

Operating Systems

Proof of Concept Linux Virtual Network Project

Continuous Assessment 2

Programme: Bachelor of Science in Computing and
Information Technology

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Number Student: 2020303

VIRTUAL LINUX NETWORK AND WEB SERVER SETUP

1. Linux Update and upgrade the system using the relevant commands:

-sudo apt update

```
--- www.google.com ping statistics ---
23 packets transmitted, 23 received, 0% packet loss, time 22039ms
rtt min/avg/max/mdev = 8.929/10.785/16.832/1.947 ms
lpino@ubuntuclient:~$ sudo apt update
[sudo] password for lpino:
```

```
Get:47 http://archive.ubuntu.com/ubuntu focal-security/multiverse amd64 c-n-f Metadata [340 B]
Fetched 19.6 MB in 2min 6s (155 kB/s)
Reading package lists... Done
Building dependency tree
Reading state information... Done
88 packages can be upgraded. Run 'apt list --upgradable' to see them.
lpino@ubuntuserver:~$ _
```

-sudo apt upgrade

```
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-5.4.0-72-generic
Found initrd image: /boot/initrd.img-5.4.0-72-generic
Found linux image: /boot/vmlinuz-5.4.0-65-generic
Found initrd image: /boot/initrd.img-5.4.0-65-generic
done
Processing triggers for initramfs-tools (0.136ubuntu6.4) ...
update-initramfs: Generating /boot/initrd.img-5.4.0-72-generic
lpino@ubuntuclient:~$
```

```
Generating grub configuration file ...
Found linux image: /boot/vmlinuz-5.4.0-72-generic
Found initrd image: /boot/initrd.img-5.4.0-72-generic
Found linux image: /boot/vmlinuz-5.4.0-65-generic
Found initrd image: /boot/initrd.img-5.4.0-65-generic
done
Processing triggers for initramfs-tools (0.136ubuntu6.4) ...
update-initramfs: Generating /boot/initrd.img-5.4.0-72-generic
lpino@ubuntuserver:~$ _
```

2. Connectivity between both systems by pinging each internal IP address:

```
Ubuntu_Server [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 14951 bytes 964716 (964.7 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
inet6 ::1 prefixlen 128 scopeid 0x10<host>
loop txqueuelen 1000 (Local Loopback)
RX packets 178 bytes 15094 (15.0 KB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 178 bytes 15094 (15.0 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

ipino@ubuntu:server:~$ ping 192.168.56.60
PING 192.168.56.60 (192.168.56.60) 56(84) bytes of data.
64 bytes from 192.168.56.60: icmp_seq=1 ttl=64 time=2.29 ms
64 bytes from 192.168.56.60: icmp_seq=2 ttl=64 time=1.03 ms
64 bytes from 192.168.56.60: icmp_seq=3 ttl=64 time=0.873 ms
64 bytes from 192.168.56.60: icmp_seq=4 ttl=64 time=1.11 ms
64 bytes from 192.168.56.60: icmp_seq=5 ttl=64 time=0.949 ms
64 bytes from 192.168.56.60: icmp_seq=6 ttl=64 time=1.03 ms
64 bytes from 192.168.56.60: icmp_seq=7 ttl=64 time=1.35 ms
64 bytes from 192.168.56.60: icmp_seq=8 ttl=64 time=1.16 ms
64 bytes from 192.168.56.60: icmp_seq=9 ttl=64 time=1.21 ms
64 bytes from 192.168.56.60: icmp_seq=10 ttl=64 time=1.15 ms
64 bytes from 192.168.56.60: icmp_seq=11 ttl=64 time=0.880 ms
64 bytes from 192.168.56.60: icmp_seq=12 ttl=64 time=1.26 ms
64 bytes from 192.168.56.60: icmp_seq=13 ttl=64 time=0.896 ms
64 bytes from 192.168.56.60: icmp_seq=14 ttl=64 time=0.780 ms
64 bytes from 192.168.56.60: icmp_seq=15 ttl=64 time=0.936 ms
64 bytes from 192.168.56.60: icmp_seq=16 ttl=64 time=1.02 ms
64 bytes from 192.168.56.60: icmp_seq=17 ttl=64 time=0.904 ms
^C
--- 192.168.56.60 ping statistics ---
17 packets transmitted, 17 received, 0% packet loss, time 16028ms
rtt min/avg/max/mdev = 0.780/1.107/2.290/0.531 ms
ipino@ubuntu:server:~$

Ubuntu_Client [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
RX packets 188892 bytes 278848771 (278.8 MB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 15112 bytes 968492 (968.4 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
inet6 ::1 prefixlen 128 scopeid 0x10<host>
loop txqueuelen 1000 (Local Loopback)
RX packets 828 bytes 62013 (62.0 KB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 828 bytes 62013 (62.0 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

ipino@ubuntu:client:~$ ping 192.168.56.50
PING 192.168.56.50 (192.168.56.50) 56(84) bytes of data.
64 bytes from 192.168.56.50: icmp_seq=1 ttl=64 time=0.874 ms
64 bytes from 192.168.56.50: icmp_seq=2 ttl=64 time=0.947 ms
64 bytes from 192.168.56.50: icmp_seq=3 ttl=64 time=1.06 ms
64 bytes from 192.168.56.50: icmp_seq=4 ttl=64 time=1.06 ms
64 bytes from 192.168.56.50: icmp_seq=5 ttl=64 time=1.13 ms
64 bytes from 192.168.56.50: icmp_seq=6 ttl=64 time=1.13 ms
64 bytes from 192.168.56.50: icmp_seq=7 ttl=64 time=1.07 ms
64 bytes from 192.168.56.50: icmp_seq=8 ttl=64 time=0.958 ms
64 bytes from 192.168.56.50: icmp_seq=9 ttl=64 time=1.07 ms
64 bytes from 192.168.56.50: icmp_seq=10 ttl=64 time=1.12 ms
64 bytes from 192.168.56.50: icmp_seq=11 ttl=64 time=1.23 ms
64 bytes from 192.168.56.50: icmp_seq=12 ttl=64 time=1.13 ms
64 bytes from 192.168.56.50: icmp_seq=13 ttl=64 time=0.907 ms
64 bytes from 192.168.56.50: icmp_seq=14 ttl=64 time=0.898 ms
64 bytes from 192.168.56.50: icmp_seq=15 ttl=64 time=0.948 ms
64 bytes from 192.168.56.50: icmp_seq=16 ttl=64 time=0.929 ms
^C
--- 192.168.56.50 ping statistics ---
16 packets transmitted, 16 received, 0% packet loss, time 15030ms
rtt min/avg/max/mdev = 0.874/1.032/1.232/0.107 ms
ipino@ubuntu:client:~$
```

