# Project

## Team Members

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# Adding A System Call To The Linux Kernel (5.8.1) In Ubuntu (20.04 LTS)

1. Fully update operating system.

```
    sudo apt update && sudo apt upgrade -y
```

2. Download and install the essential packages to compile kernels.

```
sudo apt install build-essential libncurses-dev libssl-dev libelf-dev bison flex –y

sudo apt install vim -y
```

3. Clean up installed packages.

```
sudo apt clean && sudo apt autoremove -y
```

4. Download the source code of the version of the Linux kernel (*which is 5.8.1*) to home folder.

```
wget -P ~/ https://cdn.kernel.org/pub/linux/kernel/v5.x/linux-5.8.1.tar.xz
```

5. Unpack the tarball just downloaded to home folder.

```
tar -xvf ~/linux-5.8.1.tar.xz -C ~/
```

6. Check the version of current kernel.

```
uname -r
```

display 5.4.0-42-generic

7.  Change working directory to the root directory of the recently unpacked source code.

```
cd ~/linux-5.8.1/
```

8. Create the home directory of system call.

Decide a name for system call, and keep it consistent from this point onwards. I have chosen identity.

```
mkdir identity
```

9. Create a C file for system call.

Create the C file with the following command.

```
nano identity/identity.c
```

Write the following code in it.

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

SYSCALL_DEFINE0(identity)

{
    printk("we are Mahmoud and randa.\n");
    return 0;
}
```

10. Create a Makefile for system call.

Create the Makefile with the following command.

```
nano identity/Makefile
```
Write the following code in it.

```
obj-y := identity.o
```

11. Add the home directory of system call to the main Makefile of the kernel.

Open the Makefile with the following command.

```
nano Makefile
```
Search for core-y. In the second result, The series of directories.

kernel/ certs/ mm/ fs/ ipc/ security/ crypto/ block/

Add the home directory of system call at the end like the following.

`kernel/ certs/ mm/ fs/ ipc/ security/ crypto/ block/ identity/`

12. Add a corresponding function prototype for system call to the header file of system calls.

Open the header file with the following command.

`nano include/linux/syscalls.h`

Navigate to the bottom of it and write the following code just above #endif

`asmlinkage long sys_identity(void);`

13. Add system call to the kernel's system call table.

`nano arch/x86/entry/syscalls/syscall_64.tbl`

Navigate to the bottom of it. find a series of x32 system calls. Scroll to the section above it. This is the section of interest. Add the following code at the end of this section respecting the chronology of the row as well as the format of the column. Use Tab for space.

`440     common  identity            sys_identity`

14. Configure the kernel.

The window of terminal must maximized.

Open the configuration window with the following command.

`make menuconfig`

Use **Tab** to move between options. Make no changes to keep it in default settings.

15. Find out how many logical cores.

`nproc`

The following few commands require a long time to be executed. Parallel processing will greatly speed them up. For me, it is 2. Therefore, I will put 2 after -j in the following commands.

16. write these commands

```
make clean
make mrproper
make menuconfig
make localmodconfig
```

choose yes then no then yes

17. Compile the kernel's source code.

```
make -j2
```

18. Prepare the installer of the kernel.

```
sudo make modules_install -j2
```

19. Install the kernel.

```
sudo make install -j2
```

20. Update the bootloader of the operating system with the new kernel.

```
sudo update-grub
```

21. Restart

```
shutdown –r now
```

22. Check the version of your current kernel.

```
uname -r
```

Display 5.8.1

23. Change working directory to home directory.

```
cd ~
```

24. Create a C file to generate a report of the success or failure of system call.

```
nano report.c
```

Write the following code in it.

```c
#include <linux/kernel.h>
#include <sys/syscall.h>
#include <stdio.h>
#include <unistd.h>
#include <string.h>
#include <errno.h>

#define __NR_identity 440

long identity_syscall(void)
{
    return syscall(__NR_identity);
}

int main(int argc, char *argv[])
{
    long activity;
    activity = identity_syscall();

    if(activity < 0)
    {
        perror("Sorry, mahmoud and randa.");
    }

    else
    {
        printf("Congratulations, mahmoud and randa! \n");
    }

    return 0;
}
```

25. Compile the C file just created.

```
gcc -o report report.c
```

26. Run the C file just compiled.

```
./report
```

The Output

```
randa@ubuntu: ~

randa@ubuntu:~$ gcc -o report report.c
randa@ubuntu:~$ ./report
Congratulations, mahmoud and randa!
```

## 27. Check the last line of the dmesg output.

