UNIVERSITÀ DI TRENTO

Stateless Firewall Implementation

Network Security Lab, 2016

Group 16

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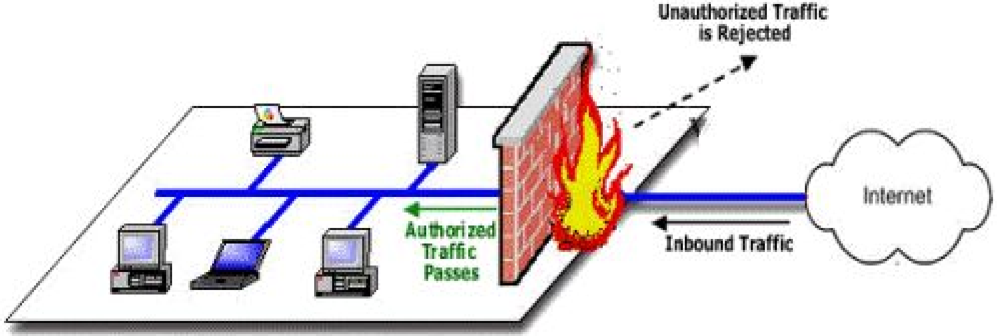
Outline :

I. Enviroment Setup

II. Today’s Task

III. Conclusion



Lab Objectives :

After this lab we expect all of you to know:

1. What is a FW with stateless rules and how it works
2. Set policies using iptables
3. Test the efficacy
4. Recommended Security Practises

I. Enviroment Setup :

➔ **WinHost(Windows server 2008)**

- Putty

➔ **UbuntuHost**

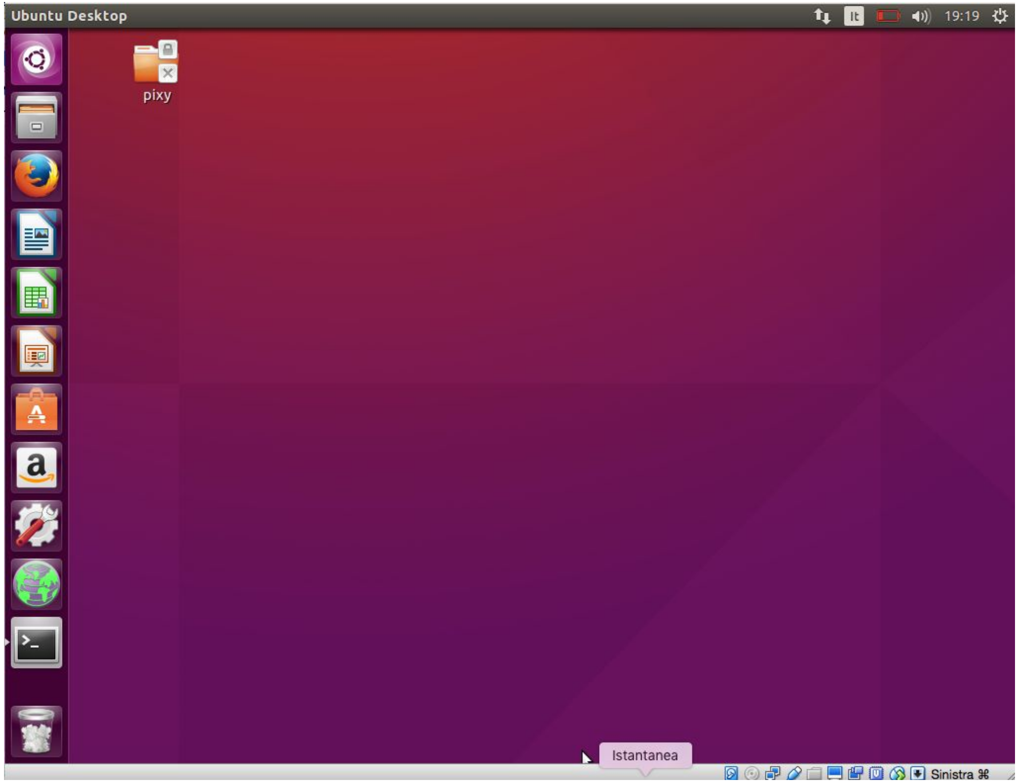
- Hping3 for port scanning

➔ **Firewall(Debian)**

- Apache2 web server
- Iptables

UbuntuHost

Login Now



➔ **UbuntuHost**

Password : ubuntuhost

Check Settings :

- *ifconfig*

➔ Should be *192.168.1.6*

Note : Access as root

➢ **Type on terminal** : sudo su

➢ **Password** : 123

WinHost

Login Now

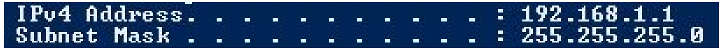
➔ **Windows server 2008**

Password : password@1

Check Settings :

- *ipconfig*

➔ Should be *192.168.1.1*



```
IPv4 Address. . . . . . . . . . . : 192.168.1.1
Subnet Mask . . . . . . . . . . . : 255.255.255.0
```

Firewall

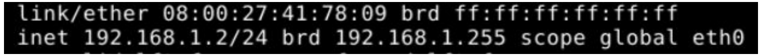
➔ **Debian**

Password : secclass

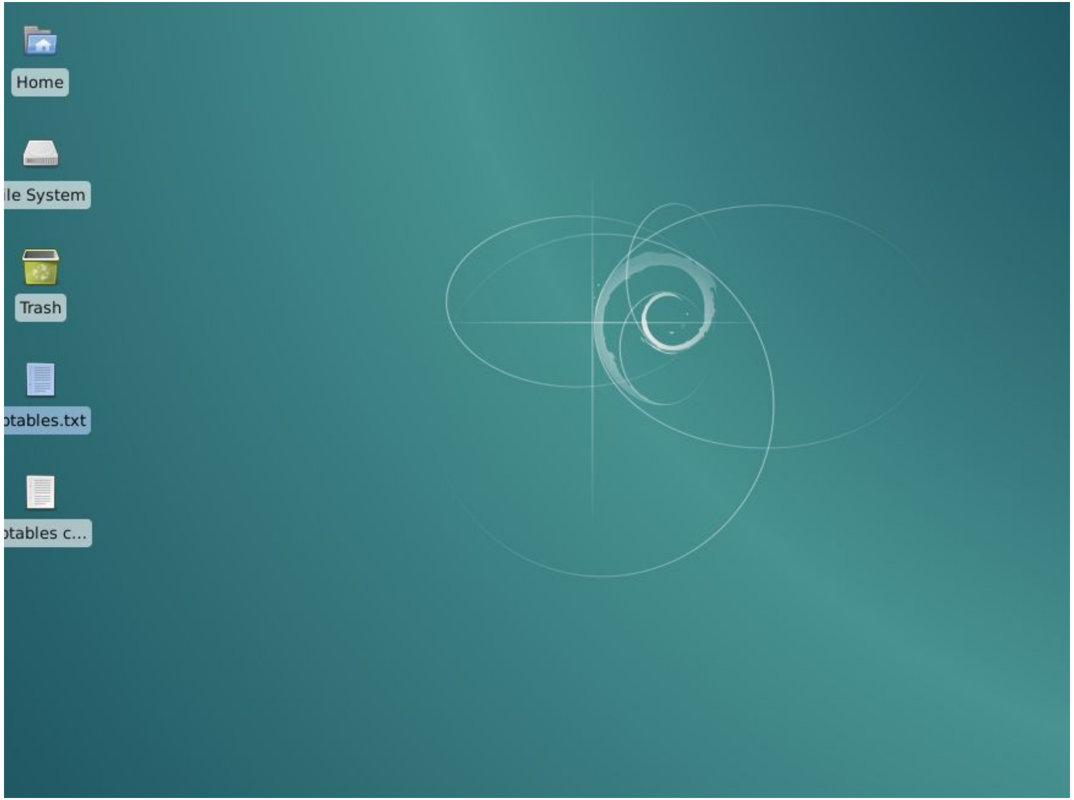
Check Settings :

- *ifconfig*

➔ Should be *192.168.1.2*



```
link/ether 08:00:27:41:78:09 brd ff:ff:ff:ff:ff:ff
inet 192.168.1.2/24 brd 192.168.1.255 scope global eth0
```



