

作業說明：<https://hackmd.io/@-ZZtFnnqSZ2F1A-Uy-GMlw/HJJj4BcKC>

報告網址：<https://hackmd.io/@iTkWej8WRj2Xrnb85FtIPQ/HJHK4MpC0>

# I. Compiling the Linux Kernel

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## 1. 下載所需套件

```
$ sudo apt update
$ sudo apt-get install git libncurses5-dev libncurses-dev libssl-dev build-essential bison flex libelf-dev
```

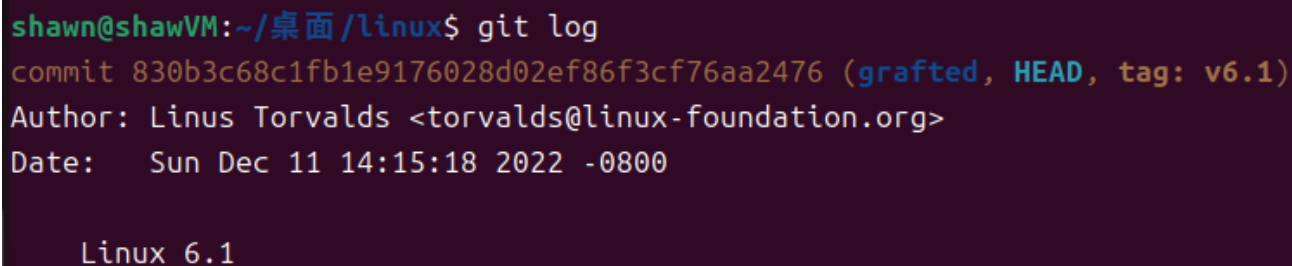
## 2. 取得 kernel source

```
git clone https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git -
depth=1 -b v6.1 -single-branch
```

## 3. 查看資料夾資訊

```
cd linux
```

```
git log
```

A terminal window with a dark purple background. The prompt is 'shawn@shawVM:~/桌面/linux\$'. The command 'git log' has been executed. The output shows a single commit: 'commit 830b3c68c1fb1e9176028d02ef86f3cf76aa2476 (grafted, HEAD, tag: v6.1)'. Below the commit hash, it says 'Author: Linus Torvalds <torvalds@linux-foundation.org>' and 'Date: Sun Dec 11 14:15:18 2022 -0800'. At the bottom of the terminal output, it says 'Linux 6.1'.

```
shawn@shawVM:~/桌面/linux$ git log
commit 830b3c68c1fb1e9176028d02ef86f3cf76aa2476 (grafted, HEAD, tag: v6.1)
Author: Linus Torvalds <torvalds@linux-foundation.org>
Date: Sun Dec 11 14:15:18 2022 -0800

Linux 6.1
```

```
head Makefile -n 5
```

```
shawn@shawVM:~/桌面/linux$ head Makefile -n 5
# SPDX-License-Identifier: GPL-2.0
VERSION = 6
PATCHLEVEL = 1
SUBLEVEL = 0
EXTRAVERSION =
```