```
dmesg
```

## The Output

**Activities**        ▣ Terminal ▾                Jun 7  13:16                        ⚡ 🔊 ⏻ ▾

**randa@ubuntu: ~**        🔍    ≡    _    ▢    ✕

```
[    0.000000] x86/fpu: Supporting XSAVE feature 0x001: 'x87 floating point reg
isters'
[    0.000000] x86/fpu: Supporting XSAVE feature 0x002: 'SSE registers'
[    0.000000] x86/fpu: Supporting XSAVE feature 0x004: 'AVX registers'
[    0.000000] x86/fpu: xstate_offset[2]:  576, xstate_sizes[2]:  256
[    0.000000] x86/fpu: Enabled xstate features 0x7, context size is 832 bytes,
 using 'standard' format.
[    0.000000] BIOS-provided physical RAM map:
[    0.000000] BIOS-e820: [mem 0x0000000000000000-0x000000000009e7ff] usable
[    0.000000] BIOS-e820: [mem 0x000000000009e800-0x000000000009ffff] reserved
[    0.000000] BIOS-e820: [mem 0x00000000000dc000-0x00000000000fffff] reserved
[    0.000000] BIOS-e820: [mem 0x0000000000100000-0x000000007fedffff] usable
[    0.000000] BIOS-e820: [mem 0x000000007fee0000-0x000000007fefefff] ACPI data
[    0.000000] BIOS-e820: [mem 0x000000007feff000-0x000000007fefffff] ACPI NVS
[    0.000000] BIOS-e820: [mem 0x000000007ff00000-0x000000007fffffff] usable
[    0.000000] BIOS-e820: [mem 0x00000000f0000000-0x00000000f7ffffff] reserved
[    0.000000] BIOS-e820: [mem 0x00000000fec00000-0x00000000fec0ffff] reserved
[    0.000000] BIOS-e820: [mem 0x00000000fee00000-0x00000000fee00fff] reserved
[    0.000000] BIOS-e820: [mem 0x00000000fffe0000-0x00000000ffffffff] reserved
[    0.000000] NX (Execute Disable) protection: active
[    0.000000] SMBIOS 2.7 present.
[    0.000000] DMI: VMware, Inc. VMware Virtual Platform/440BX Desktop Referenc
e Platform, BIOS 6.00 07/22/2020
[    0.000000] vmware: hypercall mode: 0x02
[    0.000000] Hypervisor detected: VMware
[    0.000000] vmware: TSC freq read from hypervisor : 2693.768 MHz
[    0.000000] vmware: Host bus clock speed read from hypervisor : 66000000 Hz
[    0.000000] vmware: using clock offset of 5284626927 ns
[    0.016587] tsc: Detected 2693.768 MHz processor
```

**Activities**        ▣ Terminal ▾                Jun 7  13:21                        ⚡ 🔊 ⏻ ▾

**randa@ubuntu: ~**        🔍    ≡    _    ▢    ✕

```
[    5.810251] systemd[1]: Detected virtualization vmware.
[    5.810259] systemd[1]: Detected architecture x86-64.
[    5.838859] systemd[1]: Set hostname to <ubuntu>.
[    6.039460] systemd-rc-local-generator[337]: /etc/rc.local is not marked exe
cutable, skipping.
[    6.624300] systemd[1]: Created slice system-modprobe.slice.
[    6.626448] systemd[1]: Created slice system-systemd\x2dfsck.slice.
[    6.628152] systemd[1]: Created slice User and Session Slice.
[    6.628473] systemd[1]: Started Forward Password Requests to Wall Directory
Watch.
[    6.628696] systemd[1]: Condition check resulted in Arbitrary Executable Fil
e Formats File System Automount Point being skipped.
[    6.628876] systemd[1]: Reached target User and Group Name Lookups.
[    6.629139] systemd[1]: Reached target Remote File Systems.
[    6.629194] systemd[1]: Reached target Slices.
[    6.631532] systemd[1]: Listening on Syslog Socket.
[    6.633410] systemd[1]: Listening on fsck to fsckd communication Socket.
[    6.633727] systemd[1]: Listening on initctl Compatibility Named Pipe.
[    6.634537] systemd[1]: Listening on Journal Audit Socket.
[    6.634803] systemd[1]: Listening on Journal Socket (/dev/log).
[    6.635244] systemd[1]: Listening on Journal Socket.
[    6.635858] systemd[1]: Listening on udev Control Socket.
[    6.636136] systemd[1]: Listening on udev Kernel Socket.
[    6.640219] systemd[1]: Mounting Huge Pages File System...
[    6.648232] systemd[1]: Mounting POSIX Message Queue File System...
[    6.651964] systemd[1]: Mounting Kernel Debug File System...
[    6.658419] systemd[1]: Mounting Kernel Trace File System...
[    6.666967] systemd[1]: Starting Journal Service...
[    6.670718] systemd[1]: Starting Set the console keyboard layout...
```

Player ▾  ❚❚ ▾

Activities     🖵 Terminal ▾                    Jun 7 13:21

randa@ubuntu: ~