3. Using the client, test access to the Apache home page by opening a browser on the Linux client and accessing the home page on the Ubuntu server:

```
Apache2 Ubuntu Default Page: It works (p1 of 3)

Ubuntu Logo DCC Under Construction
Leisly Alitzel Pino Duran
Student number: 2020303
It works!

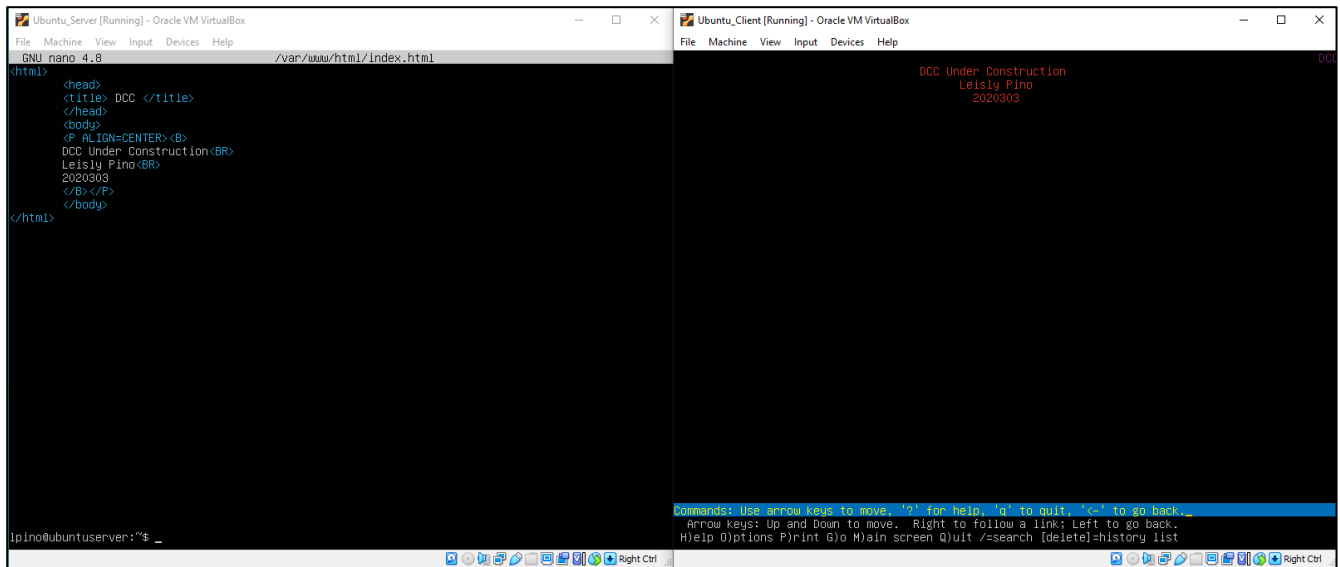
This is the default welcome page used to test the correct operation of the Apache2 server
after installation on Ubuntu systems. It is based on the equivalent page on Debian, from
which the Ubuntu Apache packaging is derived. If you can read this page, it means that the
Apache HTTP server installed at this site is working properly. You should replace this file
(located at /var/www/html/index.html) before continuing to operate your HTTP server.

If you are a normal user of this web site and don't know what this page is about, this
probably means that the site is currently unavailable due to maintenance. If the problem
persists, please contact the site's administrator.
Configuration Overview

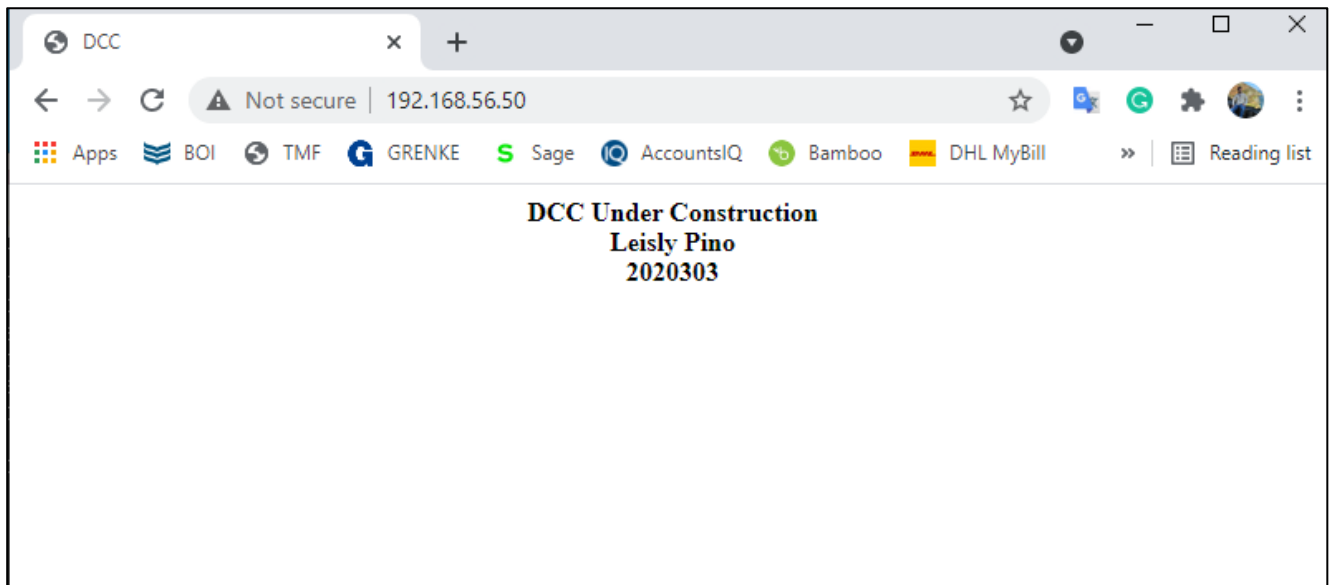
Ubuntu's Apache2 default configuration is different from the upstream default
configuration, and split into several files optimized for interaction with Ubuntu tools.
The configuration system is fully documented in /usr/share/doc/apache2/README.Debian.gz.
Refer to this for the full documentation. Documentation for the web server itself can be
found by accessing the manual if the apache2-doc package was installed on this server.

The configuration layout for an Apache2 web server installation on Ubuntu systems is as
follows:
/etc/apache2/
|-- apache2.conf
|   |-- ports.conf
|-- mods-enabled
|   |-- *.load
|   |-- *.conf
|-- conf-enabled
|   |-- *.conf
|-- sites-enabled

-- press space for next page --
Arrow keys: Up and Down to move. Right to follow a link; Left to go back.
H)elp O)ptions P)rint G)o M)ain screen Q)uit /=search [delete]=history list
```