## 4. 編譯、建置 kernel

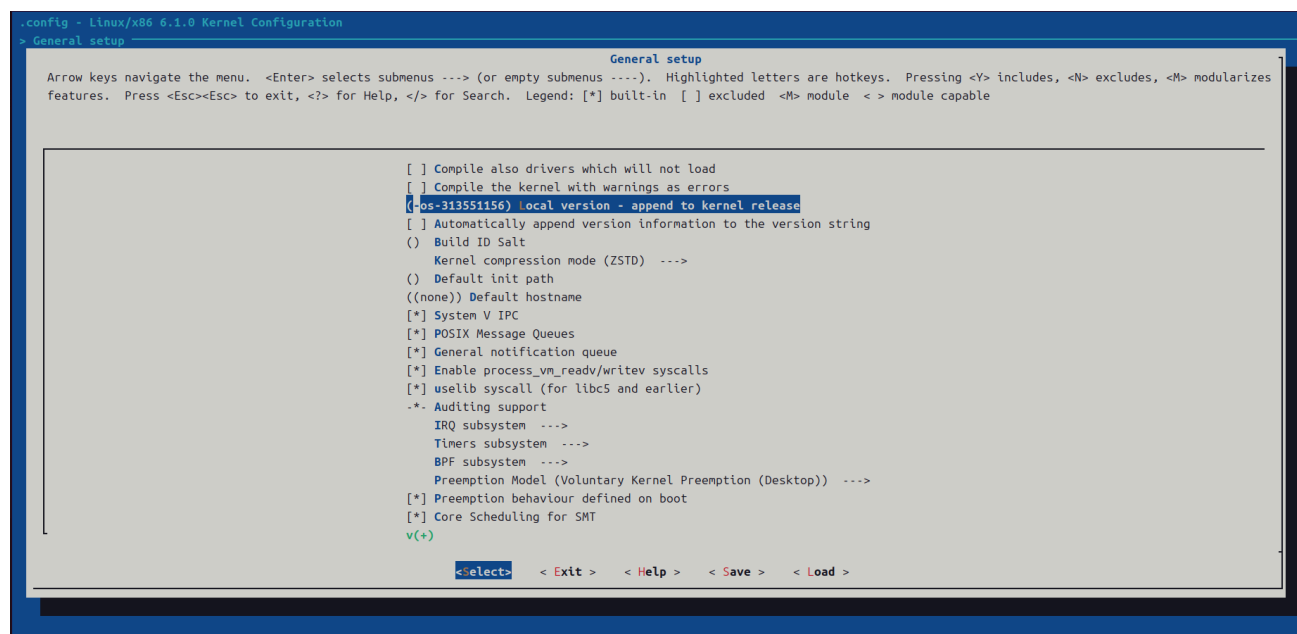
```
sudo make distclean O=build
```

### 修改 Kernel Configuration

把terminal視窗放到最大

```
make menuconfig
```

“General setup” -> “Local version - append to kernel release”



修改 .config 中的下列參數 (使用UI操作須顯示隱藏檔)

```
CONFIG_SYSTEM_TRUSTED_KEYS=""
CONFIG_SYSTEM_REVOCATION_KEYS=""
```

## 建置 kernel

```
sudo make -j4 (or sudo make -j$(nproc))
sudo make -j4 modules_install
sudo make -j4 install
```

## 更新 GRUB

- 讓 GRUB 選單自動開啟、儲存(optional)  
到 `/etc/default/grub` 修改以下資訊

```
GRUB_SAVEDFAULT=true
GRUB_TIMEOUT_STYLE=menu
GRUB_TIMEOUT=-1
```

```
sudo update-grub
```

## 5. 進入建置的 kernel 版本

重新開機，進入 GRUB 選單 (按下shift)

“Advanced options for ubuntu”-> 選版本



GNU GRUB version 2.12

```
Ubuntu, with Linux 6.8.0-45-generic
Ubuntu, with Linux 6.8.0-45-generic (recovery mode)
*Ubuntu, with Linux 6.1.1-os-313551156
Ubuntu, with Linux 6.1.1-os-313551156 (recovery mode)
```

Use the ↑ and ↓ keys to select which entry is highlighted.  
Press enter to boot the selected OS, `e` to edit the commands  
before booting or `c` for a command-line. ESC to return previous  
menu.

## 6. 確認版本

```
uname -a
cat /etc/os-release
```

```
shawn@shawnVM:~/桌面$ uname -a
Linux shawnVM 6.1.0-os-313551156 #1 SMP PREEMPT_DYNAMIC Thu Oct 3 11:18:52 CST 2024 x86_64 x86_64 x86_64 GNU/Linux
shawn@shawnVM:~/桌面$ 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/privacy-policy"
UBUNTU_CODENAME=noble
LOGO=ubuntu-logo
```

## II. Implementing a new System Call

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### 1. 創建資料夾、新增 system call 程式碼

```
cd linux
mkdir custom_syscall
cd custom_syscall
```

#### 創建 system call 檔案、編寫程式碼

```
touch revstr.c
```

- revstr.c 內容：

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

SYSCALL_DEFINE2(revstr, char*, input_str, int, n){
    char str[100];
    char temp;
    copy_from_user(str, input_str, n); // (void *to, const void *from, unsigned long
n)
    printk("The origin string: %s\n", str);

    for(int i = 0; i < n/2; i++){
        temp = str[i];
        str[i] = str[n-1-i];
        str[n-1-i] = temp;
    }

    copy_to_user(input_str, str, n);
    printk("The reversed string: %s\n", str);

    return 0;
}
```

#### 建立 custom\_syscall 的 Makefile

```
touch Makefile
```



- Makefile 內容：

```
obj-y += revstr.o
```

## 2.修改其他檔案

回 linux 資料夾

```
cd ../
```

修改 Kbuild

- 新增 obj-y += custom\_syscall/

修改 arch/x86/entry/syscalls/syscall\_64.tbl

- 在system call區域最後新增 451 common revstr sys\_revstr

修改 include/linux/syscalls.h

- 在#endif前新增一行 `asmlinkage int sys_revstr(char* input_str, int n);`

## 3. 回 linux 資料夾，編譯、安裝 kernel