Note : Login as ***root***

➢ **Type on terminal** : su -

➢ **Password** : password@1

II. Today’s Task

1. USING STATELESS RULES TO FILTER TRAFFIC

- ➔ Default Accept Policy on chains for the filter table
- ➔ Block all ICMP echo(8) packets coming to the firewall
- ➔ Default Drop Policy on chains for the filter table
- ➔ Whitelist traffic for a specific Mac address
- ➔ Allow access to tcp port 22 (ssh)

2. ALLOWING SPECIFIC TCP FLAGS(SYN,FIN ACCEPT)

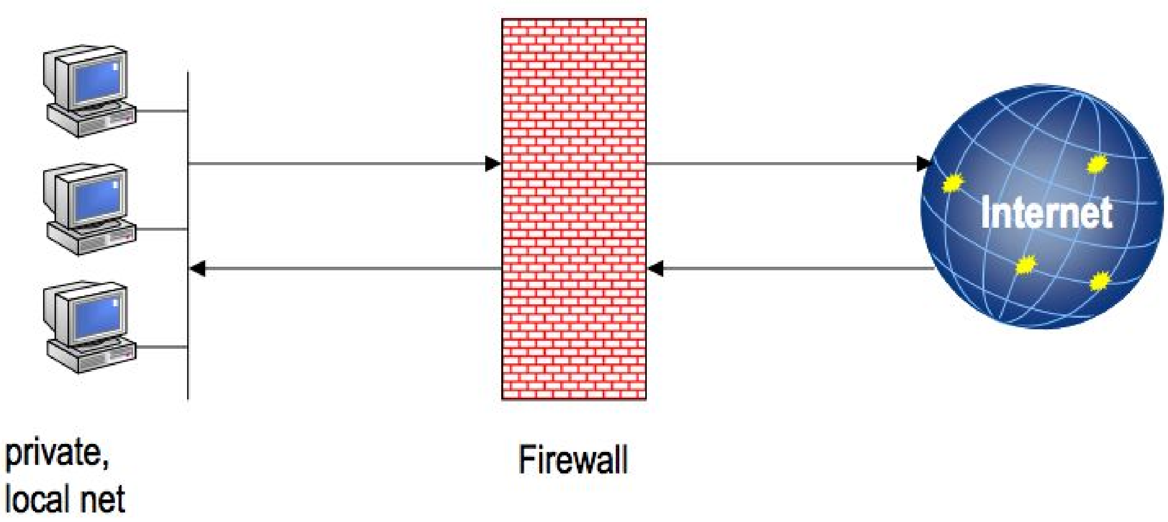
- ➔ Commands for accepting packets containing SYN & FIN

3. NAT & PORT FORWARDING

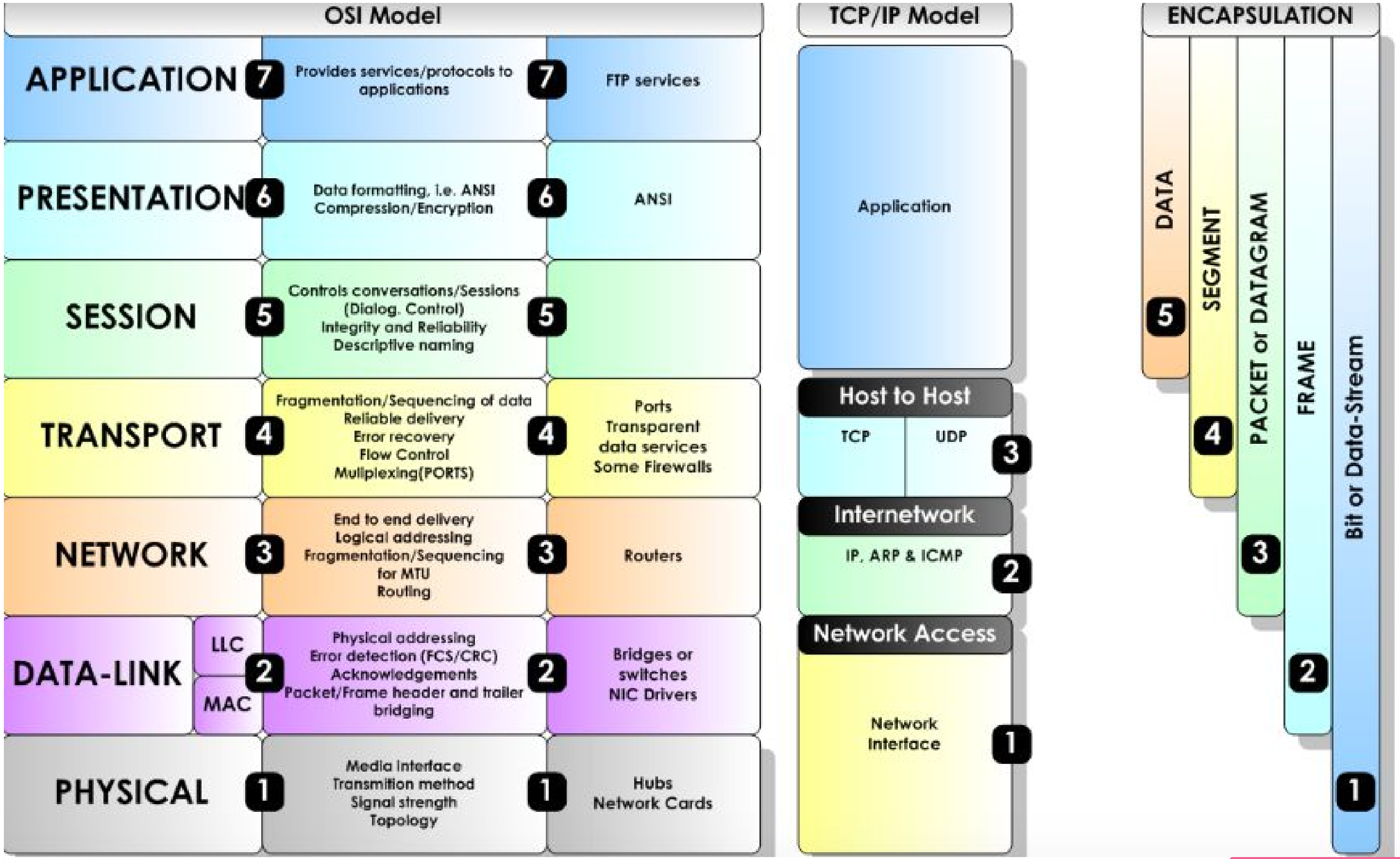
- ➔ Redirect Traffic from port 8080 to common http port 80 on DMZ interface.

★ Firewall Basics

- ➔ A Firewall is a perimeter network component that filters incoming or outgoing traffic to and from the network.



OSI vs TCP/IP Model



OSI Model

APPLICATION		7	Provides services/protocols to applications	7	FTP services
PRESENTATION		6	Data formatting, i.e. ANSI Compression/Encryption	6	ANSI
SESSION		5	Controls conversations/Sessions (Dialog. Control) Integrity and Reliability Descriptive naming	5	
TRANSPORT		4	Fragmentation/Sequencing of data Reliable delivery Error recovery Flow Control Mulipiexing(PORTS)	4	Ports Transparent data services Some Firewalls
NETWORK		3	End to end delivery Logical addressing Fragmentation/Sequencing for MTU Routing	3	Routers
DATA-LINK	LLC MAC	2	Physical addressing Error detection (FCS/CRC) Acknowledgements Packet/Frame header and trailer bridging	2	Bridges or switches NIC Drivers
PHYSICAL		1	Media interface Transmition method Signal strength Topology	1	Hubs Network Cards

TCP/IP Model

Application		
Host to Host	TCP UDP	3
Internetwork	IP, ARP & ICMP	2
Network Access	Network Interface	1

ENCAPSULATION

- DATA 5
- SEGMENT 4
- PACKET or DATAGRAM 3
- FRAME 2
- Bit or Data-Stream 1

★ Port Communication

Communication via TCP/IP operates by IP-Addresses and Ports.

