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CMPE283 Assignment 2

1. sudo apt-get update

2. sudo apt-get upgrade

3. sudo apt-get install git build-essential kernel-package libncurses5-dev bison flex libssl-dev ccache

4. reboot - Enter BIOS and disable Secure Boot in UEFI (BIOS) settings - Otherwise the third party complied ko cannot be inserted using insmod by default. Save BIOS and reboot

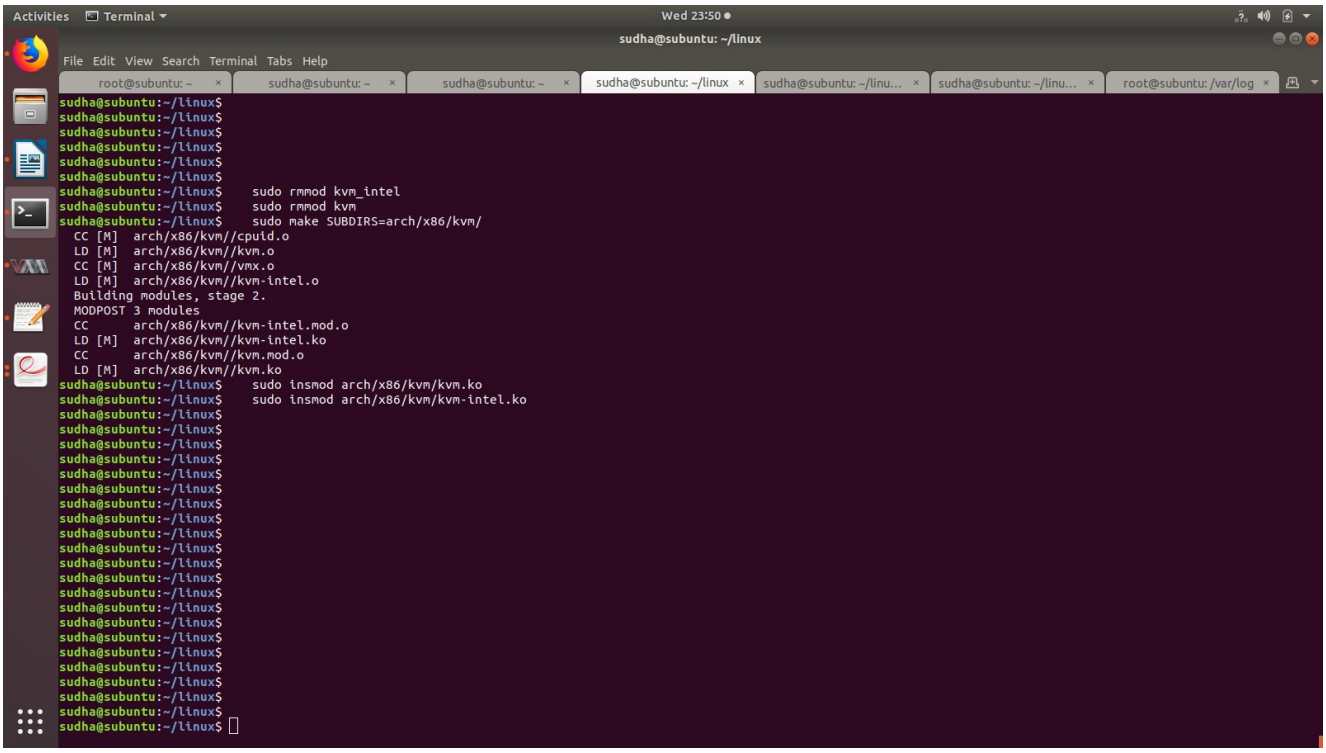
5. Download latest source code using "git clone git://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git"

6. Compile the new kernel code.
   (a) Change the directory to where the linux is downloaded
   (b) make clean && make mrproper
   (c) cp /boot/config-$(uname -r) .config
   (d) make menuconfig - save and exit
   (e) make
   (f) make modules
   (g) sudo make modules_install
   (h) sudo make install
   (i) sudo update-grub
   (j) Reboot and verify new kernel is chosen (uname -r)
       sudha@subuntu:~/linux$
       sudha@subuntu:~/linux$ uname -r
       4.20.0-rc2+

