# Linux Firewalls

Frank Kuse, AfNOG 2017

# About this presentation

Based on a previous talk by Kevin Chege and Chris Wilson, with thanks!

You can access this presentation at:

- Online: http://afnog.github.io/sse/firewalls/
- Local: http://www.ws.afnog.org/afnog2017/sse/firewalls/index.html
- Github: https://github.com/afnog/sse/blob/master/firewalls/presentation.md
- Download PDF:
  http://www.ws.afnog.org/afnog2017/sse/firewalls/presentation.pdf

  Download Exercises: http://www.ws.afnog.org/afnog2017/sse/firewalls/Exercises.pdf

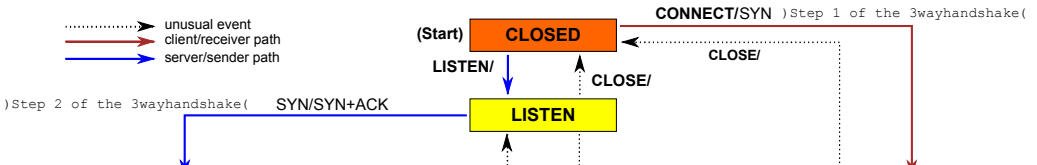
# What is a Firewall?



# Advanced Firewalls

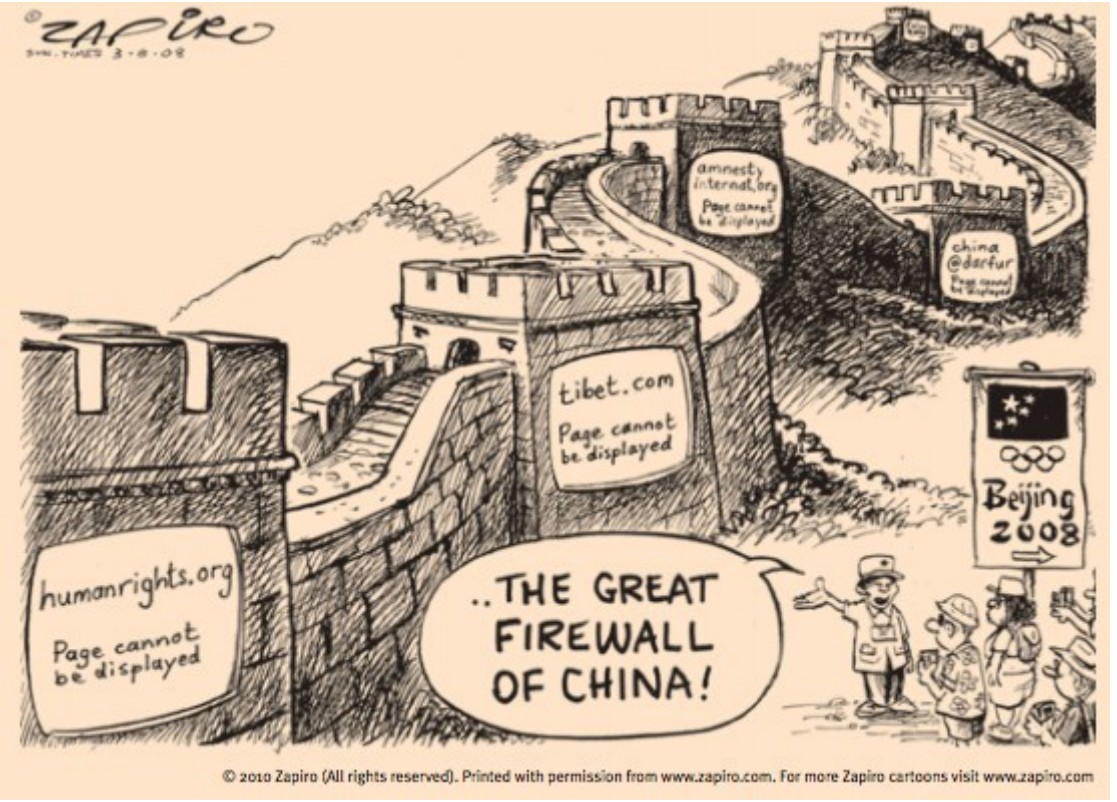
- Basic firewalls are packet filters
- Can't always make a decision based on one packet (examples?)
- Stateful firewalls (connection table)
- Application layer (L7) filtering/inspection/IDS
- Redundant firewalls with synchronisation
- VPNs and SSL "VPNs"