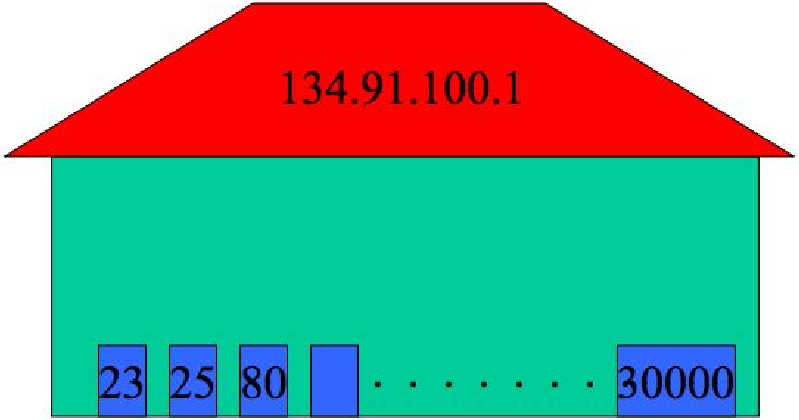
- Certain applications are associated with specific port numbers ranging from 0 to 65535
- The ports below 1024 are standardized (standard ports), which are allocated to dedicated services, i.e.

➔ 25 smtp

➔ 80 http

➔ 443 https

➔ 22 ssh



★ Policies for Packet Filtering

There are 2 different strategies :

👍 **Deny every packet (Only well defined kind of packets are allowed)**

👎 Allow every packet (Only well defined kind of untrusted packets are discarded).

➔ **Reject VS Drop :**

Reject: The Packets will be discarded and an ICMP-Error message will be delivered to the sender.

Drop: The Packets will be discarded. Better choice, because:

➔ Less traffic,
➔ Some packets could be part of an attack
➔ An error message could contain useful information for an attacker

★ Iptables (Packet filter in Linux) :

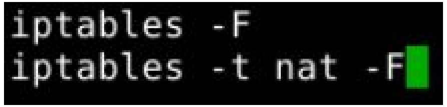
Three Chains:

- ➔ INPUT : Filters traffic destined to fw machine itself
- ➔ OUTPUT : Filters traffic generated by fw machine.
- ➔ FORWARD : Filters traffic routed through the fw.

NOTE : "Accept is the default policy of iptables."

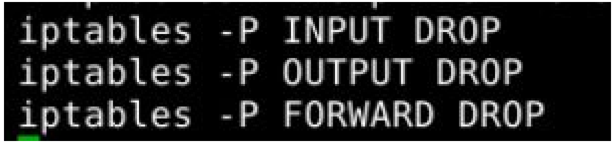
Some handy rules :

- Flush Tables :



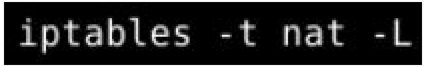
```
iptables -F
iptables -t nat -F
```

- Drop Input, Output and Forward :

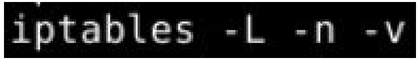


```
iptables -P INPUT DROP
iptables -P OUTPUT DROP
iptables -P FORWARD DROP
```

- Check statistics & Rules :

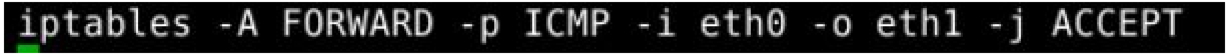


```
iptables -t nat -L
```



```
iptables -L -n -v
```

- Forward ICMP packets from eth0 to eth1



```
iptables -A FORWARD -p ICMP -i eth0 -o eth1 -j ACCEPT
```

where

- -p = Protocol like **TCP**, **UDP** and **ICMP**,
- -i and -o flags respectively **input** and **output interfaces**.
- -s and -d are **source** and **destination**.

Let's Get Our Hands DIRTY!!

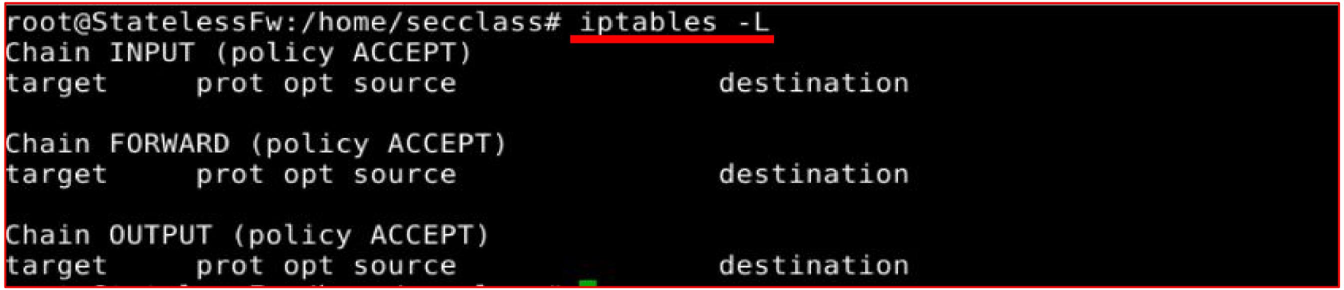
1. USING STATELESS RULES TO FILTER TRAFFIC

- ➔ Default Accept Policy on chains for the filter table
- ➔ Block all ICMP echo(8) packets coming to the firewall
- ➔ Default Drop Policy on chains for the filter table
- ➔ Whitelist traffic for a specific Mac address
- ➔ Allow access to tcp port 22 (ssh)

1. USING STATELESS RULES TO FILTER TRAFFIC

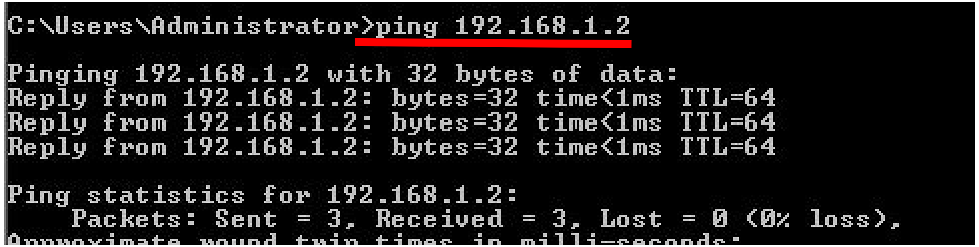
➔ Default-Allow

- *On **Firewall Vm**, check that the rules are on “default Allow” (accepting all traffic) using iptables -L -n*



```
root@StatelessFw:/home/secclass# iptables -L
Chain INPUT (policy ACCEPT)
target     prot opt source               destination

Chain FORWARD (policy ACCEPT)
target     prot opt source               destination

Chain OUTPUT (policy ACCEPT)
target     prot opt source               destination
```

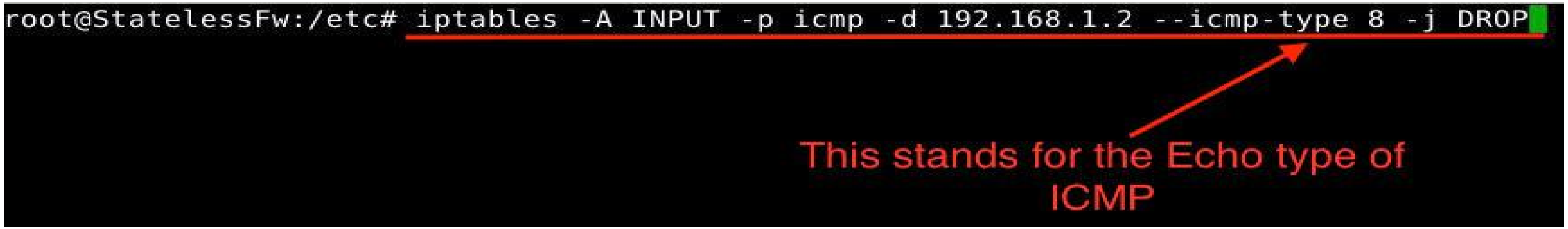
- *Open terminal and ping from **WinHost & UbuntuHost** to the **Firewall***



```
C:\Users\Administrator>ping 192.168.1.2

Pinging 192.168.1.2 with 32 bytes of data:
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.1.2:
    Packets: Sent = 3, Received = 3, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
```

➔ Block all ICMP echo(8) packets coming to the server

- *Perform a continous ping from* ***WinHost*** *terminal :* *ping 192.168.1.2 -t*
- *On* ***UbuntuHost*** *Implement the following rules :*