4. Using your host operating system, test access to the Apache home page by opening a web browser and accessing the home page on the Ubuntu server:



5. Host computer (Windows) PING the IP address of ubuntu server. Wireshark, the ICMP traffic between the browser on the host operating system and the ubuntu server webserver:

```
Command Prompt
Microsoft Windows [Version 10.0.18363.1440]
(c) 2019 Microsoft Corporation. All rights reserved.

C:\Users\mauro>ping 192.168.56.50

Pinging 192.168.56.50 with 32 bytes of data:
Reply from 192.168.56.50: bytes=32 time<1ms TTL=64
Reply from 192.168.56.50: bytes=32 time<1ms TTL=64
Reply from 192.168.56.50: bytes=32 time<1ms TTL=64
Reply from 192.168.56.50: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.56.50:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Users\mauro>
```

VirtualBox Host-Only Network

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

icmp

No.	Time	Source	Destination	Protocol	Length	Info
2	4.627055	192.168.56.1	192.168.56.50	ICMP	74	Echo (ping) request id=0x0001, seq=492/60417, ttl=128 (reply in 3)
3	4.627609	192.168.56.50	192.168.56.1	ICMP	74	Echo (ping) reply id=0x0001, seq=492/60417, ttl=64 (request in 2)
4	5.639954	192.168.56.1	192.168.56.50	ICMP	74	Echo (ping) request id=0x0001, seq=493/60673, ttl=128 (reply in 5)
5	5.640566	192.168.56.50	192.168.56.1	ICMP	74	Echo (ping) reply id=0x0001, seq=493/60673, ttl=64 (request in 4)
6	6.654787	192.168.56.1	192.168.56.50	ICMP	74	Echo (ping) request id=0x0001, seq=494/60929, ttl=128 (reply in 7)
7	6.655370	192.168.56.50	192.168.56.1	ICMP	74	Echo (ping) reply id=0x0001, seq=494/60929, ttl=64 (request in 6)
8	7.668203	192.168.56.1	192.168.56.50	ICMP	74	Echo (ping) request id=0x0001, seq=495/61185, ttl=128 (reply in 9)
9	7.668858	192.168.56.50	192.168.56.1	ICMP	74	Echo (ping) reply id=0x0001, seq=495/61185, ttl=64 (request in 8)

> Frame 2: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface \Device\NPF_{B95AF14F-B437-4FC9-B9E8-19D5380C3C9D}, id 0
> Ethernet II, Src: 0a:00:27:00:00:12 (0a:00:27:00:00:12), Dst: PcsCompu_e8:d5:4f (08:00:27:e8:d5:4f)
> Internet Protocol Version 4, Src: 192.168.56.1, Dst: 192.168.56.50
> Internet Control Message Protocol

Offset	Hex	ASCII
0000	08 00 27 e8 d5 4f 0a 00 27 00 00 12 08 00 45 00	..'.O.. '.....E.
0010	00 3c 04 ac 00 00 80 01 44 91 c0 a8 38 01 c0 a8	..<.....D...8...
0020	38 32 08 00 4b 6f 00 01 01 ec 61 62 63 64 65 66	82..Ko.. ..abcdef
0030	67 68 69 6a 6b 6c 6d 6e 6f 70 71 72 73 74 75 76	ghijklmn opqrstuv
0040	77 61 62 63 64 65 66 67 68 69	wabdefgh i

Internet Control Message Protocol: Protocol | Packets: 21 · Displayed: 8 (38.1%) | Profile: Default

6. From the host computer, the IP address of ubuntu server is entered into Chrome browser. This is HTTP contents being transferred from the ubuntu server to the host operating system on Wireshark on the host operating system:

The image shows a Wireshark network traffic capture window titled "Capturing from VirtualBox Host-Only Network". The interface includes a menu bar (File, Edit, View, Go, Capture, Analyze, Statistics, Telephony, Wireless, Tools, Help) and a toolbar. A filter bar at the top shows "http". The main display area is divided into three sections: a packet list, a packet details pane, and a packet bytes pane.