```
rq 56
[    4.093264] ata24: SATA max UDMA/133 abar m4096@0xfd5ee000 port 0xfd5eeb80 i
rq 56
[    4.093265] ata25: SATA max UDMA/133 abar m4096@0xfd5ee000 port 0xfd5eec00 i
rq 56
[    4.093265] ata26: SATA max UDMA/133 abar m4096@0xfd5ee000 port 0xfd5eec80 i
rq 56
[    4.093267] ata27: SATA max UDMA/133 abar m4096@0xfd5ee000 port 0xfd5eed00 i
rq 56
[    4.093267] ata28: SATA max UDMA/133 abar m4096@0xfd5ee000 port 0xfd5eed80 i
rq 56
[    4.093268] ata29: SATA max UDMA/133 abar m4096@0xfd5ee000 port 0xfd5eee00 i
rq 56
[    4.093269] ata30: SATA max UDMA/133 abar m4096@0xfd5ee000 port 0xfd5eee80 i
rq 56
[    4.093269] ata31: SATA max UDMA/133 abar m4096@0xfd5ee000 port 0xfd5eef00 i
rq 56
[    4.093270] ata32: SATA max UDMA/133 abar m4096@0xfd5ee000 port 0xfd5eef80 i
rq 56
[    4.139165] usb 2-2: New USB device found, idVendor=0e0f, idProduct=0002, bc
dDevice= 1.00
[    4.139167] usb 2-2: New USB device strings: Mfr=1, Product=2, SerialNumber=
0
[    4.139169] usb 2-2: Product: VMware Virtual USB Hub
[    4.139170] usb 2-2: Manufacturer: VMware, Inc.
[    4.159553] hub 2-2:1.0: USB hub found
[    4.169471] hub 2-2:1.0: 7 ports detected
[    4.186826] ioc0: LSI53C1030 B0: Capabilities={Initiator}
[    4.227900] hid: raw HID events driver (C) Jiri Kosina
[    4.241082] usbcore: registered new interface driver usbhid
```

```
[    3.126836] Linux agpgart interface v0.103
[    3.127139] agpgart-intel 0000:00:00.0: Intel 440BX Chipset
[    3.128521] agpgart-intel 0000:00:00.0: AGP aperture is 256M @ 0x0
[    3.216045] loop: module loaded
[    3.217004] ata_piix 0000:00:07.1: version 2.13
[    3.218928] scsi host0: ata_piix
[    3.219858] scsi host1: ata_piix
[    3.220010] ata1: PATA max UDMA/33 cmd 0x1f0 ctl 0x3f6 bmdma 0x1060 irq 14
[    3.220013] ata2: PATA max UDMA/33 cmd 0x170 ctl 0x376 bmdma 0x1068 irq 15
[    3.220605] libphy: Fixed MDIO Bus: probed
[    3.220608] tun: Universal TUN/TAP device driver, 1.6
[    3.220856] PPP generic driver version 2.4.2
[    3.220992] VFIO - User Level meta-driver version: 0.3
[    3.221304] ehci_hcd: USB 2.0 'Enhanced' Host Controller (EHCI) Driver
[    3.221315] ehci-pci: EHCI PCI platform driver
[    3.223272] ehci-pci 0000:02:03.0: EHCI Host Controller
[    3.223288] ehci-pci 0000:02:03.0: new USB bus registered, assigned bus numb
er 1
[    3.223984] ehci-pci 0000:02:03.0: cache line size of 64 is not supported
[    3.224042] ehci-pci 0000:02:03.0: irq 17, io mem 0xfd5ef000
[    3.238196] ehci-pci 0000:02:03.0: USB 2.0 started, EHCI 1.00
[    3.238521] usb usb1: New USB device found, idVendor=1d6b, idProduct=0002, b
cdDevice= 5.08
[    3.238528] usb usb1: New USB device strings: Mfr=3, Product=2, SerialNumber
=1
[    3.238533] usb usb1: Product: EHCI Host Controller
[    3.238537] usb usb1: Manufacturer: Linux 5.8.1 ehci_hcd
[    3.238541] usb usb1: SerialNumber: 0000:02:03.0
[    3.239158] hub 1-0:1.0: USB hub found
```

Ubuntu 64-bit (6) - VMware Workstation 16 Player (Non-commercial use only)

Player ▾

Activities     Terminal ▾                    Jun 7  13:20

randa@ubuntu: ~

