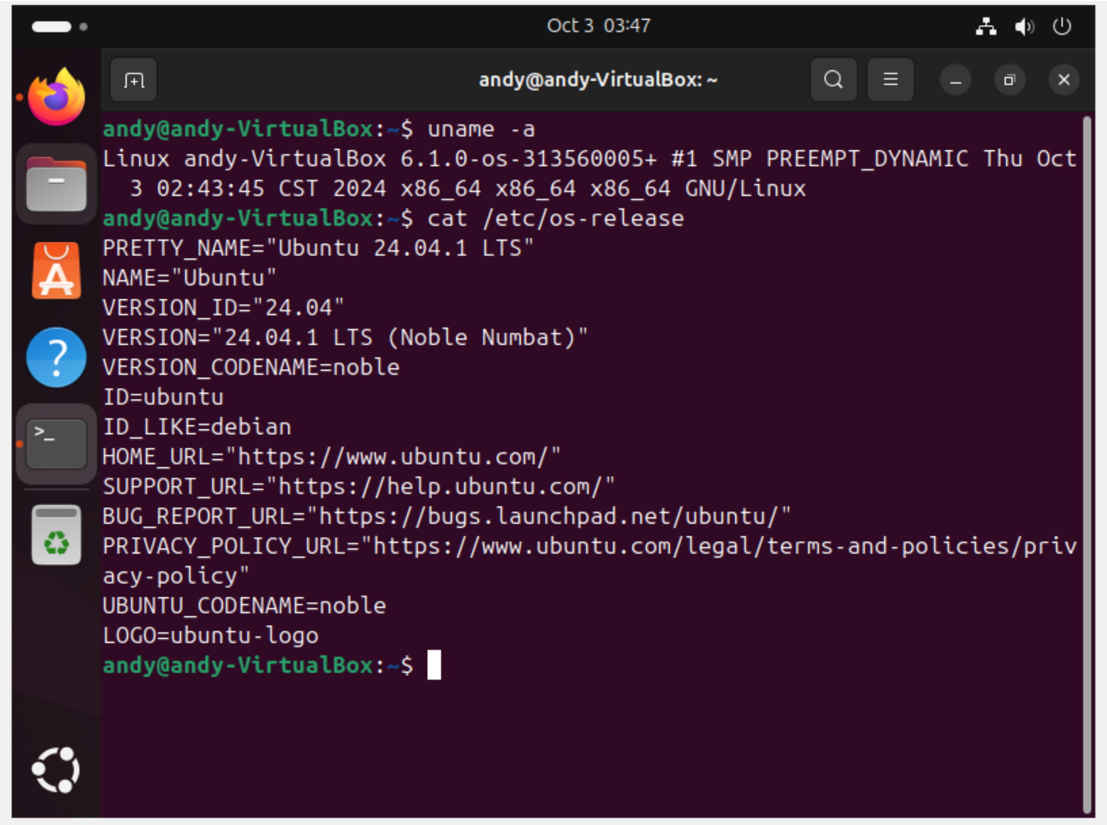
I. Compiling the Linux Kernel



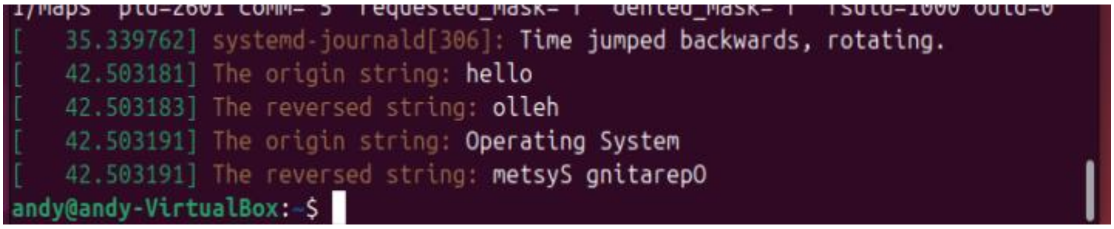
```
andy@andy-VirtualBox:~$ uname -a
Linux andy-VirtualBox 6.1.0-os-313560005+ #1 SMP PREEMPT_DYNAMIC Thu Oct
 3 02:43:45 CST 2024 x86_64 x86_64 x86_64 GNU/Linux
andy@andy-VirtualBox:~$ cat /etc/os-release
PRETTY_NAME="Ubuntu 24.04.1 LTS"
NAME="Ubuntu"
VERSION_ID="24.04"
VERSION="24.04.1 LTS (Noble Numbat)"
VERSION_CODENAME=noble
ID=ubuntu
ID_LIKE=debian
HOME_URL="https://www.ubuntu.com/"
SUPPORT_URL="https://help.ubuntu.com/"
BUG_REPORT_URL="https://bugs.launchpad.net/ubuntu/"
PRIVACY_POLICY_URL="https://www.ubuntu.com/legal/terms-and-policies/priv
acy-policy"
UBUNTU_CODENAME=noble
LOGO=ubuntu-logo
andy@andy-VirtualBox:~$ 
```