Packet List:

No.	Time	Source	Destination	Protocol	Length	Info
6	1.157708	192.168.56.1	192.168.56.50	HTTP	596	GET / HTTP/1.1
8	1.160015	192.168.56.50	192.168.56.1	HTTP	531	HTTP/1.1 200 OK (text/html)
19	35.211044	192.168.56.1	192.168.56.50	HTTP	622	GET / HTTP/1.1
21	35.213511	192.168.56.50	192.168.56.1	HTTP	531	HTTP/1.1 200 OK (text/html)

Packet Details:

- Frame 6: 596 bytes on wire (4768 bits), 596 bytes captured (4768 bits) on interface \Device\NPF_{B95AF14F-B437-4FC9-B9E8-19D53B0C3C9D}, id 0
- Ethernet II, Src: 0a:00:27:00:00:12 (0a:00:27:00:00:12), Dst: PcsCompu_e8:d5:4f (08:00:27:e8:d5:4f)
- Internet Protocol Version 4, Src: 192.168.56.1, Dst: 192.168.56.50
- Transmission Control Protocol, Src Port: 51842, Dst Port: 80, Seq: 1, Ack: 1, Len: 542
- Hypertext Transfer Protocol

Packet Bytes:

```
0000 08 00 27 e8 d5 4f 0a 00 27 00 00 12 08 00 45 00  ..'..O.. '.....E.
0010 02 46 04 a3 40 00 80 06 02 8b c0 a8 38 01 c0 a8  ..F..@... ..8...
0020 38 32 ca 82 00 50 79 0d 62 1f d7 1b 9e a4 50 18  82...Py..b.....P.
0030 20 14 bc 34 00 00 47 45 54 20 2f 20 48 54 54 50  ..4...GE T / HTTP
0040 2f 31 2e 31 0d 0a 48 6f 73 74 3a 20 31 39 32 2e  /1.1...Host: 192.
0050 31 36 38 2e 35 36 2e 35 30 0d 0a 43 6f 6e 6e 65  168.56.50...Conne
0060 63 74 69 6f 6e 3a 20 6b 65 65 70 2d 61 6c 69 76  ction: keep-aliv
0070 65 0d 0a 55 70 67 72 61 64 65 2d 49 6e 73 65 63  e..Upgra de-Insec
0080 75 72 65 2d 52 65 71 75 65 73 74 73 3a 20 31 0d  ure-Requ ests: 1
```

The status bar at the bottom indicates "VirtualBox Host-Only Network: <live capture in progress>", "Packets: 27 · Displayed: 4 (14.8%)", and "Profile: Default".

SSH

7. Host operating system (Windows) logging into the ubuntu server using SSH:

```
lpino@ubuntuserver: ~  
lpino@192.168.56.50's password:  
Welcome to Ubuntu 20.04.2 LTS (GNU/Linux 5.4.0-72-generic x86_64)  
  
* Documentation:  https://help.ubuntu.com  
* Management:    https://landscape.canonical.com  
* Support:        https://ubuntu.com/advantage  
  
System information as of Fri  7 May 20:45:36 UTC 2021  
  
System load:  0.08           Users logged in:      1  
Usage of / :  50.5% of 8.79GB IPv4 address for enp0s3: 192.168.56.50  
Memory usage: 22%           IPv4 address for enp0s3: 192.168.56.104  
Swap usage:   0%            IPv4 address for enp0s8: 10.0.3.15  
Processes:    111  
  
* Pure upstream Kubernetes 1.21, smallest, simplest cluster ops!  
  
https://microk8s.io/  
  
Last login: Fri May  7 20:39:08 2021 from 192.168.56.1  
lpino@ubuntuserver:~$
```