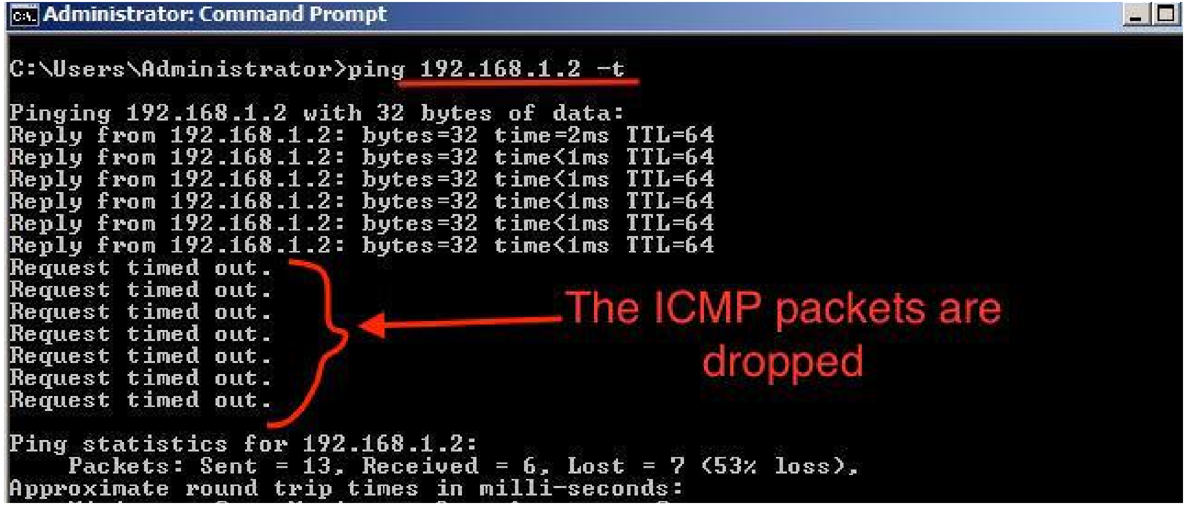


```
root@StatelessFw:/etc# iptables -A INPUT -p icmp -d 192.168.1.2 --icmp-type 8 -j DROP
```

This stands for the Echo type of ICMP

Note : ICMP (Internet Control Message Protocol) is an *error-reporting protocol*, It is ***not*** a transport protocol that sends data between systems. Any IP network device has the capability to send, receive or process ICMP messages.

Testing :



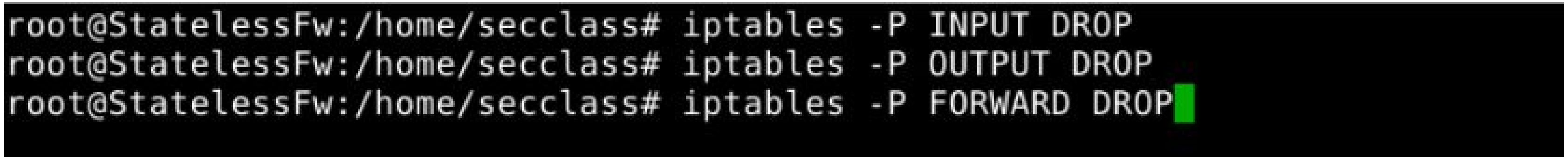
```
C:\Users\Administrator>ping 192.168.1.2 -t

Pinging 192.168.1.2 with 32 bytes of data:
Reply from 192.168.1.2: bytes=32 time=2ms TTL=64
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.1.2:
    Packets: Sent = 13, Received = 6, Lost = 7 (53% loss),
Approximate round trip times in milli-seconds:
```

The ICMP packets are dropped

As it can be observed, initaily there was a contionuous flow of packets, but after the rules are implemented the ICMP packets are dropped.

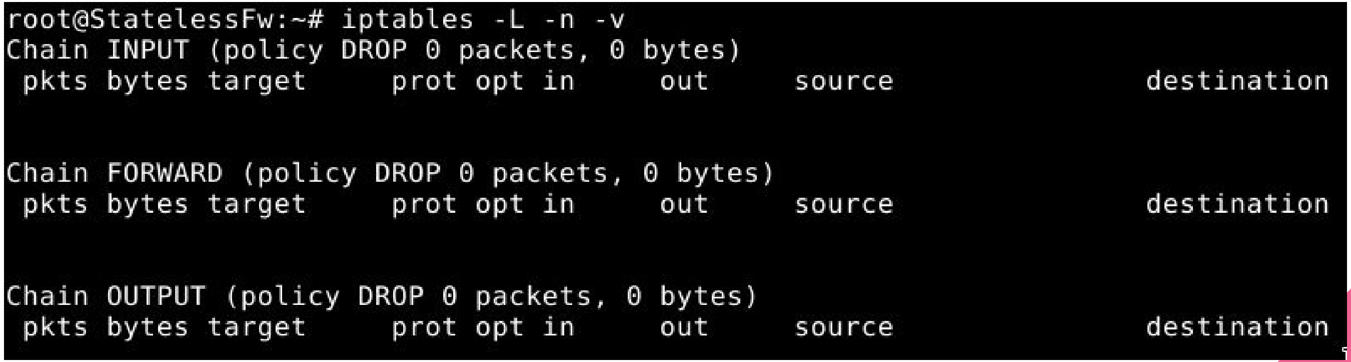
➔ Default Drop Policy on chains for the filter table

- *From the **terminal** on the **Firewall***
- ***Type** the following commands to set all policies to DROP **from ACCEPT***



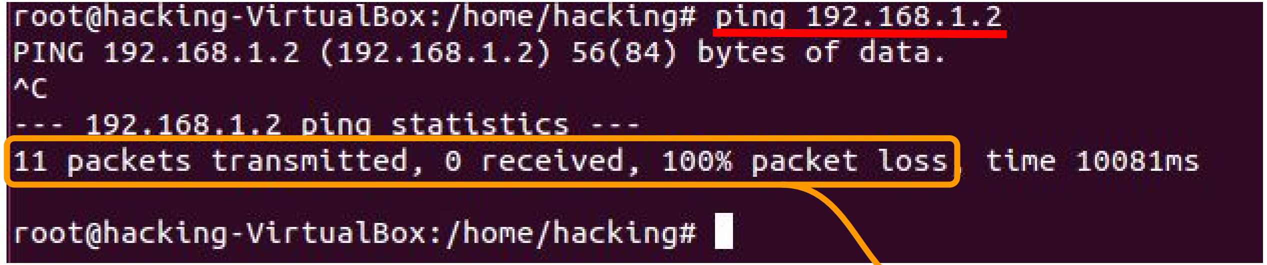
```
root@StatelessFw:/home/secclass# iptables -P INPUT DROP
root@StatelessFw:/home/secclass# iptables -P OUTPUT DROP
root@StatelessFw:/home/secclass# iptables -P FORWARD DROP
```

- *List the new policies using **iptables -L -n -v***



```
root@StatelessFw:~# iptables -L -n -v
Chain INPUT (policy DROP 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination


Chain FORWARD (policy DROP 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination


Chain OUTPUT (policy DROP 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination
```

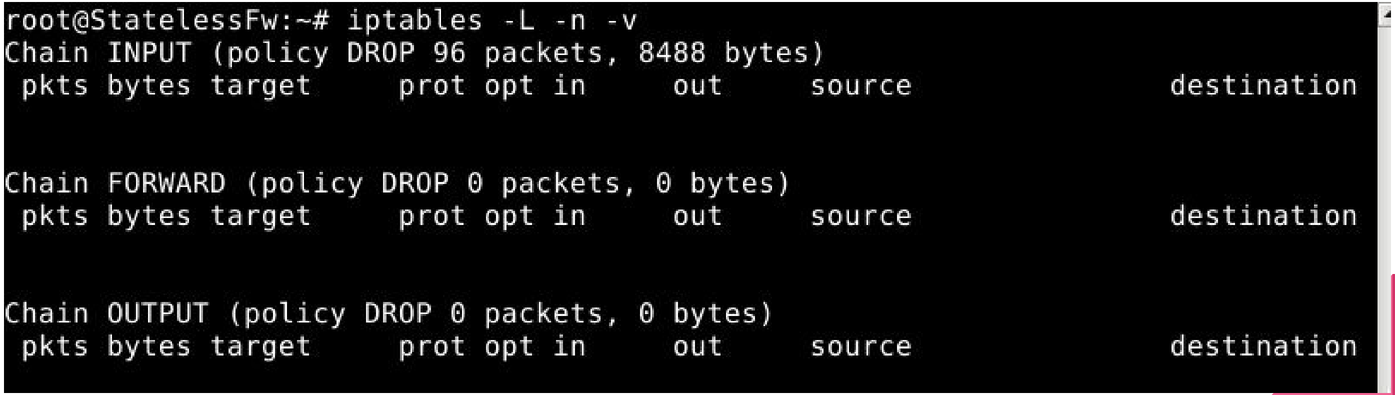
- *Open terminal on the* ***UbuntuHost*** *and ping the* ***Firewall***



```
root@hacking-VirtualBox:/home/hacking# ping 192.168.1.2
PING 192.168.1.2 (192.168.1.2) 56(84) bytes of data.
^C
--- 192.168.1.2 ping statistics ---
11 packets transmitted, 0 received, 100% packet loss, time 10081ms

root@hacking-VirtualBox:/home/hacking# 
```