```
[    1.362671] Unpacking initramfs...
[    2.814593] Freeing initrd memory: 55976K
[    2.814925] check: Scanning for low memory corruption every 60 seconds
[    2.818132] Initialise system trusted keyrings
[    2.818144] Key type blacklist registered
[    2.818490] workingset: timestamp_bits=36 max_order=19 bucket_order=0
[    2.820853] zbud: loaded
[    2.833621] squashfs: version 4.0 (2009/01/31) Phillip Lougher
[    2.834668] fuse: init (API version 7.31)
[    2.835742] integrity: Platform Keyring initialized
[    2.875067] Key type asymmetric registered
[    2.875073] Asymmetric key parser 'x509' registered
[    2.875402] Block layer SCSI generic (bsg) driver version 0.4 loaded (major
244)
[    2.876103] io scheduler mq-deadline registered
[    2.879396] pcieport 0000:00:15.0: PME: Signaling with IRQ 24
[    2.879876] pcieport 0000:00:15.0: pciehp: Slot #160 AttnBtn+ PwrCtrl+ MRL-
AttnInd- PwrInd- HotPlug+ Surprise- Interlock- NoCompl+ IbPresDis- LLActRep+
[    2.884837] pcieport 0000:00:15.1: PME: Signaling with IRQ 25
[    2.885335] pcieport 0000:00:15.1: pciehp: Slot #161 AttnBtn+ PwrCtrl+ MRL-
AttnInd- PwrInd- HotPlug+ Surprise- Interlock- NoCompl+ IbPresDis- LLActRep+
[    2.890563] pcieport 0000:00:15.2: PME: Signaling with IRQ 26
[    2.890969] pcieport 0000:00:15.2: pciehp: Slot #162 AttnBtn+ PwrCtrl+ MRL-
AttnInd- PwrInd- HotPlug+ Surprise- Interlock- NoCompl+ IbPresDis- LLActRep+
[    2.896510] pcieport 0000:00:15.3: PME: Signaling with IRQ 27
[    2.897073] pcieport 0000:00:15.3: pciehp: Slot #163 AttnBtn+ PwrCtrl+ MRL-
AttnInd- PwrInd- HotPlug+ Surprise- Interlock- NoCompl+ IbPresDis- LLActRep+
[    2.901835] pcieport 0000:00:15.4: PME: Signaling with IRQ 28
[    2.902242] pcieport 0000:00:15.4: pciehp: Slot #164 AttnBtn+ PwrCtrl+ MRL-
```

Ubuntu 64-bit (6) - VMware Workstation 16 Player (Non-commercial use only)

Player ▾

Activities     Terminal ▾                    Jun 7  13:20

randa@ubuntu: ~

```
add_size 1000
[    1.353369] pci 0000:00:15.4: bridge window [io  0x1000-0x0fff] to [bus 07]
add_size 1000
[    1.353370] pci 0000:00:15.5: bridge window [io  0x1000-0x0fff] to [bus 08]
add_size 1000
[    1.353371] pci 0000:00:15.6: bridge window [io  0x1000-0x0fff] to [bus 09]
add_size 1000
[    1.353373] pci 0000:00:15.7: bridge window [io  0x1000-0x0fff] to [bus 0a]
add_size 1000
[    1.353375] pci 0000:00:16.3: bridge window [io  0x1000-0x0fff] to [bus 0e]
add_size 1000
[    1.353376] pci 0000:00:16.4: bridge window [io  0x1000-0x0fff] to [bus 0f]
add_size 1000
[    1.353377] pci 0000:00:16.5: bridge window [io  0x1000-0x0fff] to [bus 10]
add_size 1000
[    1.353378] pci 0000:00:16.6: bridge window [io  0x1000-0x0fff] to [bus 11]
add_size 1000
[    1.353380] pci 0000:00:16.7: bridge window [io  0x1000-0x0fff] to [bus 12]
add_size 1000
[    1.353381] pci 0000:00:17.3: bridge window [io  0x1000-0x0fff] to [bus 16]
add_size 1000
[    1.353383] pci 0000:00:17.4: bridge window [io  0x1000-0x0fff] to [bus 17]
add_size 1000
[    1.353389] pci 0000:00:17.5: bridge window [io  0x1000-0x0fff] to [bus 18]
add_size 1000
[    1.353391] pci 0000:00:17.6: bridge window [io  0x1000-0x0fff] to [bus 19]
add_size 1000
[    1.353393] pci 0000:00:17.7: bridge window [io  0x1000-0x0fff] to [bus 1a]
add_size 1000
```

Player ▾

Activities        Terminal ▾                    Jun 7 13:20

randa@ubuntu: ~

