Report A1-PartA

1. First we installed build-essentials and other required packages to compile and build the kernel.

```
sudo apt-get install build-essential rsync gcc bc bison libssl-dev
libncurses5-dev libelf-dev dwarves flex qt5*
```

2. We increase the grub menu timeout value to 10 so that we can boot to different kernel versions.
3. The linux kernel-5.6.9 is downloaded from HERE
4. Next, we extracted the downloaded zip file for linux kernel and further copied the *.config* file from */boot/config-$(uname -r)/* to the extracted directory.
5. Next, we executed *make xconfig* and disable *AppArmor*, *DCCP protocol*, and default *TCP congestion control* algorithm is set to *Reno*. (See Figure 1)

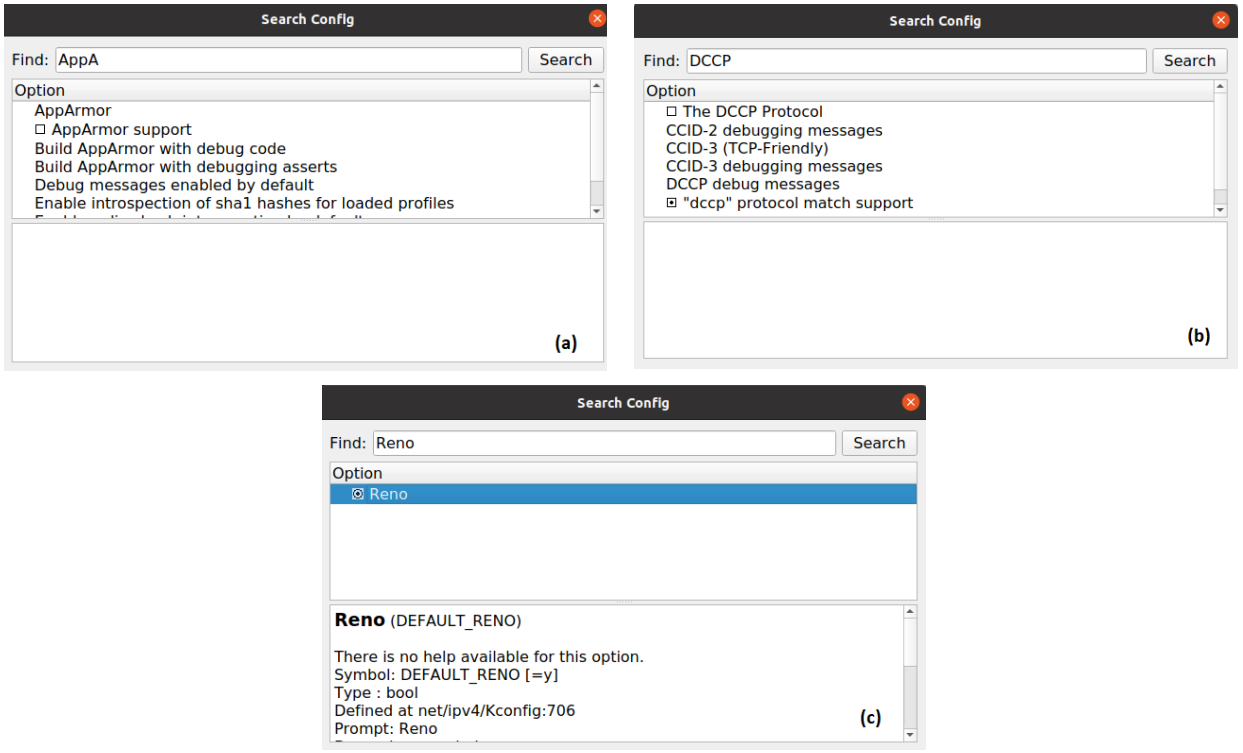

Fig. 1: Kernel configurations (a) Disabled AppArmor, (b) DCCP protocol is disabled, (c) TCP congestion control protocol is set to Reno.