All Packets are lost

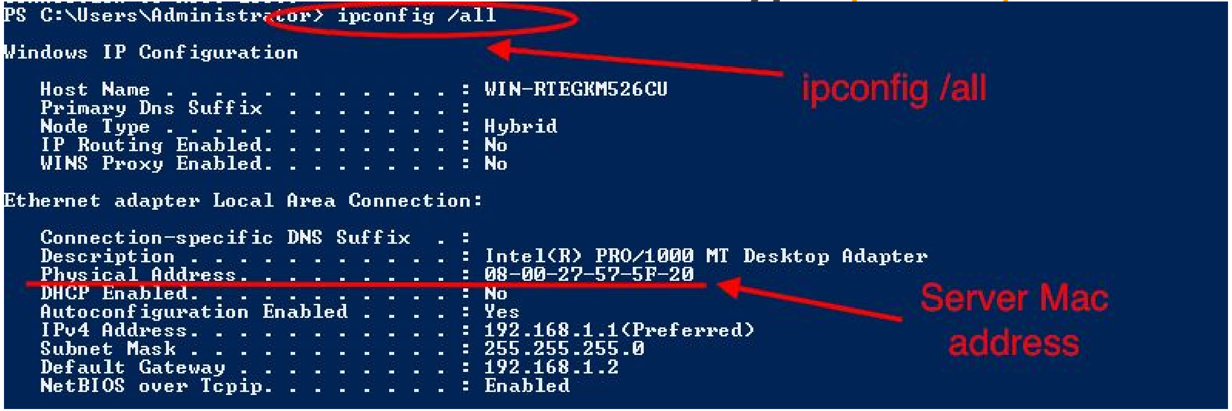
- *Check traffic on the* ***Firewall*** *using* ***iptables -L -n -v***



```
root@StatelessFw:~# iptables -L -n -v
Chain INPUT (policy DROP 96 packets, 8488 bytes)
 pkts bytes target     prot opt in     out     source               destination


Chain FORWARD (policy DROP 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination


Chain OUTPUT (policy DROP 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination
```

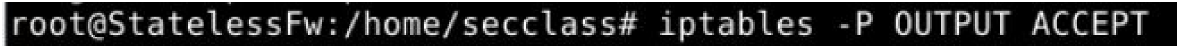
➔ Whitelist traffic from the WinHost’s mac address

- *Check mac address of* ***WinHost*** *:* ***Type*** *ipconfig /all*



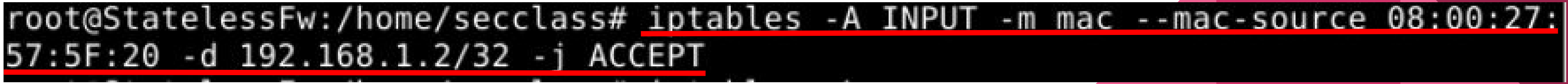
```
PS C:\Users\Administrator> ipconfig /all

Windows IP Configuration

   Host Name . . . . . . . . . . . . : WIN-RTEGKM526CU
   Primary Dns Suffix  . . . . . . . :
   Node Type . . . . . . . . . . . . : Hybrid
   IP Routing Enabled. . . . . . . . : No
   WINS Proxy Enabled. . . . . . . . : No

Ethernet adapter Local Area Connection:

   Connection-specific DNS Suffix  . :
   Description . . . . . . . . . . . : Intel(R) PRO/1000 MT Desktop Adapter
   Physical Address. . . . . . . . . : 08-00-27-57-5F-20
   DHCP Enabled. . . . . . . . . . . : No
   Autoconfiguration Enabled . . . . : Yes
   IPv4 Address. . . . . . . . . . . : 192.168.1.1(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 192.168.1.2
   NetBIOS over Tcpip. . . . . . . . : Enabled
```

- *Define policy to allow outgoing traffic from the firewall :*



```
root@StatelessFw:/home/secclass# iptables -P OUTPUT ACCEPT
```

- *Allow traffic for the Winhost’s mac address*

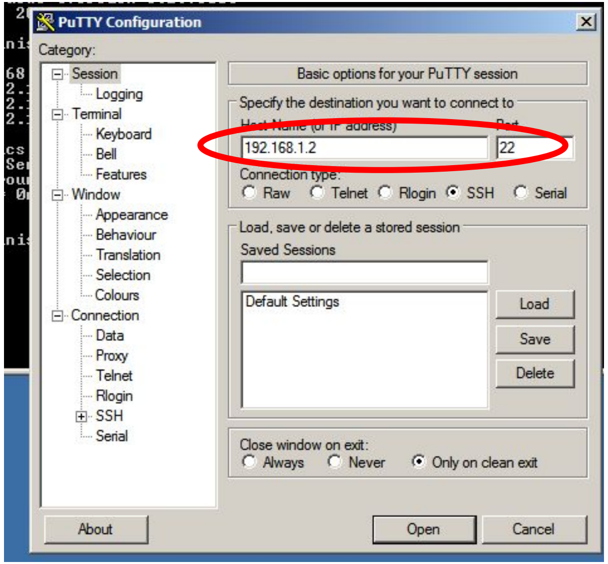


```
root@StatelessFw:/home/secclass# iptables -A INPUT -m mac --mac-source 08:00:27:
57:5F:20 -d 192.168.1.2/32 -j ACCEPT
```

Testing :

- *On **WinHost**, Open Putty located on the taskbar and connect to the **Firewall** :*

A



Specify the destination you want to connect to

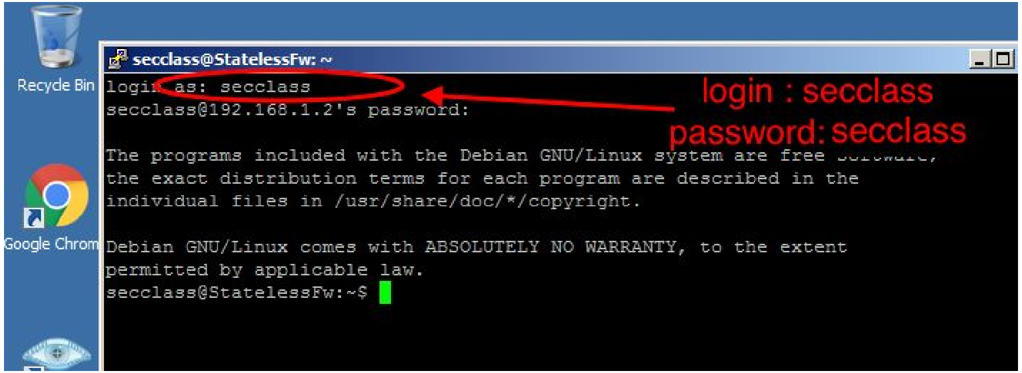
Host Name (or IP address): 192.168.1.2 Port: 22