```
[    1.149685] ACPI: bus type USB registered
[    1.149685] usbcore: registered new interface driver usbfs
[    1.149685] usbcore: registered new interface driver hub
[    1.149685] usbcore: registered new device driver usb
[    1.149685] pps_core: LinuxPPS API ver. 1 registered
[    1.149685] pps_core: Software ver. 5.3.6 - Copyright 2005-2007 Rodolfo Giom
etti <giometti@linux.it>
[    1.149685] PTP clock support registered
[    1.149685] EDAC MC: Ver: 3.0.0
[    1.157784] NetLabel: Initializing
[    1.157787] NetLabel:  domain hash size = 128
[    1.157788] NetLabel:  protocols = UNLABELED CIPSOv4 CALIPSO
[    1.157816] NetLabel:  unlabeled traffic allowed by default
[    1.157929] PCI: Using ACPI for IRQ routing
[    1.199967] PCI: pci_cache_line_size set to 64 bytes
[    1.202299] e820: reserve RAM buffer [mem 0x0009e800-0x0009ffff]
[    1.202303] e820: reserve RAM buffer [mem 0x7fee0000-0x7fffffff]
[    1.203005] hpet0: at MMIO 0xfed00000, IRQs 2, 8, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0
[    1.203014] hpet0: 16 comparators, 64-bit 14.318180 MHz counter
[    1.207052] clocksource: Switched to clocksource tsc-early
[    1.301339] VFS: Disk quotas dquot_6.6.0
[    1.301543] VFS: Dquot-cache hash table entries: 512 (order 0, 4096 bytes)
[    1.301959] AppArmor: AppArmor Filesystem Enabled
[    1.301990] pnp: PnP ACPI init
[    1.302243] system 00:00: [io   0x1000-0x103f] has been reserved
[    1.302244] system 00:00: [io   0x1040-0x104f] has been reserved
[    1.302246] system 00:00: [io   0x0cf0-0x0cf1] has been reserved
[    1.302252] system 00:00: Plug and Play ACPI device, IDs PNP0c02 (active)
```

Player ▾

Activities        Terminal ▾                    Jun 7 13:19

randa@ubuntu: ~

```
it pref]
[    0.957314] pci 0000:00:15.1: PCI bridge to [bus 04]
[    0.957346] pci 0000:00:15.1:   bridge window [io  0x8000-0x8fff]
[    0.957374] pci 0000:00:15.1:   bridge window [mem 0xfd000000-0xfd0fffff]
[    0.957429] pci 0000:00:15.1:   bridge window [mem 0xe7600000-0xe76fffff 64b
it pref]
[    0.961230] pci 0000:00:15.2: PCI bridge to [bus 05]
[    0.961261] pci 0000:00:15.2:   bridge window [io  0xc000-0xcfff]
[    0.961289] pci 0000:00:15.2:   bridge window [mem 0xfcc00000-0xfccfffff]
[    0.961344] pci 0000:00:15.2:   bridge window [mem 0xe7200000-0xe72fffff 64b
it pref]
[    0.965253] pci 0000:00:15.3: PCI bridge to [bus 06]
[    0.965314] pci 0000:00:15.3:   bridge window [mem 0xfc800000-0xfc8fffff]
[    0.965369] pci 0000:00:15.3:   bridge window [mem 0xe6e00000-0xe6efffff 64b
it pref]
[    0.969149] pci 0000:00:15.4: PCI bridge to [bus 07]
[    0.969205] pci 0000:00:15.4:   bridge window [mem 0xfc400000-0xfc4fffff]
[    0.969260] pci 0000:00:15.4:   bridge window [mem 0xe6a00000-0xe6afffff 64b
it pref]
[    0.973163] pci 0000:00:15.5: PCI bridge to [bus 08]
[    0.973224] pci 0000:00:15.5:   bridge window [mem 0xfc000000-0xfc0fffff]
[    0.973279] pci 0000:00:15.5:   bridge window [mem 0xe6600000-0xe66fffff 64b
it pref]
[    0.977125] pci 0000:00:15.6: PCI bridge to [bus 09]
[    0.977183] pci 0000:00:15.6:   bridge window [mem 0xfbc00000-0xfbcfffff]
[    0.977238] pci 0000:00:15.6:   bridge window [mem 0xe6200000-0xe62fffff 64b
it pref]
[    0.981042] pci 0000:00:15.7: PCI bridge to [bus 0a]
[    0.981101] pci 0000:00:15.7:   bridge window [mem 0xfb800000-0xfb8fffff]
```