6. While compiling the kernel we mainly faced two error as follows:

```
make[1]: *** No rule to make target 'debian/canonical-certs.pem', needed by
'certs/x509_certificate_list'.  Stop.
make: *** [Makefile:1809: certs] Error 2
```

   a. To solve the above error, we assign CONFIG_SYSTEM_TRUSTED_KEYS="" in the .config file.
   b. Memory exhausted during the compilation process. We solved it by increasing the allocated storage for the virtual machine.
7. Next, we install the build kernel by `sudo dpkg -i linux-*.deb`
8. Apart from this we change `GRUB_DEFAULT="Advanced options for Ubuntu>Ubuntu, with Linux 5.6.9"` so that the VM boots to the linux kernel 5.6.9 by default.

Observed Changes in the modified kernel 5.6.9:

Changes for AppArmor

In linux kernel 5.15.0-48-generic, AppArmor service is activated and profiles are loaded.

```
aos@aos-VirtualBox:~$ sudo systemctl status  apparmor
● apparmor.service - Load AppArmor profiles
     Loaded: loaded (/lib/systemd/system/apparmor.service; enabled; vendor pres>
     Active: active (exited) since Sat 2022-10-01 01:13:48 IST; 1min 2s ago
       Docs: man:apparmor(7)
             https://gitlab.com/apparmor/apparmor/wikis/home/
    Process: 534 ExecStart=/lib/apparmor/apparmor.systemd reload (code=exited, >
   Main PID: 534 (code=exited, status=0/SUCCESS)

Oct 01 01:13:47 aos-VirtualBox systemd[1]: Starting Load AppArmor profiles...
Oct 01 01:13:47 aos-VirtualBox apparmor.systemd[534]: Restarting AppArmor
Oct 01 01:13:47 aos-VirtualBox apparmor.systemd[534]: Reloading AppArmor profile>
Oct 01 01:13:48 aos-VirtualBox apparmor.systemd[551]: Skipping profile in /etc/>
Oct 01 01:13:48 aos-VirtualBox apparmor.systemd[553]: Skipping profile in /etc/>
Oct 01 01:13:48 aos-VirtualBox systemd[1]: Finished Load AppArmor profiles.
```

Whereas, in compiled linux kernel 5.6.9, AppArmor service is inactive.

```
aos@aos-VirtualBox:~$ sudo systemctl status  apparmor
● apparmor.service - Load AppArmor profiles
     Loaded: loaded (/lib/systemd/system/apparmor.service; enabled; vendor preset: en>
     Active: inactive (dead)
  Condition: start condition failed at Fri 2022-09-30 02:14:47 IST; 22h ago
       Docs: man:apparmor(7)
             https://gitlab.com/apparmor/apparmor/wikis/home/

Sep 30 02:14:47 aos-VirtualBox systemd[1]: Condition check resulted in Load AppArmor >
```

Changes for DCCP protocol

In the base linux kernel 5.15.0-48-generic, DCCP is an optional kernel module and it does not run by default. However, the pre-compiled kernel object file can be found at /lib/modules/5.15.0-48-generic/kernel/net/dccp/dccp.ko location. We can initiate the LKM by the insmod command.

Terminal	dmesg
aos@aos-VirtualBox:~$ modprobe -n -v dccp insmod /lib/modules/5.15.0-48-generic/kernel/net/dccp/dccp.ko aos@aos-VirtualBox:~$ sudo insmod /lib/modules/5.15.0-48-generic/kernel/net/dccp/dccp.ko aos@aos-VirtualBox:~$ sudo rmmod /lib/modules/5.15.0-48-generic/kernel/net/dccp/dccp.ko	[1977.842152] DCCP: Activated CCID 2 (TCP-like) [2045.736048] DCCP: Deactivated CCID 2 (TCP-like)

In compiled linux kernel 5.6.9, we remove the DCCP protocol hence the dccp module is not found in /lib/modules/5.6.9. Hence we can’t enable it even if we want to.

Terminal	dmesg
aos@aos-VirtualBox:~$ modprobe -n -v dccp modprobe: FATAL: Module dccp not found in directory /lib/modules/5.6.9	None

Changes for Reno

In linux kernel 5.15.0-48-generic, default ipv4 tcp congestion control protocol is cubic.

```
aos@aos-VirtualBox:~$ cat /proc/sys/net/ipv4/tcp_congestion_control
cubic
```

In compiled linux kernel 5.6.9, we modified the tcp congestion control protocol to reno.

```
aos@aos-VirtualBox:~$ cat /proc/sys/net/ipv4/tcp_congestion_control
reno
```