7. Now install KVM QEMU
   (a) sudo apt install cpu-checker – tool to check CPU compatibility with KVM
   (b) sudo kvm-ok – should be displayed.
   (c) sudo apt-get install qemu-kvm libvirt-bin ubuntu-vm-builder bridge-utils virt-manager
   (d) sudo adduser `id -un` libvirtd
   (e) sudo adduser `id -un` kvm
   (f) Setup bridge network interface.
   (g) Open virt-manager and install an Ubuntu Guest VM using an iso image of Ubuntu
   (h) Install CPUID package as well in the Guest VM
   (I) Shutdown the Guest VM

8. On the Host Ubuntu machine, modify the kernel code in the two files as in the diff file given.
   ~/linux/arch/x86/kvm/cpuid.c
   ~/linux/arch/x86/kvm/vmx.c

9. Run the following commands in ~/linux directory of the Host Ubuntu machine
   (a) sudo rmmod kvm_intel
   (b) sudo rmmod kvm
   (c) sudo make SUBDIRS=arch/x86/kvm/
   (d) sudo insmod arch/x86/kvm/kvm.ko
   (e) sudo insmod arch/x86/kvm/kvm-intel.ko

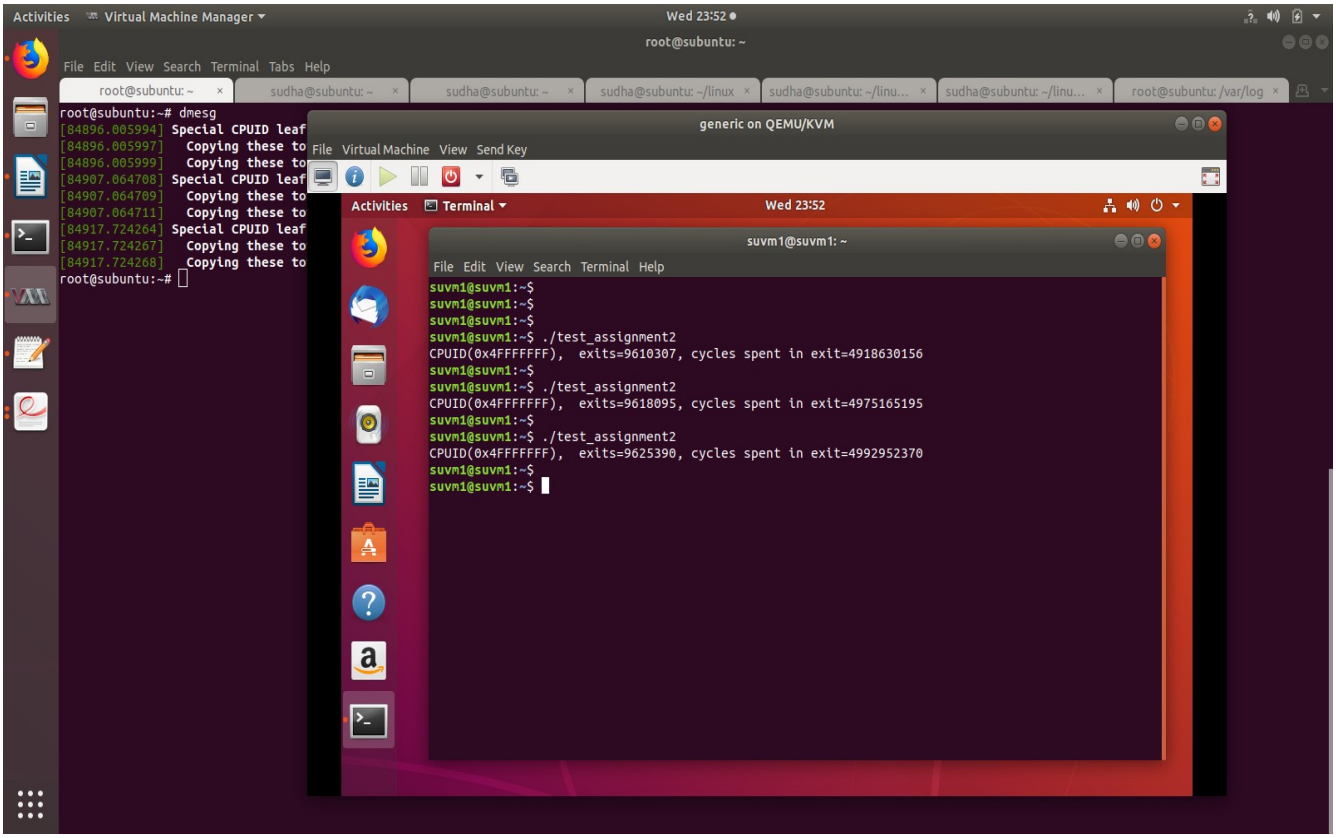


10. Start the Guest VM in virt-manager.

11. Once the Guest VM is up, issue the following shell script test_assignment2 few times

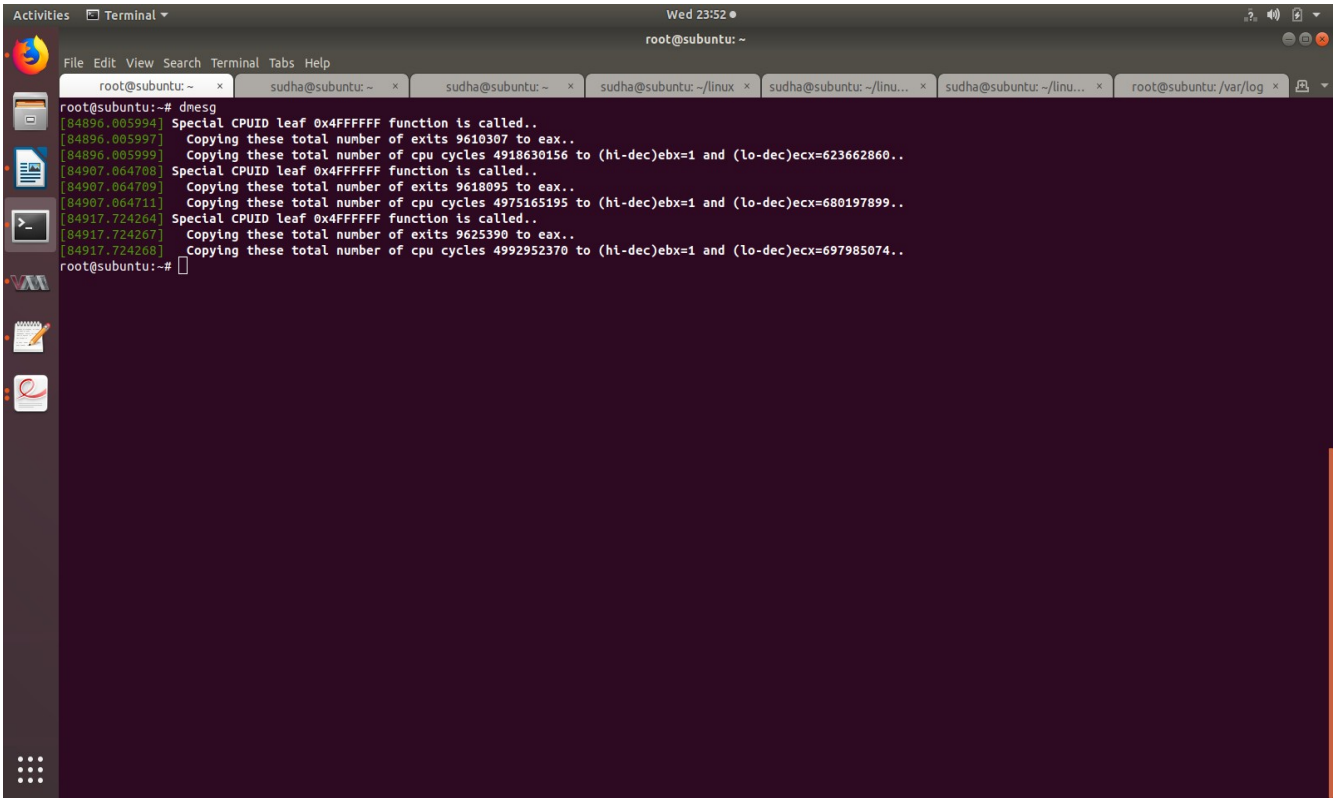
```
suvm1@suvm1:~$ cat test_assignment2
#!/bin/bash

cpuid="0x4FFFFFFF"
output=$(cpuid -l $cpuid -1)

eax=$(echo $output | grep 0x4fffffff | awk '{print toupper($4)}' | cut -c7-14)
ebx=$(echo $output | grep 0x4fffffff | awk '{print toupper($5)}' | cut -c7-14)
ecx=$(echo $output | grep 0x4fffffff | awk '{print toupper($6)}' | cut -c7-14)

exits=$(echo "ibase=16; $eax" | bc)
cycles=$(echo "ibase=16; $ebx$ecx" | bc)

echo "CPUID($cpuid),  exits=$exits, cycles spent in exit=$cycles"
```