```
[    0.926970] acpiphp: Slot [58] registered
[    0.926995] acpiphp: Slot [59] registered
[    0.927020] acpiphp: Slot [60] registered
[    0.927045] acpiphp: Slot [61] registered
[    0.927069] acpiphp: Slot [62] registered
[    0.927094] acpiphp: Slot [63] registered
[    0.927195] pci 0000:02:00.0: [15ad:0774] type 00 class 0x0c0300
[    0.928621] pci 0000:02:00.0: reg 0x20: [io   0x2080-0x209f]
[    0.929977] pci 0000:02:01.0: [8086:100f] type 00 class 0x020000
[    0.930878] pci 0000:02:01.0: reg 0x10: [mem 0xfd5c0000-0xfd5dffff 64bit]
[    0.931709] pci 0000:02:01.0: reg 0x18: [mem 0xfdff0000-0xfdffffff 64bit]
[    0.932464] pci 0000:02:01.0: reg 0x20: [io   0x2000-0x203f]
[    0.933949] pci 0000:02:01.0: reg 0x30: [mem 0x00000000-0x0000ffff pref]
[    0.934389] pci 0000:02:01.0: PME# supported from D0 D3hot D3cold
[    0.934968] pci 0000:02:02.0: [1274:1371] type 00 class 0x040100
[    0.935324] pci 0000:02:02.0: reg 0x10: [io   0x2040-0x207f]
[    0.937985] pci 0000:02:03.0: [15ad:0770] type 00 class 0x0c0320
[    0.938435] pci 0000:02:03.0: reg 0x10: [mem 0xfd5ef000-0xfd5effff]
[    0.941549] pci 0000:02:05.0: [15ad:07e0] type 00 class 0x010601
[    0.943766] pci 0000:02:05.0: reg 0x24: [mem 0xfd5ee000-0xfd5eefff]
[    0.944123] pci 0000:02:05.0: reg 0x30: [mem 0x00000000-0x0000ffff pref]
[    0.944668] pci 0000:02:05.0: PME# supported from D3hot
[    0.948993] pci 0000:00:11.0: PCI bridge to [bus 02] (subtractive decode)
[    0.949023] pci 0000:00:11.0:   bridge window [io   0x2000-0x3fff]
[    0.949052] pci 0000:00:11.0:   bridge window [mem 0xfd500000-0xfdffffff]
[    0.949106] pci 0000:00:11.0:   bridge window [mem 0xe7b00000-0xe7ffffff 64b
it pref]
[    0.949108] pci 0000:00:11.0:   bridge window [mem 0x000a0000-0x000bffff win
```

```
[    0.525949] Simple Boot Flag at 0x36 set to 0x80
[    0.525949] ACPI: bus type PCI registered
[    0.525949] acpiphp: ACPI Hot Plug PCI Controller Driver version: 0.5
[    0.525949] PCI: MMCONFIG for domain 0000 [bus 00-7f] at [mem 0xf0000000-0xf
7ffffff] (base 0xf0000000)
[    0.525949] PCI: MMCONFIG at [mem 0xf0000000-0xf7ffffff] reserved in E820
[    0.525949] PCI: Using configuration type 1 for base access
[    0.526004] core: PMU erratum BJ122, BV98, HSD29 workaround disabled, HT off
[    0.533582] HugeTLB registered 1.00 GiB page size, pre-allocated 0 pages
[    0.533582] HugeTLB registered 2.00 MiB page size, pre-allocated 0 pages
[    0.581547] ACPI: Added _OSI(Module Device)
[    0.581550] ACPI: Added _OSI(Processor Device)
[    0.581553] ACPI: Added _OSI(3.0 _SCP Extensions)
[    0.581555] ACPI: Added _OSI(Processor Aggregator Device)
[    0.581557] ACPI: Added _OSI(Linux-Dell-Video)
[    0.581560] ACPI: Added _OSI(Linux-Lenovo-NV-HDMI-Audio)
[    0.581562] ACPI: Added _OSI(Linux-HPI-Hybrid-Graphics)
[    0.624853] ACPI: 1 ACPI AML tables successfully acquired and loaded
[    0.629607] ACPI: [Firmware Bug]: BIOS _OSI(Linux) query ignored
[    0.696695] ACPI: Interpreter enabled
[    0.696743] ACPI: (supports S0 S1 S4 S5)
[    0.696747] ACPI: Using IOAPIC for interrupt routing
[    0.696829] PCI: Using host bridge windows from ACPI; if necessary, use "pci
=nocrs" and report a bug
[    0.699830] ACPI: Enabled 4 GPEs in block 00 to 0F
[    0.821797] ACPI: PCI Root Bridge [PCI0] (domain 0000 [bus 00-7f])
[    0.821805] acpi PNP0A03:00: _OSC: OS supports [ExtendedConfig ASPM ClockPM
Segments MSI HPX-Type3]
[    0.822080] acpi PNP0A03:00: _OSC: platform does not support [AER LTR]
[    0.822353] acpi PNP0A03:00: _OSC: OS now controls [PCIeHotplug SHPCHotplug
```