Step:

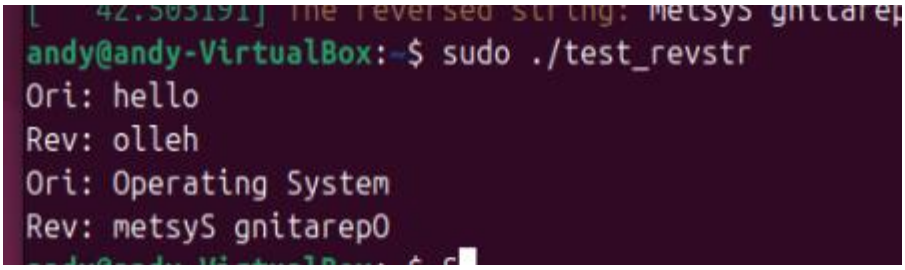
1. sudo apt-get -y install gcc libncurses5-dev build-essential fakeroot kernel-package bzip2
2. sudo cp /boot/config-`uname –r` .
3. 修改 Makefile 的 EXTRAVERSION = -os-313560005
4. scripts/config --disable SYSTEM_TRUSTED_KEYS
5. scripts/config --disable SYSTEM_REVOCATION_KEYS
6. sudo make menuconfig
7. sudo make –j 4 clean
8. sudo make –j 4
9. sudo make modules –j 4
10. sudo make modules_install
11. sudo make install
12. sudo vim /etc/default/grub 在裡面設定 GRUB_DEFAULT="Advanced options for Ubuntu>Ubuntu, with Linux 6.1.0-os-313560005+"
13. sudo update-grub

II. Implementing a new System Calls

先給結果:



```
1/maps  pid=2601 comm="S  requested_mask="r  denied_mask="r  fsuid=1000 ouid=0
[   35.339762] systemd-journald[306]: Time jumped backwards, rotating.
[   42.503181] The origin string: hello
[   42.503183] The reversed string: olleh
[   42.503191] The origin string: Operating System
[   42.503191] The reversed string: metsyS gnitarepO
andy@andy-VirtualBox:~$ 
```



```
[   42.503191] The reversed string: metsyS gnitarep
andy@andy-VirtualBox:~$ sudo ./test_revstr
Ori: hello
Rev: olleh
Ori: Operating System
Rev: metsyS gnitarepO
andy@andy-VirtualBox:~$ c
```

過程:

先新增以下幾點

linux/include/linux/syscalls.h:

asmlinkage long sys_revstr(char __user *str ,size_t len);

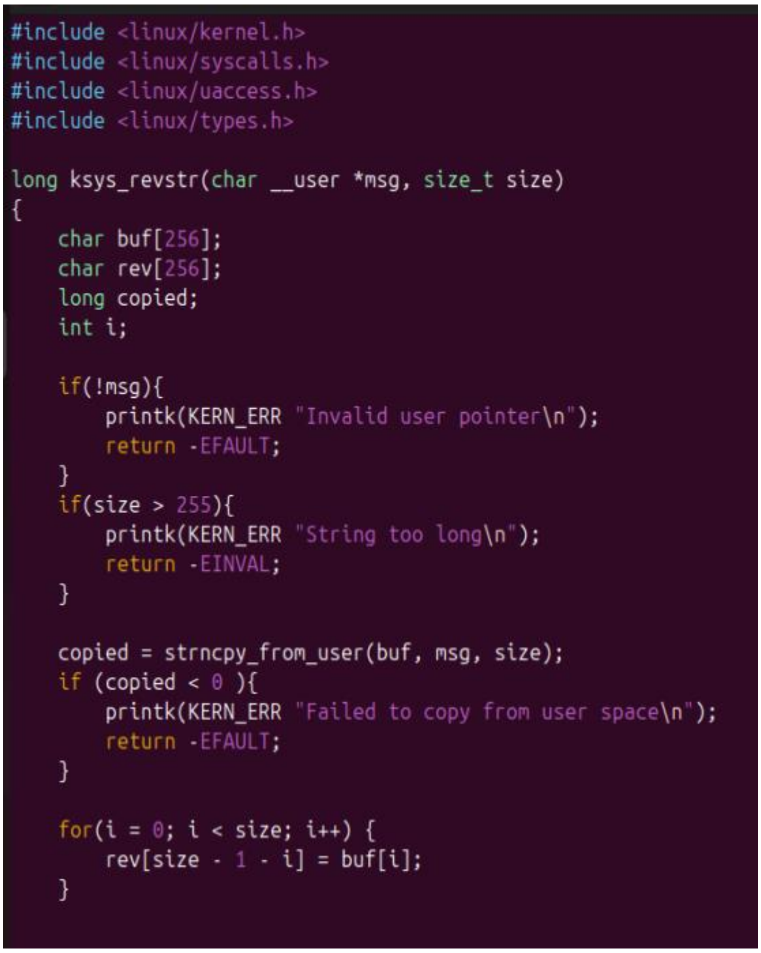
linux-5.19.12/include/uapi/asm-generic/unistd.h