```
sudo make clean
sudo make -j$(nproc)
sudo make -j$(nproc) modules_install install
```

## 4. 進入建置的 kernel 版本

重新開機，進入 GRUB 選單，選擇 kernel (6.1.0-os-313551156+)

## 5. 測試 system call

建立測試用程式碼

```
touch test_revstr.c
```

- test\_revstr.c 内容：

```
#include <unistd.h>
#include <string.h>
#include <stdio.h>
#include <assert.h>

#define __NR_revstr 451

int main(int argc, char *argv[]) {

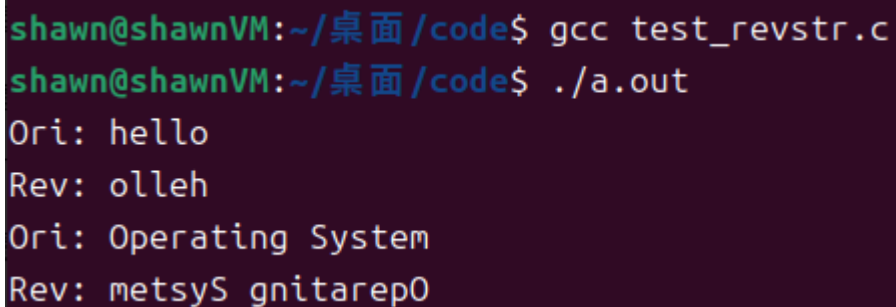
    char str1[20] = "hello";
    printf("Ori: %s\n", str1);
    int ret1 = syscall(__NR_revstr, str1, strlen(str1));
    assert(ret1 == 0);
    printf("Rev: %s\n", str1);

    char str2[20] = "Operating System";
    printf("Ori: %s\n", str2);
    int ret2 = syscall(__NR_revstr, str2, strlen(str2));
    assert(ret2 == 0);
    printf("Rev: %s\n", str2);

    return 0;
}
```

## 編譯、執行 test\_revstr.c

```
gcc test_revstr.c
./a.out
```



```
shawn@shawnVM:~/桌面/code$ gcc test_revstr.c
shawn@shawnVM:~/桌面/code$ ./a.out
Ori: hello
Rev: olleh
Ori: Operating System
Rev: metsyS gnitarepO
```

## 查看 kernel ring buffer

```
sudo dmesg
```

```
[ 618.575268] The origin string: hello
[ 618.575273] The reversed string: olleh
[ 618.575290] The origin string: Operating System
[ 618.575291] The reversed string: metsyS gnitarep0
```

## III. Patch

---

### 1. 設定 git config 、commit

```
git status
git config --global user.email "a0935262880@gmail.com"
git config --global user.name "Shawn"
git commit -m "add the system call - revstr"
git log
```

```
shawn@shawnVM:~/桌面/linux$ git log
commit b9c47a56c04d2246631bea345378317d9a352e22 (HEAD)
Author: Shawn <a0935262880@gmail.com>
Date:   Fri Oct 4 14:32:02 2024 +0800

    add the system call - revstr

commit 830b3c68c1fb1e9176028d02ef86f3cf76aa2476 (grafted, tag: v6.1)
Author: Linus Torvalds <torvalds@linux-foundation.org>
Date:   Sun Dec 11 14:15:18 2022 -0800

    Linux 6.1
```

### 2. 製作 patch

```
git format-patch -root -o ./patch
```

```
shawn@shawnVM:~/桌面/linux$ git format-patch --root -o ./patch
./patch/0001-Linux-6.1.patch
./patch/0002-add-the-system-call-revstr.patch
```



## IV. Package list

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### 1. 列出下載的 packages

```
dpkg --get-selections > packages_list_313551156.txt
```