```
[    0.469358] smpboot: CPU0: Intel(R) Core(TM) i7-4800MQ CPU @ 2.70GHz (family
: 0x6, model: 0x3c, stepping: 0x3)
[    0.470091] Performance Events: Haswell events, core PMU driver.
[    0.470141] core: CPUID marked event: 'cpu cycles' unavailable
[    0.470142] core: CPUID marked event: 'instructions' unavailable
[    0.470144] core: CPUID marked event: 'bus cycles' unavailable
[    0.470145] core: CPUID marked event: 'cache references' unavailable
[    0.470146] core: CPUID marked event: 'cache misses' unavailable
[    0.470147] core: CPUID marked event: 'branch instructions' unavailable
[    0.470149] core: CPUID marked event: 'branch misses' unavailable
[    0.470154] ... version:                 1
[    0.470156] ... bit width:               48
[    0.470157] ... generic registers:       4
[    0.470161] ... value mask:              0000ffffffffffff
[    0.470162] ... max period:              000000007fffffff
[    0.470163] ... fixed-purpose events:    0
[    0.470165] ... event mask:              000000000000000f
[    0.470488] rcu: Hierarchical SRCU implementation.
[    0.472853] NMI watchdog: Perf NMI watchdog permanently disabled
[    0.497102] smp: Bringing up secondary CPUs ...
[    0.498321] x86: Booting SMP configuration:
[    0.498325] .... node  #0, CPUs:         #1
[    0.028398] Disabled fast string operations
[    0.028398] smpboot: CPU 1 Converting physical 2 to logical package 1
[    0.028398] smpboot: CPU 1 Converting physical 0 to logical die 1
[    0.501434] smp: Brought up 1 node, 2 CPUs
[    0.501434] smpboot: Max logical packages: 128
[    0.501434] smpboot: Total of 2 processors activated (10775.07 BogoMIPS)
[    0.505084] devtmpfs: initialized
```

```
[    0.050630] PM: hibernation: Registered nosave memory: [mem 0x000dc000-0x000
fffff]
[    0.050631] PM: hibernation: Registered nosave memory: [mem 0x7fee0000-0x7fe
fefff]
[    0.050632] PM: hibernation: Registered nosave memory: [mem 0x7feff000-0x7fe
fffff]
[    0.050634] [mem 0x80000000-0xefffffff] available for PCI devices
[    0.050635] Booting paravirtualized kernel on VMware hypervisor
[    0.050639] clocksource: refined-jiffies: mask: 0xffffffff max_cycles: 0xfff
fffff, max_idle_ns: 7645519600211568 ns
[    0.050647] setup_percpu: NR_CPUS:8192 nr_cpumask_bits:128 nr_cpu_ids:128 nr
_node_ids:1
[    0.335012] percpu: Embedded 56 pages/cpu s192512 r8192 d28672 u262144
[    0.335048] pcpu-alloc: s192512 r8192 d28672 u262144 alloc=1*2097152
[    0.335051] pcpu-alloc: [0] 000 001 002 003 004 005 006 007
[    0.335058] pcpu-alloc: [0] 008 009 010 011 012 013 014 015
[    0.335065] pcpu-alloc: [0] 016 017 018 019 020 021 022 023
[    0.335071] pcpu-alloc: [0] 024 025 026 027 028 029 030 031
[    0.335077] pcpu-alloc: [0] 032 033 034 035 036 037 038 039
[    0.335083] pcpu-alloc: [0] 040 041 042 043 044 045 046 047
[    0.335088] pcpu-alloc: [0] 048 049 050 051 052 053 054 055
[    0.335094] pcpu-alloc: [0] 056 057 058 059 060 061 062 063
[    0.335100] pcpu-alloc: [0] 064 065 066 067 068 069 070 071
[    0.335106] pcpu-alloc: [0] 072 073 074 075 076 077 078 079
[    0.335112] pcpu-alloc: [0] 080 081 082 083 084 085 086 087
[    0.335118] pcpu-alloc: [0] 088 089 090 091 092 093 094 095
[    0.335124] pcpu-alloc: [0] 096 097 098 099 100 101 102 103
[    0.335130] pcpu-alloc: [0] 104 105 106 107 108 109 110 111
[    0.335136] pcpu-alloc: [0] 112 113 114 115 116 117 118 119
[    0.335142] pcpu-alloc: [0] 120 121 122 123 124 125 126 127
```