12. Notice the output of number of vm exits and the number of cpu cycles on the Guest VM.



suvm1@suvm1:~$ ./test_assignment2
CPUID(0x4FFFFFFF), exits=10556620, cycles spent in exit=8518086635
suvm1@suvm1:~$
suvm1@suvm1:~$ ./test_assignment2
CPUID(0x4FFFFFFF), exits=10557096, cycles spent in exit=8520475237
suvm1@suvm1:~$
suvm1@suvm1:~$ ./test_assignment2
CPUID(0x4FFFFFFF), exits=10557570, cycles spent in exit=8523226043

13. Verify the same with the dmesg on the host VM



root@subuntu:~# dmesg
[84896.005994] Special CPUID leaf 0x4FFFFFF function is called..
[84896.005997] Copying these total number of exits 9610307 to eax..
[84896.005999] Copying these total number of cpu cycles 4918630156 to (hi-dec)ebx=1 and (lo-dec)ecx=623662860..
[84907.064708] Special CPUID leaf 0x4FFFFFF function is called..
[84907.064709] Copying these total number of exits 9618095 to eax..
[84907.064711] Copying these total number of cpu cycles 4975165195 to (hi-dec)ebx=1 and (lo-dec)ecx=680197899..
[84917.724264] Special CPUID leaf 0x4FFFFFF function is called..
[84917.724267] Copying these total number of exits 9625390 to eax..
[84917.724268] Copying these total number of cpu cycles 4992952370 to (hi-dec)ebx=1 and (lo-dec)ecx=697985074..
root@subuntu:~#

14. Git Log

```
sudha@subuntu:~/linux$
sudha@subuntu:~/linux$
sudha@subuntu:~/linux$ git log
commit c67a98c00ea3c1fad14833f440fcd770232d24e7 (HEAD -> master, origin/master,
origin/HEAD)
Merge: 03582f338e39 45e79815b891
Author: Linus Torvalds <torvalds@linux-foundation.org>
Date:   Sun Nov 18 11:31:26 2018 -0800

    Merge branch 'akpm' (patches from Andrew)

    Merge misc fixes from Andrew Morton:
     "16 fixes"

    * emailed patches from Andrew Morton <akpm@linux-foundation.org>:
      mm/memblock.c: fix a typo in __next_mem_pfn_range() comments
      mm, page_alloc: check for max order in hot path
      scripts/spdxcheck.py: make python3 compliant
      tmpfs: make lseek(SEEK_DATA/SEK_HOLE) return ENXIO with a negative offset
      lib/ubsan.c: don't mark __ubsan_handle_builtin_unreachable as noreturn
      mm/vmstat.c: fix NUMA statistics updates
      mm/gup.c: fix follow_page_mask() kerneldoc comment
      ocfs2: free up write context when direct IO failed
      scripts/faddr2line: fix location of start_kernel in comment
      mm: don't reclaim inodes with many attached pages
      mm, memory_hotplug: check zone_movable in has_unmovable_pages
      mm/swapfile.c: use kvzalloc for swap_info_struct allocation
      MAINTAINERS: update OMAP MMC entry
      hugetlbfs: fix kernel BUG at fs/hugetlbfs/inode.c:444!
      kernel/sched/psi.c: simplify cgroup_move_task()
      z3fold: fix possible reclaim races

commit 03582f338e39ed8f8e8451ef1ef04f060d785a87
Merge: b53e27f618b5 c469933e7721
Author: Linus Torvalds <torvalds@linux-foundation.org>
Date:   Sun Nov 18 10:58:20 2018 -0800

    Merge branch 'sched-urgent-for-linus' of git://git.kernel.org/pub/scm/linux/kernel/git/tip/tip

    Pull scheduler fix from Ingo Molnar:
     "Fix an exec() related scalability/performance regression, which was
      caused by incorrectly calculating load and migrating tasks on exec()
      when they shouldn't be"

    * 'sched-urgent-for-linus' of git://git.kernel.org/pub/scm/linux/kernel/git/tip/tip:
      sched/fair: Fix cpu_util_wake() for 'execl' type workloads
```