8. Wireshark on the host operating system, this is the packet that shows the SSH encrypted traffic:

VirtualBox Host-Only Network

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

ssh

No.	Time	Source	Destination	Protocol	Length	Info
12	23.391185	192.168.56.1	192.168.56.50	SSHv2	82	Client: Protocol (SSH-2.0-PuTTY_Release_0.74)
14	23.411707	192.168.56.50	192.168.56.1	SSHv2	95	Server: Protocol (SSH-2.0-OpenSSH_8.2p1 Ubuntu-4ubuntu0.2)
15	23.425708	192.168.56.1	192.168.56.50	SSHv2	1222	Client: Key Exchange Init
16	23.426249	192.168.56.50	192.168.56.1	SSHv2	1110	Server: Key Exchange Init
17	23.438898	192.168.56.1	192.168.56.50	SSHv2	102	Client: Elliptic Curve Diffie-Hellman Key Exchange Init
19	23.473515	192.168.56.50	192.168.56.1	SSHv2	262	Server: Elliptic Curve Diffie-Hellman Key Exchange Reply, New Keys
21	23.526069	192.168.56.1	192.168.56.50	SSHv2	134	Client: New Keys, Encrypted packet (len=64)
22	23.526737	192.168.56.50	192.168.56.1	SSHv2	118	Server: Encrypted packet (len=64)
24	27.643141	192.168.56.1	192.168.56.50	SSHv2	134	Client: Encrypted packet (len=80)
25	27.651863	192.168.56.50	192.168.56.1	SSHv2	134	Server: Encrypted packet (len=80)
27	31.732966	192.168.56.1	192.168.56.50	SSHv2	326	Client: Encrypted packet (len=272)
29	31.789455	192.168.56.50	192.168.56.1	SSHv2	102	Server: Encrypted packet (len=48)
30	31.791305	192.168.56.1	192.168.56.50	SSHv2	134	Client: Encrypted packet (len=80)
32	33.696246	192.168.56.50	192.168.56.1	SSHv2	710	Server: Encrypted packet (len=656)
34	33.736792	192.168.56.50	192.168.56.1	SSHv2	118	Server: Encrypted packet (len=64)
35	33.738019	192.168.56.1	192.168.56.50	SSHv2	230	Client: Encrypted packet (len=176)
37	33.742288	192.168.56.50	192.168.56.1	SSHv2	214	Server: Encrypted packet (len=160)
38	33.744334	192.168.56.50	192.168.56.1	SSHv2	182	Server: Encrypted packet (len=128)
40	33.744726	192.168.56.50	192.168.56.1	SSHv2	118	Server: Encrypted packet (len=64)

> Frame 21: 134 bytes on wire (1072 bits), 134 bytes captured (1072 bits) on interface \Device\NPF_{B95AF14F-B437-4FC9-B9E8-19D5380C3C9D}, id 0
> Ethernet II, Src: 0a:00:27:00:00:12 (0a:00:27:00:00:12), Dst: PcsCompu_e8:d5:4f (08:00:27:e8:d5:4f)
> Internet Protocol Version 4, Src: 192.168.56.1, Dst: 192.168.56.50
> Transmission Control Protocol, Src Port: 52701, Dst Port: 22, Seq: 1245, Ack: 1306, Len: 80
> SSH Protocol

0000 08 00 27 e8 d5 4f 0a 00 27 00 00 12 08 00 45 00 ..'.0.. '.....E:
0010 00 78 04 db 40 00 80 06 04 21 c0 a8 38 01 c0 a8 .x. @... -!..8...
0020 38 32 cd dd 00 16 78 a3 25 ea cc 12 0d b4 50 18 82....x. %....P:
0030 20 0f c1 e9 00 00 00 00 00 0c 0a 15 cd 2e 3e 6e>n
0040 89 a7 f0 cc b3 49 36 a2 fe 2d a2 35 1f 89 1c adI6. --5....