```
fffff] -> [mem 0x00000000-0x7fffffff]
[    0.037473] NODE_DATA(0) allocated [mem 0x7ffd6000-0x7fffffff]
[    0.037849] Zone ranges:
[    0.037850]   DMA      [mem 0x0000000000001000-0x0000000000ffffff]
[    0.037851]   DMA32    [mem 0x0000000001000000-0x000000007fffffff]
[    0.037853]   Normal   empty
[    0.037854]   Device   empty
[    0.037854] Movable zone start for each node
[    0.037858] Early memory node ranges
[    0.037860]   node   0: [mem 0x0000000000001000-0x000000000009dfff]
[    0.037861]   node   0: [mem 0x0000000000100000-0x000000007fedffff]
[    0.037862]   node   0: [mem 0x000000007ff00000-0x000000007fffffff]
[    0.037865] Zeroed struct page in unavailable ranges: 131 pages
[    0.037867] Initmem setup node 0 [mem 0x0000000000001000-0x000000007fffffff]
[    0.037868] On node 0 totalpages: 524157
[    0.037870]   DMA zone: 64 pages used for memmap
[    0.037870]   DMA zone: 21 pages reserved
[    0.037872]   DMA zone: 3997 pages, LIFO batch:0
[    0.037903]   DMA32 zone: 8128 pages used for memmap
[    0.037904]   DMA32 zone: 520160 pages, LIFO batch:63
[    0.050388] ACPI: PM-Timer IO Port: 0x1008
[    0.050393] ACPI: Local APIC address 0xfee00000
[    0.050399] system APIC only can use physical flat
[    0.050420] ACPI: LAPIC_NMI (acpi_id[0x00] high edge lint[0x1])
[    0.050421] ACPI: LAPIC_NMI (acpi_id[0x01] high edge lint[0x1])
[    0.050422] ACPI: LAPIC_NMI (acpi_id[0x02] high edge lint[0x1])
[    0.050423] ACPI: LAPIC_NMI (acpi_id[0x03] high edge lint[0x1])
[    0.050423] ACPI: LAPIC_NMI (acpi_id[0x04] high edge lint[0x1])
[    0.050424] ACPI: LAPIC_NMI (acpi_id[0x05] high edge lint[0x1])
```

```
[    0.037395] SRAT: PXM 0 -> APIC 0x5c -> Node 0
[    0.037396] SRAT: PXM 0 -> APIC 0x5e -> Node 0
[    0.037397] SRAT: PXM 0 -> APIC 0x60 -> Node 0
[    0.037397] SRAT: PXM 0 -> APIC 0x62 -> Node 0
[    0.037398] SRAT: PXM 0 -> APIC 0x64 -> Node 0
[    0.037399] SRAT: PXM 0 -> APIC 0x66 -> Node 0
[    0.037399] SRAT: PXM 0 -> APIC 0x68 -> Node 0
[    0.037400] SRAT: PXM 0 -> APIC 0x6a -> Node 0
[    0.037401] SRAT: PXM 0 -> APIC 0x6c -> Node 0
[    0.037401] SRAT: PXM 0 -> APIC 0x6e -> Node 0
[    0.037402] SRAT: PXM 0 -> APIC 0x70 -> Node 0
[    0.037403] SRAT: PXM 0 -> APIC 0x72 -> Node 0
[    0.037403] SRAT: PXM 0 -> APIC 0x74 -> Node 0
[    0.037404] SRAT: PXM 0 -> APIC 0x76 -> Node 0
[    0.037405] SRAT: PXM 0 -> APIC 0x78 -> Node 0
[    0.037405] SRAT: PXM 0 -> APIC 0x7a -> Node 0
[    0.037406] SRAT: PXM 0 -> APIC 0x7c -> Node 0
[    0.037406] SRAT: PXM 0 -> APIC 0x7e -> Node 0
[    0.037407] SRAT: PXM 0 -> APIC 0x80 -> Node 0
[    0.037408] SRAT: PXM 0 -> APIC 0x82 -> Node 0
[    0.037408] SRAT: PXM 0 -> APIC 0x84 -> Node 0
[    0.037409] SRAT: PXM 0 -> APIC 0x86 -> Node 0
[    0.037410] SRAT: PXM 0 -> APIC 0x88 -> Node 0
[    0.037410] SRAT: PXM 0 -> APIC 0x8a -> Node 0
[    0.037411] SRAT: PXM 0 -> APIC 0x8c -> Node 0
[    0.037412] SRAT: PXM 0 -> APIC 0x8e -> Node 0
[    0.037412] SRAT: PXM 0 -> APIC 0x90 -> Node 0
[    0.037413] SRAT: PXM 0 -> APIC 0x92 -> Node 0
[    0.037414] SRAT: PXM 0 -> APIC 0x94 -> Node 0
[    0.037414] SRAT: PXM 0 -> APIC 0x96 -> Node 0
```

```
[  423.407499] we are mahmoud and randa.
[  609.968774] we are mahmoud and randa.
randa@ubuntu:~$
```

# References :

- https://dev.to/jasper/adding-a-system-call-to-the-linux-kernel-5-8-1-in-ubuntu-20-04-lts-2ga8