15. Git status

```
sudha@subuntu:~/linux$
sudha@subuntu:~/linux$ git status
On branch master
Your branch is up to date with 'origin/master'.

Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git checkout -- <file>..." to discard changes in working directory)

        modified:   arch/x86/kvm/cpuid.c
        modified:   arch/x86/kvm/vmx.c

no changes added to commit (use "git add" and/or "git commit -a")
```

16. Git Commit

```
sudha@subuntu:~/linux$
sudha@subuntu:~/linux$
sudha@subuntu:~/linux$ git commit -am "cmpe283-2 assignment"
[master f7b645192e40] cmpe283-2 assignment
 2 files changed, 57 insertions(+), 2 deletions(-)
sudha@subuntu:~/linux$
sudha@subuntu:~/linux$
sudha@subuntu:~/linux$ git log
commit f7b645192e404e0d80006e62793caf058a5ba95b (HEAD -> master)
Author: SudhaAmarnath <sudha04.a@gmail.com>
Date:   Thu Nov 22 00:32:54 2018 -0800

    cmpe283-2 assignment

commit c67a98c00ea3c1fad14833f440fcd770232d24e7 (origin/master, origin/HEAD)
Merge: 03582f338e39 45e79815b891
Author: Linus Torvalds <torvalds@linux-foundation.org>
Date:   Sun Nov 18 11:31:26 2018 -0800

    Merge branch 'akpm' (patches from Andrew)
```

17. **Comment on the frequency of exits – does the number of exits increase at a stable rate?**

Yes. The frequency of exits increase at a stable rate.

```
suvm1@suvm1:~$ ./test_assignment2; sleep 10; ./test_assignment2; sleep 10; ./test_assignment2;
sleep 10; ./test_assignment2; sleep 10;
CPUID(0x4FFFFFFF),  exits=10138837, cycles spent in exit=6851132872
CPUID(0x4FFFFFFF),  exits=10139578, cycles spent in exit=6855077521
CPUID(0x4FFFFFFF),  exits=10140435, cycles spent in exit=6858999424
CPUID(0x4FFFFFFF),  exits=10141211, cycles spent in exit=6863978597
suvm1@suvm1:~$
```

On an average with the test after each 10 secs, the number of exits is around 750.

```
suvm1@suvm1:~$ ./test_assignment2; sleep 100; ./test_assignment2; sleep 100;
./test_assignment2; sleep 100; ./test_assignment2;
CPUID(0x4FFFFFFF),  exits=10192955, cycles spent in exit=7174174659
CPUID(0x4FFFFFFF),  exits=10199178, cycles spent in exit=7209451429
CPUID(0x4FFFFFFF),  exits=10208843, cycles spent in exit=7260205865
CPUID(0x4FFFFFFF),  exits=10215747, cycles spent in exit=7302036518
suvm1@suvm1:~$
```

On an average with the test after each 100 secs, the number of exits is around 7000 or nearly 10 times of the previous 10 secs tests.

18. **Or are there more exits performed during certain VM operations?**

There would be considerably high number of exits when the VM boots.
If there are any other tasks performed on VM, then too the exits counter increases

19. **Approximately how many exits does a full VM boot entail?**

In my machine just after a minute of VM boot, the number of exits is showing a value of 20,219,771

```
suvm1@suvm1:~$ ./test_assignment2
CPUID(0x4FFFFFFF),  exits=20219771, cycles spent in exit=13260700700
suvm1@suvm1:~$ uptime
 01:00:02 up 1 min,  2 users,  load average: 0.57, 0.38, 0.15
suvm1@suvm1:~$
```