IP ADDRESS & HOSTNAME MANAGEMENT

9. The ubuntu servers IP addresses configured and PING:

```
Ubuntu_Server [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
* Pure upstream Kubernetes 1.21, smallest, simplest cluster ops!

https://microk8s.io/

Last login: Fri May 7 20:45:38 UTC 2021 from 192.168.56.1 on pts/0
ipino@ubuntu-server:~$ ifconfig
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.56.100 netmask 255.255.255.0 broadcast 192.168.56.255
    inet6 fe80::a00:27ff:fe8b:d54f prefixlen 64 scopeid 0x20<link>
    ether 08:00:27:eb:d5:4f txqueuelen 1000 (Ethernet)
    RX packets 1 bytes 60 (60.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 10 bytes 796 (796.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

enp0s8: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.3.15 netmask 255.255.255.0 broadcast 10.0.3.255
    inet6 fe80::a00:27ff:fe73:2223 prefixlen 64 scopeid 0x20<link>
    ether 08:00:27:73:22:23 txqueuelen 1000 (Ethernet)
    RX packets 602 bytes 860958 (860.9 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 88 bytes 12116 (12.1 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 92 bytes 7100 (7.1 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 92 bytes 7100 (7.1 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

ipino@ubuntu-server:~$ _

Ubuntu_Client [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
GNU nano 4.8 00-installer-config.yaml Modified
# This is the network config written by 'subiquity'
network:
  ethernets:
    enp0s3:
      addresses:
        - 192.168.56.200/24
      dhcp4: false
    enp0s8:
      dhcp4: true
  version: 2
```

```
Ubuntu_Server [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
* Pure upstream Kubernetes 1.21, smallest, simplest cluster ops!

https://microk8s.io/

Last login: Fri May 7 20:45:38 UTC 2021 from 192.168.56.1 on pts/0
ipino@ubuntu-server:~$ ifconfig
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.56.100 netmask 255.255.255.0 broadcast 192.168.56.255
    inet6 fe80::a00:27ff:fe8b:d54f prefixlen 64 scopeid 0x20<link>
    ether 08:00:27:eb:d5:4f txqueuelen 1000 (Ethernet)
    RX packets 1 bytes 60 (60.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 10 bytes 796 (796.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

enp0s8: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.3.15 netmask 255.255.255.0 broadcast 10.0.3.255
    inet6 fe80::a00:27ff:fe73:2223 prefixlen 64 scopeid 0x20<link>
    ether 08:00:27:73:22:23 txqueuelen 1000 (Ethernet)
    RX packets 602 bytes 860958 (860.9 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 88 bytes 12116 (12.1 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 92 bytes 7100 (7.1 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 92 bytes 7100 (7.1 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

ipino@ubuntu-server:~$

Ubuntu_Client [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help

ipino@ubuntu-client:~$ sudo netplan apply
ipino@ubuntu-client:~$
ipino@ubuntu-client:~$ ifconfig
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.56.200 netmask 255.255.255.0 broadcast 192.168.56.255
    inet6 fe80::a00:27ff:fe8b:d293 prefixlen 64 scopeid 0x20<link>
    ether 08:00:27:80:d2:93 txqueuelen 1000 (Ethernet)
    RX packets 187 bytes 31820 (31.8 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 207 bytes 24491 (24.4 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

enp0s8: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.3.15 netmask 255.255.255.0 broadcast 10.0.3.255
    inet6 fe80::a00:27ff:fe58:5b15 prefixlen 64 scopeid 0x20<link>
    ether 08:00:27:58:5b:15 txqueuelen 1000 (Ethernet)
    RX packets 156 bytes 60268 (60.2 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 179 bytes 22205 (22.2 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 106 bytes 8304 (8.3 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 106 bytes 8304 (8.3 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

ipino@ubuntu-client:~$
```



```
Ubuntu_Server [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
    inet6 fe80::a00:27ff:fe8b:d54f prefixlen 64 scopeid 0x20<link>
    ether 08:00:27:e8:d5:4f txqueuelen 1000 (Ethernet)
    RX packets 1 bytes 60 (60.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 10 bytes 796 (796.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

enp0s8: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.3.15 netmask 255.255.255.0 broadcast 10.0.3.255
    inet6 fe80::a00:27ff:fe73:2223 prefixlen 64 scopeid 0x20<link>
    ether 08:00:27:73:22:23 txqueuelen 1000 (Ethernet)
    RX packets 602 bytes 86958 (86.9 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 88 bytes 12116 (12.1 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 92 bytes 7100 (7.1 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 92 bytes 7100 (7.1 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lpino@ubuntu:~$ ping 192.168.56.200
PING 192.168.56.200 (192.168.56.200) 56(84) bytes of data:
64 bytes from 192.168.56.200: icmp_seq=1 ttl=64 time=2.56 ms
64 bytes from 192.168.56.200: icmp_seq=2 ttl=64 time=0.985 ms
64 bytes from 192.168.56.200: icmp_seq=3 ttl=64 time=1.08 ms
64 bytes from 192.168.56.200: icmp_seq=4 ttl=64 time=1.09 ms
64 bytes from 192.168.56.200: icmp_seq=5 ttl=64 time=1.04 ms
^C
--- 192.168.56.200 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4008ms
rtt min/avg/max/mdev = 0.985/1.352/2.564/0.606 ms
lpino@ubuntu:~$ _

Ubuntu_Client [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
    ether 08:00:27:80:d2:93 txqueuelen 1000 (Ethernet)
    RX packets 194 bytes 32430 (32.4 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 218 bytes 25381 (25.3 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

enp0s8: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.3.15 netmask 255.255.255.0 broadcast 10.0.3.255
    inet6 fe80::a00:27ff:fe58:6b15 prefixlen 64 scopeid 0x20<link>
    ether 08:00:27:58:6b:15 txqueuelen 1000 (Ethernet)
    RX packets 156 bytes 60260 (60.2 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 183 bytes 22485 (22.4 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 106 bytes 8304 (8.3 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 106 bytes 8304 (8.3 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lpino@ubuntu:~$ ping 192.168.56.100
PING 192.168.56.100 (192.168.56.100) 56(84) bytes of data:
64 bytes from 192.168.56.100: icmp_seq=1 ttl=64 time=1.11 ms
64 bytes from 192.168.56.100: icmp_seq=2 ttl=64 time=1.34 ms
64 bytes from 192.168.56.100: icmp_seq=3 ttl=64 time=0.874 ms
64 bytes from 192.168.56.100: icmp_seq=4 ttl=64 time=1.15 ms
64 bytes from 192.168.56.100: icmp_seq=5 ttl=64 time=1.20 ms
64 bytes from 192.168.56.100: icmp_seq=6 ttl=64 time=1.72 ms
^C
--- 192.168.56.100 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5011ms
rtt min/avg/max/mdev = 0.874/1.233/1.722/0.259 ms
lpino@ubuntu:~$ _
```