Connection type: ○ Raw ○ Telnet ○ Rlogin ● SSH ○ Serial

Saved Sessions: Default Settings

Close window on exit: ○ Always ○ Never ● Only on clean exit

B

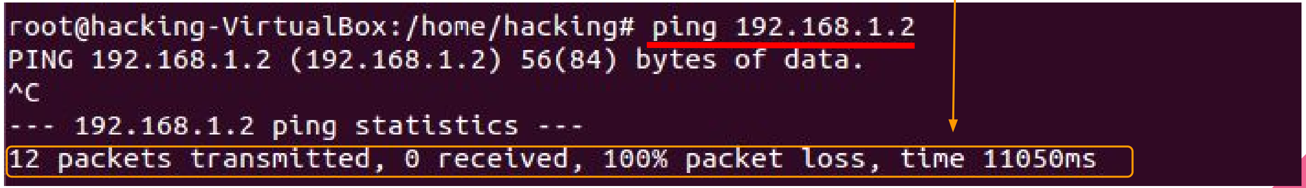


```
login as: secclass
secclass@192.168.1.2's password:

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
secclass@StatelessFw:~$
```

login : secclass
password: secclass

Pings from UbuntuHost to Firewall vm doesn't work

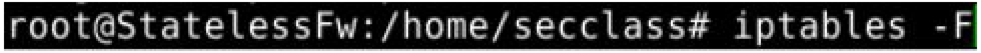
C



```
root@hacking-VirtualBox:/home/hacking# ping 192.168.1.2
PING 192.168.1.2 (192.168.1.2) 56(84) bytes of data.
^C
--- 192.168.1.2 ping statistics ---
12 packets transmitted, 0 received, 100% packet loss, time 11050ms
```

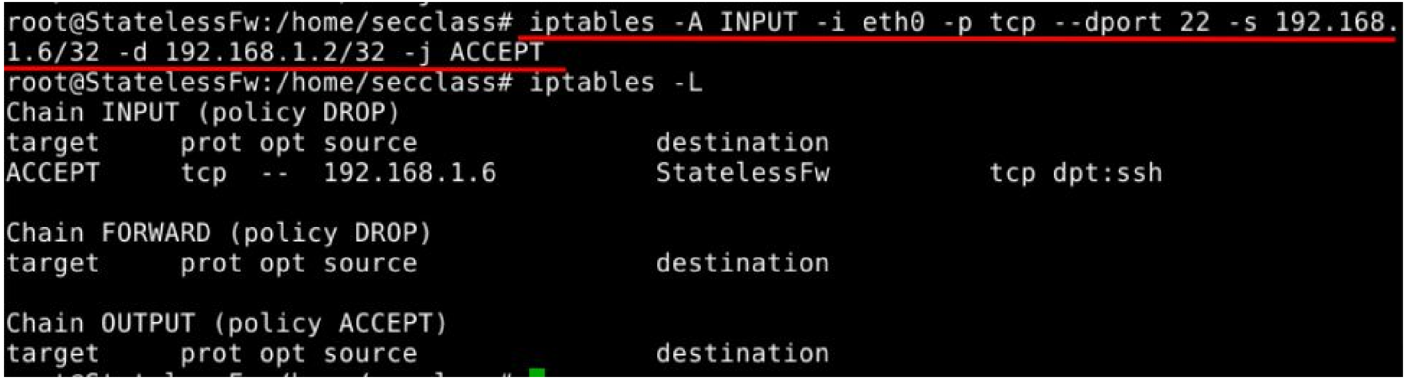
➔ Allow access to tcp port 22(ssh) from UbuntuHost

- *Open **Terminal** on **Firewall***
- *Flush the Iptables using*



```
root@StatelessFw:/home/secclass# iptables -F
```

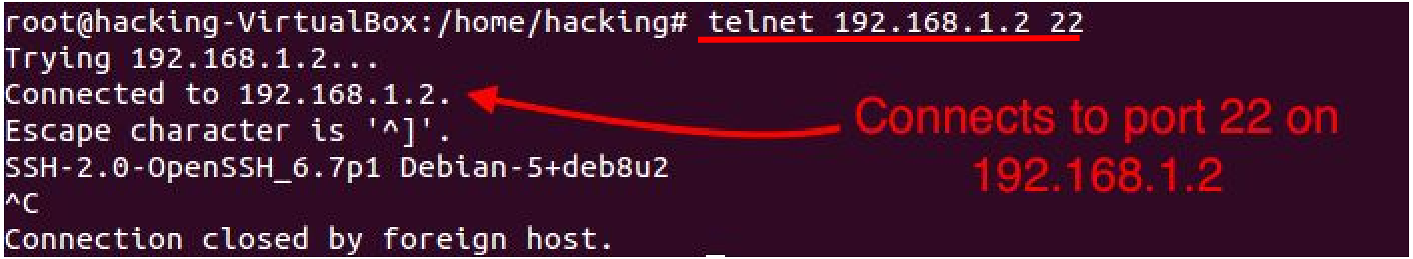
- *Allow access for 192.168.1.6*



```
root@StatelessFw:/home/secclass# iptables -A INPUT -i eth0 -p tcp --dport 22 -s 192.168.
1.6/32 -d 192.168.1.2/32 -j ACCEPT
root@StatelessFw:/home/secclass# iptables -L
Chain INPUT (policy DROP)
target     prot opt source               destination
ACCEPT     tcp  --  192.168.1.6          StatelessFw          tcp dpt:ssh

Chain FORWARD (policy DROP)
target     prot opt source               destination

Chain OUTPUT (policy ACCEPT)
target     prot opt source               destination
```

- **Testing :**

*Test by Telnet 192.168.1.2 22 from **UbuntuHost***



```
root@hacking-VirtualBox:/home/hacking# telnet 192.168.1.2 22
Trying 192.168.1.2...
Connected to 192.168.1.2.
Escape character is '^]'.
SSH-2.0-OpenSSH_6.7p1 Debian-5+deb8u2
^C
Connection closed by foreign host.
```

Connects to port 22 on 192.168.1.2

2. FILTERING SPECIFIC TCP FLAGS(SYN,FIN ACCEPT)

➔ **Accepting only packets containing SYN & FIN**

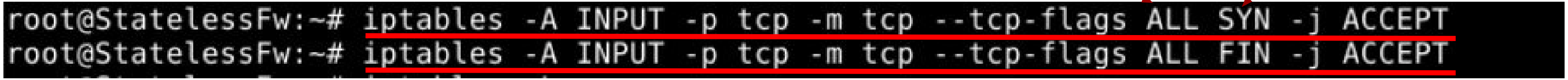
where

➔ **URG** - Urgent, **ACK** - Acknowledgement, **PSH** - Push, **RST** - Reset, **SYN** - Synchronize, and **FIN** - Finished are Flags contained in Transiting Packets

Lists All Flags

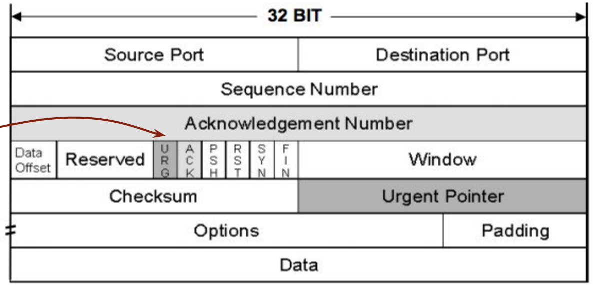
Flag chosen to implement rule

- on **Firewall** , insert the following rules :



```
root@StatelessFw:~# iptables -A INPUT -p tcp -m tcp --tcp-flags ALL SYN -j ACCEPT
root@StatelessFw:~# iptables -A INPUT -p tcp -m tcp --tcp-flags ALL FIN -j ACCEPT
```