#define __NR_revstr 451 __SYSCALL(__NR_revstr, sys_revstr)

arch/x86/entry/syscalls/syscall_64.tbl:

451 common revstr sys_revstr

之後在 linux 目錄底下新增資料夾 revstr，並且新增以下腳本 sys_revstr.c



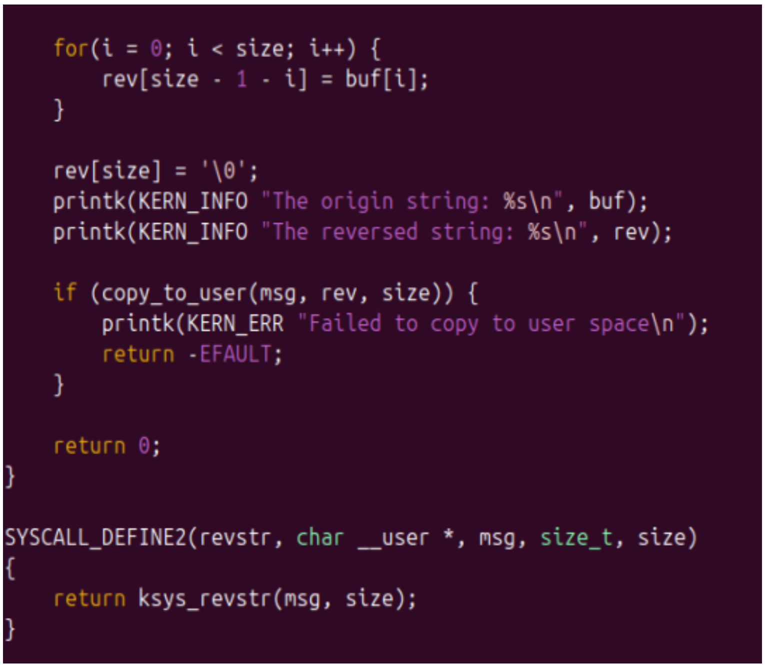
```
#include <linux/kernel.h>
#include <linux/syscalls.h>
#include <linux/uaccess.h>
#include <linux/types.h>

long ksys_revstr(char __user *msg, size_t size)
{
    char buf[256];
    char rev[256];
    long copied;
    int i;

    if(!msg){
        printk(KERN_ERR "Invalid user pointer\n");
        return -EFAULT;
    }
    if(size > 255){
        printk(KERN_ERR "String too long\n");
        return -EINVAL;
    }

    copied = strncpy_from_user(buf, msg, size);
    if (copied < 0 ){
        printk(KERN_ERR "Failed to copy from user space\n");
        return -EFAULT;
    }

    for(i = 0; i < size; i++) {
        rev[size - 1 - i] = buf[i];
    }
```



```
    for(i = 0; i < size; i++) {
        rev[size - 1 - i] = buf[i];
    }

    rev[size] = '\0';
    printk(KERN_INFO "The origin string: %s\n", buf);
    printk(KERN_INFO "The reversed string: %s\n", rev);

    if (copy_to_user(msg, rev, size)) {
        printk(KERN_ERR "Failed to copy to user space\n");
        return -EFAULT;
    }

    return 0;
}
SYSCALL_DEFINE2(revstr, char __user *, msg, size_t, size)
{
    return ksys_revstr(msg, size);
}
```

最後再創一個 Makefile，新增 obj-y += sys_revstr.o，再回到 linux 目錄的 Makefile 新增 core-y += revstr/ ，接著編譯 kernel 就有了。