10. The ubuntu servers configured and re-named:

```
Ubuntu_Server [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lpino@ubuntu:~$ ping 192.168.56.200
PING 192.168.56.200 (192.168.56.200) 56(84) bytes of data:
64 bytes from 192.168.56.200: icmp_seq=1 ttl=64 time=2.56 ms
64 bytes from 192.168.56.200: icmp_seq=2 ttl=64 time=0.985 ms
64 bytes from 192.168.56.200: icmp_seq=3 ttl=64 time=1.08 ms
64 bytes from 192.168.56.200: icmp_seq=4 ttl=64 time=1.09 ms
64 bytes from 192.168.56.200: icmp_seq=5 ttl=64 time=1.04 ms
^C
--- 192.168.56.200 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4008ms
rtt min/avg/max/mdev = 0.985/1.352/2.564/0.606 ms
lpino@ubuntu:~$ sudo su
[sudo] password for lpino:
root@ubuntu:~# hostnamectl
  Static hostname: ubuntu-server
    Icon name: computer-vm
      Chassis: vm
        Machine ID: 924fa1154434480d8db2bfb2d11d933
        Boot ID: c70a1e913bce4438a368f946a5a96158
    Virtualization: oracle
    Operating System: Ubuntu 20.04.2 LTS
      Kernel: Linux 5.4.0-72-generic
    Architecture: x86_64
root@ubuntu:~# hostnamectl set-hostname web-server-303
root@ubuntu:~# hostnamectl
  Static hostname: web-server-303
    Icon name: computer-vm
      Chassis: vm
        Machine ID: 924fa1154434480d8db2bfb2d11d933
        Boot ID: c70a1e913bce4438a368f946a5a96158
    Virtualization: oracle
    Operating System: Ubuntu 20.04.2 LTS
      Kernel: Linux 5.4.0-72-generic
    Architecture: x86_64
root@ubuntu:~#

Ubuntu_Client [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
lpino@ubuntu:~$ ping 192.168.56.100
PING 192.168.56.100 (192.168.56.100) 56(84) bytes of data:
64 bytes from 192.168.56.100: icmp_seq=1 ttl=64 time=1.11 ms
64 bytes from 192.168.56.100: icmp_seq=2 ttl=64 time=1.34 ms
64 bytes from 192.168.56.100: icmp_seq=3 ttl=64 time=0.874 ms
64 bytes from 192.168.56.100: icmp_seq=4 ttl=64 time=1.15 ms
64 bytes from 192.168.56.100: icmp_seq=5 ttl=64 time=1.20 ms
64 bytes from 192.168.56.100: icmp_seq=6 ttl=64 time=1.72 ms
^C
--- 192.168.56.100 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5011ms
rtt min/avg/max/mdev = 0.874/1.233/1.722/0.259 ms
lpino@ubuntu:~$ sudo su
[sudo] password for lpino:
root@ubuntu:~# hostnamectl
  Static hostname: ubuntu-client
    Icon name: computer-vm
      Chassis: vm
        Machine ID: a52ad0aeab054127964762be32d8ccdf
        Boot ID: 82ee0ee73cd24ec7ba01020957dda6e5
    Virtualization: oracle
    Operating System: Ubuntu 20.04.2 LTS
      Kernel: Linux 5.4.0-72-generic
    Architecture: x86_64
root@ubuntu:~# hostnamectl set-hostname web-client-303
root@ubuntu:~# hostnamectl
  Static hostname: web-client-303
    Icon name: computer-vm
      Chassis: vm
        Machine ID: a52ad0aeab054127964762be32d8ccdf
        Boot ID: 82ee0ee73cd24ec7ba01020957dda6e5
    Virtualization: oracle
    Operating System: Ubuntu 20.04.2 LTS
      Kernel: Linux 5.4.0-72-generic
    Architecture: x86_64
root@ubuntu:~#
```

FIREWALL

11. The SSH not being permitted:

The screenshot shows two terminal windows side-by-side, both running Ubuntu in a VirtualBox environment. The left window is titled 'Ubuntu_Server [Running] - Oracle VM VirtualBox' and the right window is titled 'Ubuntu_Client [Running] - Oracle VM VirtualBox'. Both windows show the user 'ipino' at the prompt. In the server window, the user runs 'sudo ufw status', which shows the firewall is active. Then, the user runs 'sudo ufw deny in ssh', which adds a rule to deny incoming SSH traffic. The user then runs 'sudo ufw status' again, showing the updated rule. In the client window, the user runs 'sudo ufw status', which shows the firewall is active. Then, the user runs 'sudo ufw deny out ssh', which adds a rule to deny outgoing SSH traffic. The user then runs 'sudo ufw status' again, showing the updated rule. Both windows show a table of rules with columns 'To', 'Action', and 'From'.

```
ipino@ubuntuserver:~$ sudo ufw status
Status: inactive
ipino@ubuntuserver:~$ sudo ufw enable
Firewall is active and enabled on system startup
ipino@ubuntuserver:~$ sudo ufw status
Status: active
ipino@ubuntuserver:~$ sudo ufw deny in ssh
Rule added
Rule added (v6)
ipino@ubuntuserver:~$ sudo ufw status
Status: active

To Action From
--
22/tcp DENY Anywhere
22/tcp (v6) DENY Anywhere (v6)

ipino@ubuntuserver:~$ sudo ufw deny out ssh
Rule added
Rule added (v6)
ipino@ubuntuserver:~$ sudo ufw status
Status: active

To Action From
--
22/tcp DENY Anywhere
22/tcp (v6) DENY Anywhere (v6)
22/tcp DENY OUT Anywhere
22/tcp (v6) DENY OUT Anywhere (v6)

ipino@ubuntuserver:~$
```

```
ipino@buntucient:~$ sudo ufw status
Status: inactive
ipino@buntucient:~$ sudo ufw enable
Firewall is active and enabled on system startup
ipino@buntucient:~$ sudo ufw status
Status: active
ipino@buntucient:~$ sudo ufw deny in ssh
Rule added
Rule added (v6)
ipino@buntucient:~$ sudo ufw status
Status: active

To Action From
--
22/tcp DENY Anywhere
22/tcp (v6) DENY Anywhere (v6)

ipino@buntucient:~$ sudo ufw deny out ssh
Rule added
Rule added (v6)
ipino@buntucient:~$ sudo ufw status
Status: active

To Action From
--
22/tcp DENY Anywhere
22/tcp (v6) DENY Anywhere (v6)
22/tcp DENY OUT Anywhere
22/tcp (v6) DENY OUT Anywhere (v6)

ipino@buntucient:~$
```