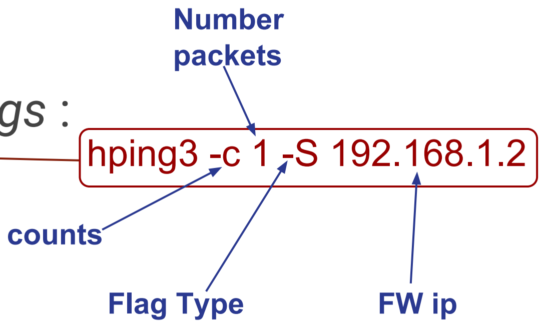
Remember ***Tcp*** scheme

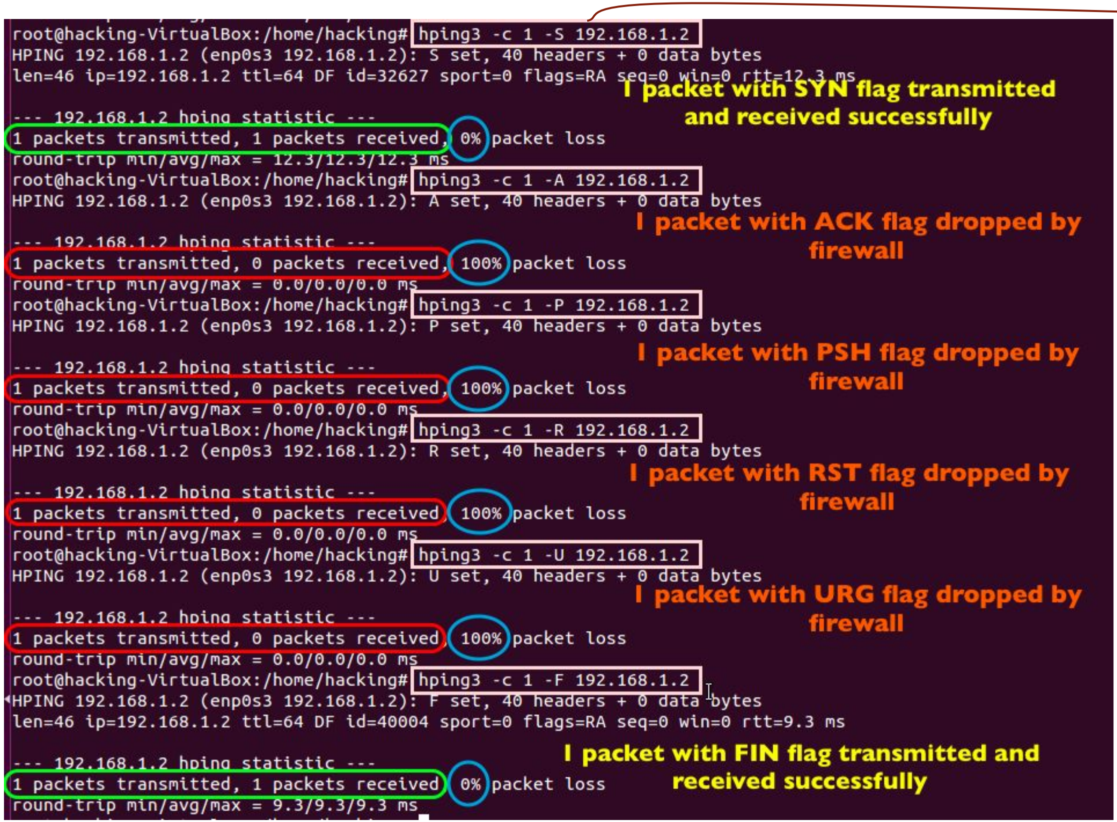


Flags

Testing :

- On **UbuntuHost** , Use **hping3** to view the dropped *tcp flags* :





```
root@hacking-VirtualBox:/home/hacking# hping3 -c 1 -S 192.168.1.2
HPING 192.168.1.2 (enp0s3 192.168.1.2): S set, 40 headers + 0 data bytes
len=46 ip=192.168.1.2 ttl=64 DF id=32627 sport=0 flags=RA seq=0 win=0 rtt=12.3 ms

--- 192.168.1.2 hping statistic ---
1 packets transmitted, 1 packets received, 0% packet loss
round-trip min/avg/max = 12.3/12.3/12.3 ms
root@hacking-VirtualBox:/home/hacking# hping3 -c 1 -A 192.168.1.2
HPING 192.168.1.2 (enp0s3 192.168.1.2): A set, 40 headers + 0 data bytes

--- 192.168.1.2 hping statistic ---
1 packets transmitted, 0 packets received, 100% packet loss
round-trip min/avg/max = 0.0/0.0/0.0 ms
root@hacking-VirtualBox:/home/hacking# hping3 -c 1 -P 192.168.1.2
HPING 192.168.1.2 (enp0s3 192.168.1.2): P set, 40 headers + 0 data bytes

--- 192.168.1.2 hping statistic ---
1 packets transmitted, 0 packets received, 100% packet loss
round-trip min/avg/max = 0.0/0.0/0.0 ms
root@hacking-VirtualBox:/home/hacking# hping3 -c 1 -R 192.168.1.2
HPING 192.168.1.2 (enp0s3 192.168.1.2): R set, 40 headers + 0 data bytes

--- 192.168.1.2 hping statistic ---
1 packets transmitted, 0 packets received 100% packet loss
round-trip min/avg/max = 0.0/0.0/0.0 ms
root@hacking-VirtualBox:/home/hacking# hping3 -c 1 -U 192.168.1.2
HPING 192.168.1.2 (enp0s3 192.168.1.2): U set, 40 headers + 0 data bytes

--- 192.168.1.2 hping statistic ---
1 packets transmitted, 0 packets received 100% packet loss
round-trip min/avg/max = 0.0/0.0/0.0 ms
root@hacking-VirtualBox:/home/hacking# hping3 -c 1 -F 192.168.1.2
HPING 192.168.1.2 (enp0s3 192.168.1.2): F set, 40 headers + 0 data bytes
len=46 ip=192.168.1.2 ttl=64 DF id=40004 sport=0 flags=RA seq=0 win=0 rtt=9.3 ms

--- 192.168.1.2 hping statistic ---
1 packets transmitted, 1 packets received 0% packet loss
round-trip min/avg/max = 9.3/9.3/9.3 ms
```

I packet with SYN flag transmitted and received successfully

I packet with ACK flag dropped by firewall

I packet with PSH flag dropped by firewall

I packet with RST flag dropped by firewall

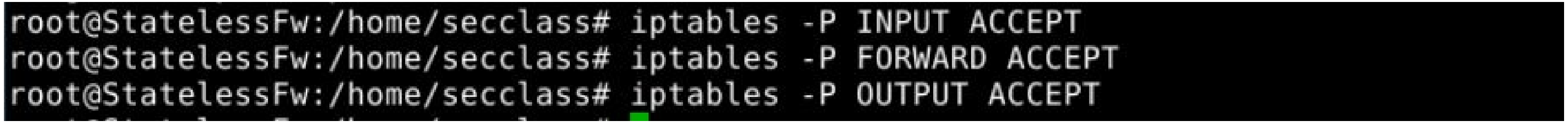
I packet with URG flag dropped by firewall

I packet with FIN flag transmitted and received successfully

3. NAT & PORT FORWARDING

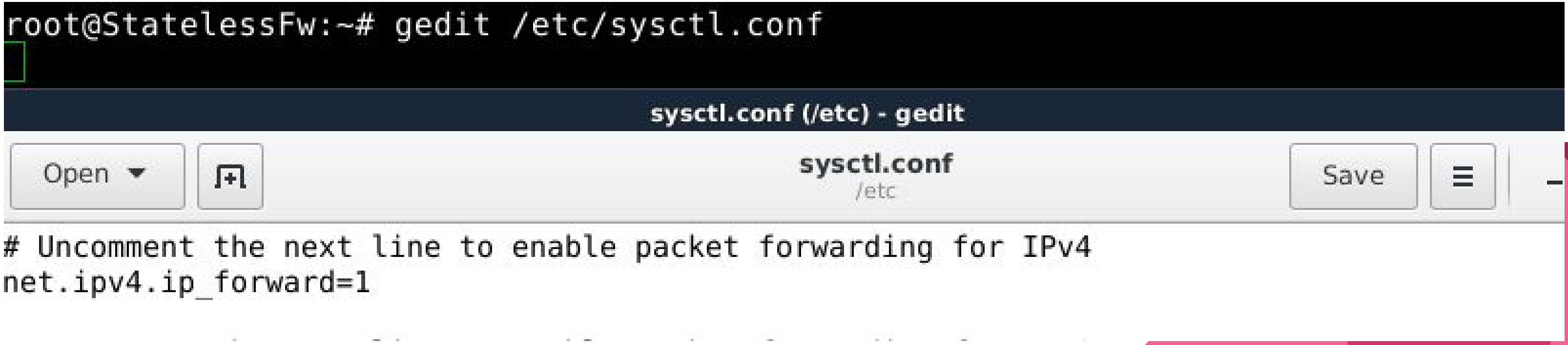
➔ ***Redirect Traffic from port 8080 to common http port 80***

- *Flush iptables with iptables -F & iptables -t nat -F*
- *Define all policies to **accept traffic***



```
root@StatelessFw:/home/secclass# iptables -P INPUT ACCEPT
root@StatelessFw:/home/secclass# iptables -P FORWARD ACCEPT
root@StatelessFw:/home/secclass# iptables -P OUTPUT ACCEPT
```