12. The HTTP traffic not being permitted:

The screenshot shows two terminal windows side-by-side, both running Ubuntu in a VirtualBox environment. The left window is titled 'Ubuntu_Server [Running] - Oracle VM VirtualBox' and the right window is titled 'Ubuntu_Client [Running] - Oracle VM VirtualBox'. Both windows show the user 'ipino' at the prompt. In the server window, the user runs 'sudo ufw deny out ssh', which adds a rule to deny outgoing SSH traffic. The user then runs 'sudo ufw status', which shows the updated rule. Then, the user runs 'sudo ufw deny in http', which adds a rule to deny incoming HTTP traffic. The user then runs 'sudo ufw status' again, showing the updated rule. In the client window, the user runs 'sudo ufw deny out ssh', which adds a rule to deny outgoing SSH traffic. The user then runs 'sudo ufw status', which shows the updated rule. Then, the user runs 'sudo ufw deny in http', which adds a rule to deny incoming HTTP traffic. The user then runs 'sudo ufw status' again, showing the updated rule. Both windows show a table of rules with columns 'To', 'Action', and 'From'.

```
ipino@ubuntuserver:~$ sudo ufw deny out ssh
Rule added
Rule added (v6)
ipino@ubuntuserver:~$ sudo ufw status
Status: active

To Action From
--
22/tcp DENY Anywhere
22/tcp (v6) DENY Anywhere (v6)
22/tcp DENY OUT Anywhere
22/tcp (v6) DENY OUT Anywhere (v6)

ipino@ubuntuserver:~$ sudo ufw deny in http
Rule added
Rule added (v6)
ipino@ubuntuserver:~$ sudo ufw deny out http
Rule added
Rule added (v6)
ipino@ubuntuserver:~$ sudo ufw status
Status: active

To Action From
--
22/tcp DENY Anywhere
30/tcp DENY Anywhere
22/tcp (v6) DENY Anywhere (v6)
30/tcp (v6) DENY Anywhere (v6)
22/tcp DENY OUT Anywhere
30/tcp DENY OUT Anywhere
22/tcp (v6) DENY OUT Anywhere (v6)
30/tcp (v6) DENY OUT Anywhere (v6)

ipino@ubuntuserver:~$
```

```
ipino@buntucient:~$ sudo ufw deny out ssh
Rule added
Rule added (v6)
ipino@buntucient:~$ sudo ufw status
Status: active

To Action From
--
22/tcp DENY Anywhere
22/tcp (v6) DENY Anywhere (v6)
22/tcp DENY OUT Anywhere
22/tcp (v6) DENY OUT Anywhere (v6)

ipino@buntucient:~$ sudo ufw deny in http
Rule added
Rule added (v6)
ipino@buntucient:~$ sudo ufw deny out http
Rule added
Rule added (v6)
ipino@buntucient:~$ sudo ufw status
Status: active

To Action From
--
22/tcp DENY Anywhere
80/tcp DENY Anywhere
22/tcp (v6) DENY Anywhere (v6)
80/tcp (v6) DENY Anywhere (v6)
22/tcp DENY OUT Anywhere
80/tcp DENY OUT Anywhere
22/tcp (v6) DENY OUT Anywhere (v6)
80/tcp (v6) DENY OUT Anywhere (v6)

ipino@buntucient:~$
```

13. The SSH being allowed but all other traffic denied:

Ubuntu_Server [Running] - Oracle VM VirtualBox

FileMachineViewInputDevicesHelp

ipino@ubuntu:~\$ sudo ufw status

Status: active

To	Action	From
22/tcp	DENY	Anywhere
80/tcp	DENY	Anywhere
22/tcp (v6)	DENY	Anywhere (v6)
80/tcp (v6)	DENY	Anywhere (v6)
22/tcp	DENY OUT	Anywhere
80/tcp	DENY OUT	Anywhere
22/tcp (v6)	DENY OUT	Anywhere (v6)
80/tcp (v6)	DENY OUT	Anywhere (v6)

ipino@ubuntu:~\$ sudo ufw allow in ssh

Rule updated

Rule updated (v6)

ipino@ubuntu:~\$ sudo ufw allow out ssh

Rule updated

Rule updated (v6)

ipino@ubuntu:~\$ sudo ufw status

Status: active

To	Action	From
22/tcp	ALLOW	Anywhere
80/tcp	DENY	Anywhere
22/tcp (v6)	ALLOW	Anywhere (v6)
80/tcp (v6)	DENY	Anywhere (v6)
22/tcp	ALLOW OUT	Anywhere
80/tcp	DENY OUT	Anywhere
22/tcp (v6)	ALLOW OUT	Anywhere (v6)
80/tcp (v6)	DENY OUT	Anywhere (v6)

ipino@ubuntu:~\$

Ubuntu_Client [Running] - Oracle VM VirtualBox

FileMachineViewInputDevicesHelp

ipino@ubuntu:~\$ sudo ufw status

Status: active

To	Action	From
22/tcp	DENY	Anywhere
80/tcp	DENY	Anywhere
22/tcp (v6)	DENY	Anywhere (v6)
80/tcp (v6)	DENY	Anywhere (v6)
22/tcp	DENY OUT	Anywhere
80/tcp	DENY OUT	Anywhere
22/tcp (v6)	DENY OUT	Anywhere (v6)
80/tcp (v6)	DENY OUT	Anywhere (v6)

ipino@ubuntu:~\$ sudo ufw allow in ssh

Rule updated

Rule updated (v6)

ipino@ubuntu:~\$ sudo ufw allow out ssh

Rule updated

Rule updated (v6)

ipino@ubuntu:~\$ sudo ufw status

Status: active

To	Action	From
22/tcp	ALLOW	Anywhere
80/tcp	DENY	Anywhere
22/tcp (v6)	ALLOW	Anywhere (v6)
80/tcp (v6)	DENY	Anywhere (v6)
22/tcp	ALLOW OUT	Anywhere
80/tcp	DENY OUT	Anywhere
22/tcp (v6)	ALLOW OUT	Anywhere (v6)
80/tcp (v6)	DENY OUT	Anywhere (v6)

ipino@ubuntu:~\$