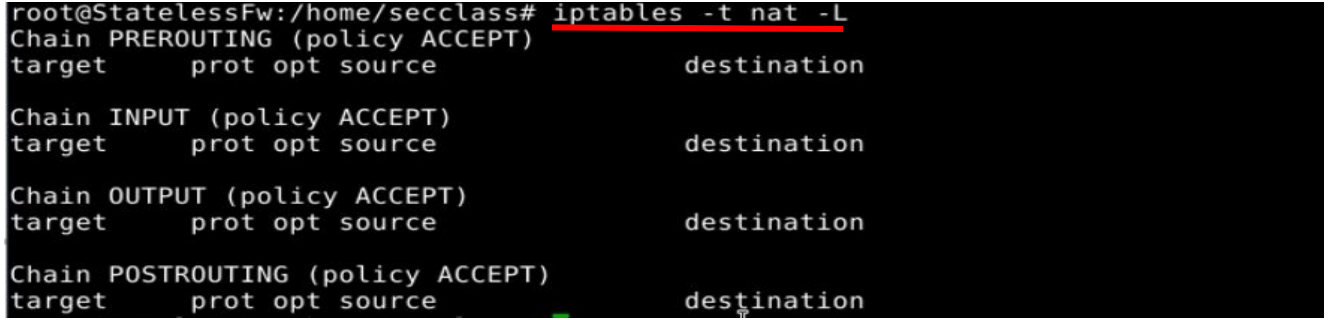
- *Uncomment the following line in the sysctl.conf file*



```
root@StatelessFw:~# gedit /etc/sysctl.conf
```

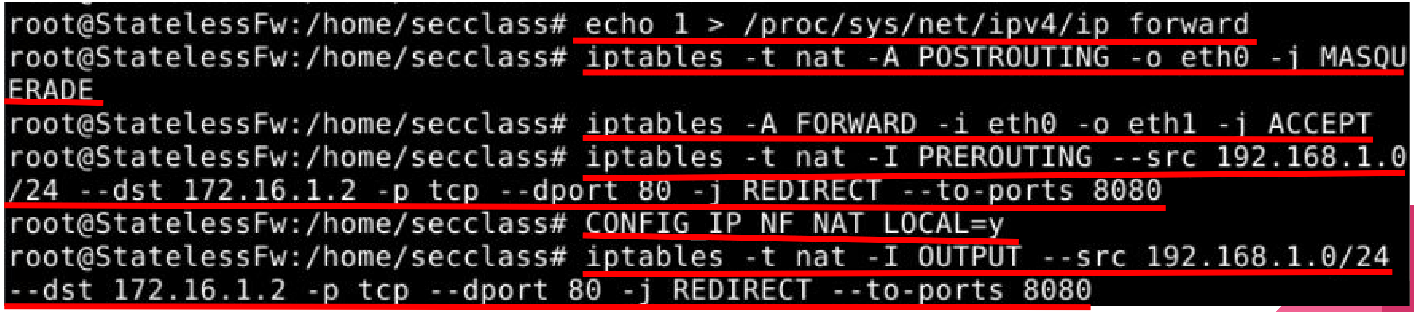
```
# Uncomment the next line to enable packet forwarding for IPv4
net.ipv4.ip_forward=1
```

- ***check iptables*** *iptables -L & check the nat policies by using iptables -t nat -L*



```
root@StatelessFw:/home/secclass# iptables -t nat -L
Chain PREROUTING (policy ACCEPT)
target     prot opt source               destination

Chain INPUT (policy ACCEPT)
target     prot opt source               destination

Chain OUTPUT (policy ACCEPT)
target     prot opt source               destination

Chain POSTROUTING (policy ACCEPT)
target     prot opt source               destination
```

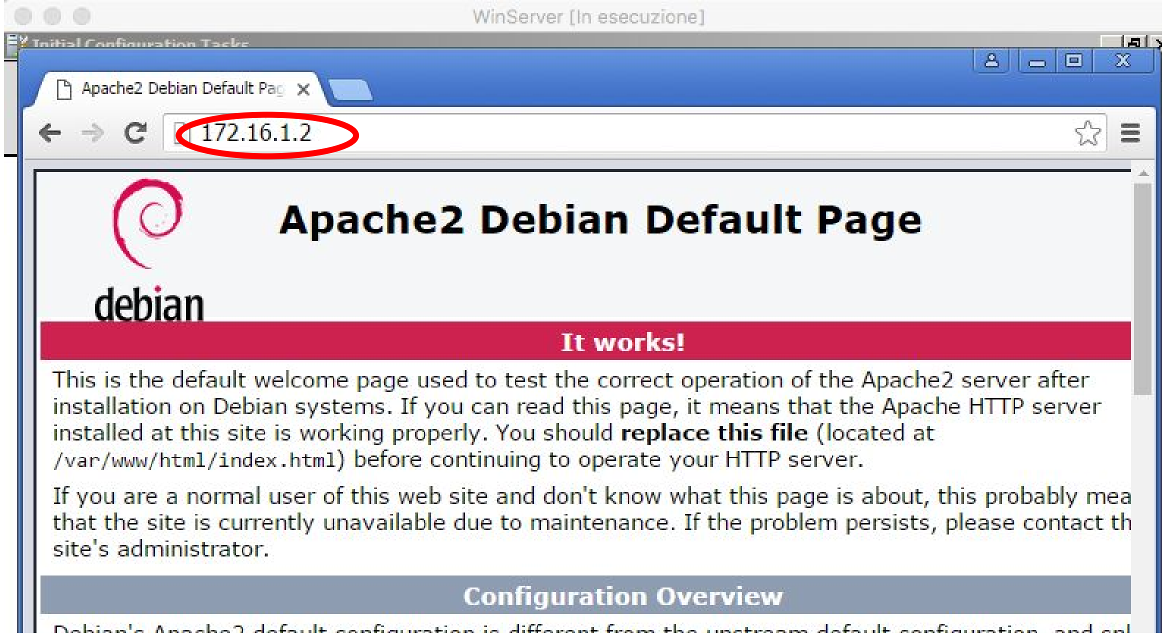
- *Insert the following rules to activate port redirection :*



```
root@StatelessFw:/home/secclass# echo 1 > /proc/sys/net/ipv4/ip_forward
root@StatelessFw:/home/secclass# iptables -t nat -A POSTROUTING -o eth0 -j MASQU
ERADE
root@StatelessFw:/home/secclass# iptables -A FORWARD -i eth0 -o eth1 -j ACCEPT
root@StatelessFw:/home/secclass# iptables -t nat -I PREROUTING --src 192.168.1.0
/24 --dst 172.16.1.2 -p tcp --dport 80 -j REDIRECT --to-ports 8080
root@StatelessFw:/home/secclass# CONFIG_IP_NF_NAT_LOCAL=y
root@StatelessFw:/home/secclass# iptables -t nat -I OUTPUT --src 192.168.1.0/24
--dst 172.16.1.2 -p tcp --dport 80 -j REDIRECT --to-ports 8080
```

Testing :

- *Open a browser on **WinHost** and **Type "172.16.1.2:80"***



WinServer [In esecuzione]
Initial Configuration Tasks
Apache2 Debian Default Pag
172.16.1.2
debian

Apache2 Debian Default Page

It works!

This is the default welcome page used to test the correct operation of the Apache2 server after installation on Debian systems. 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 mea that the site is currently unavailable due to maintenance. If the problem persists, please contact th site's administrator.

Configuration Overview

Debian's Apache2 default configuration is different from the upstream default configuration, and spl

- *It Works!!*

III. Conclusion

➔ How can I protect my own PC

- **Uninstall** all programs which are not permanently used.
- **Uninstall** all programs with well known security gaps e.g. Adobe Flash
- Up**date your applications and operating systems as soon as stable updates are available**
- Invest in a good antivirus system **e.g. Kaspersky**
- Install a **personal firewall** (Freeware:ZoneAlarm)
- Encrypt your hard drive
- Scan all external usbs
- Use a trusted VPN service provider to encrypt your traffic

➔ Best practices for firewall administrators

- **Document all firewall rule changes.**
- **Install all access rules with minimal access rights. Eg.** Avoid rules where the service field is 'ANY', it opens up 65,535 TCP ports as well as udp & icmp ports
- **Verify every firewall change against compliance policies and change requests.**
- **Remove unused rules from the firewall rule bases when services are decommissioned.**
- **Perform a complete firewall review at least twice per year.**

Thanks!!