# Stateful Firewalls

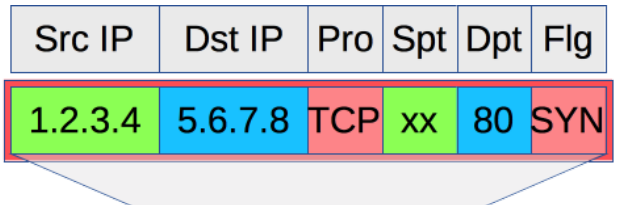


# Limitations of Firewalls

# Blocking Websites



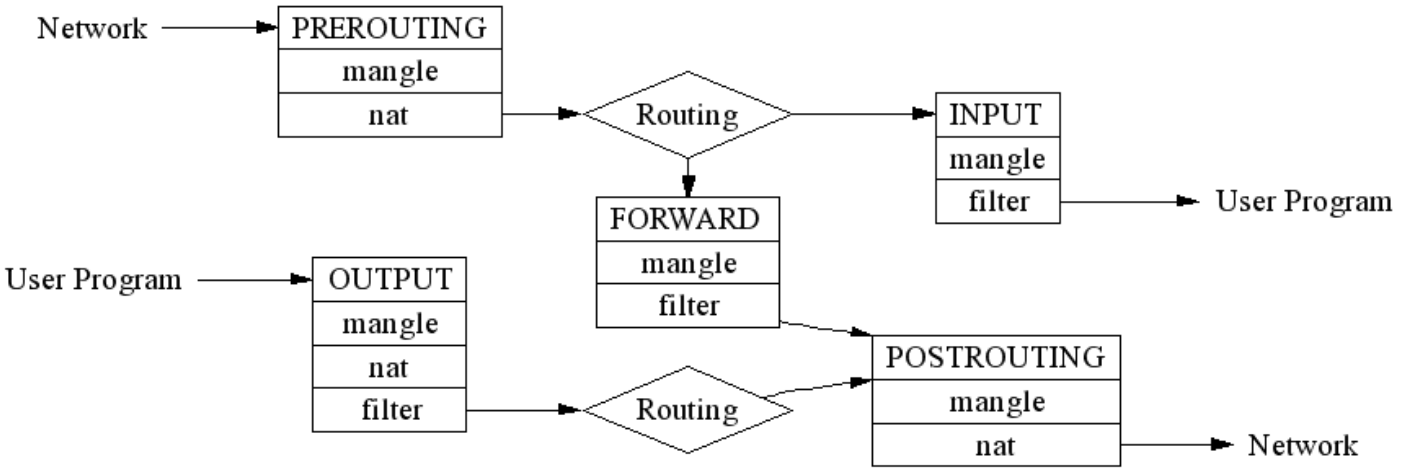
# What do firewalls filter?



# Typical features

- Rulesets (lists of rules, read in order)
- Rules (IF this THEN that)
- Match conditions
  - interface, IP address, protocol, port, time, contents
- Actions
  - accept, drop, reject, jump to another table, return
- Default policy

# iptables/netfilter



# Listing current rules

We use the `iptables` command to interact with the firewall (in the kernel):

```
$ sudo apt install iptables
```

```
$ sudo iptables -L -nv
```

```
Chain INPUT (policy ACCEPT 119 packets, 30860 bytes)
```

```
 pkts bytes target     prot opt in     out     source
  destination
```

```
Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
```

```
 pkts bytes target     prot opt in     out     source
  destination
```

```
Chain OUTPUT (policy ACCEPT 36 packets, 1980 bytes)
```

```
 pkts bytes target     prot opt in     out     source
  destination
```

# Your first ruleset

Configure your firewall to allow ICMP packets.

```
$ sudo iptables -A INPUT -p icmp -j ACCEPT
```

```
$ sudo iptables -L INPUT -nv
```

```
Chain INPUT (policy ACCEPT 4 packets, 520 bytes)
```

```
 pkts bytes target     prot opt in     out     source
  destination
```

```
    0     0 ACCEPT     icmp --  *      *       0.0.0.0/0
  0.0.0.0/0
```

What effect will this have?

What are the numbers?

# Testing rules

How can you test it?

```
$ ping -c4 127.0.0.1
```

```
PING 127.0.0.1 (127.0.0.1) 56(84) bytes of data.
```

```
64 bytes from 127.0.0.1: icmp_seq=1 ttl=64 time=0.058 ms
```

```
...
```

```
$ sudo iptables -L INPUT -nv
```

```
Chain INPUT (policy ACCEPT 220 packets, 218K bytes)
```

```
 pkts bytes target     prot opt in     out     source
  destination
```

```
    8   672 ACCEPT     icmp --  *      *       0.0.0.0/0
  0.0.0.0/0
```

Why do we see 8 packets against the rule, instead of 4?

You can use `iptables -L INPUT -nZ` to `Z`ero the counters.

# Blocking pings

Add another rule:

```
$ sudo iptables -A INPUT -p icmp -j DROP
```

```
$ sudo iptables -L INPUT -nv
```

```
Chain INPUT (policy ACCEPT 12 packets, 1560 bytes)
```

```
 pkts bytes target     prot opt in     out     source
  destination
```

```
    8   672 ACCEPT     icmp --  *      *       0.0.0.0/0
  0.0.0.0/0
```

```
    0     0 DROP       icmp --  *      *       0.0.0.0/0
  0.0.0.0/0
```

```
$ ping -c1 127.0.0.1
```

```
64 bytes from 127.0.0.1: icmp_seq=1 ttl=64 time=0.067 ms
```

Is that what you expected?

# Rule precedence

Insert a DROP rule **before** the ACCEPT rule with `-I`:

```
$ sudo iptables -I INPUT -p icmp -j DROP
```

```
$ sudo iptables -L INPUT -nv
```

```
Chain INPUT (policy ACCEPT 12 packets, 1560 bytes)
```

```
 pkts bytes target     prot opt in     out     source
  destination
```

```
    0     0 DROP       icmp --  *      *       0.0.0.0/0
  0.0.0.0/0
```

```
   10   840 ACCEPT     icmp --  *      *       0.0.0.0/0
  0.0.0.0/0
```

```
    0     0 DROP       icmp --  *      *       0.0.0.0/0
  0.0.0.0/0
```

# Rule precedence testing

```
$ ping -c1 127.0.0.1
PING 127.0.0.1 (127.0.0.1) 56(84) bytes of data.
^C
--- 127.0.0.1 ping statistics ---
1 packets transmitted, 0 received, 100% packet loss, time 0ms
```

# List rules with indexes

Use the iptables `-L --line-numbers` options:

```
$ sudo iptables -L INPUT -nv --line-numbers
```

```
Chain INPUT (policy ACCEPT 15 packets, 1315 bytes)
```

```
num   pkts bytes target   prot opt in     out   source
  destination
```

```
1        0     0 DROP     icmp --  *      *     0.0.0.0/0
  0.0.0.0/0
```

```
2        0     0 ACCEPT   icmp --  *      *     0.0.0.0/0
  0.0.0.0/0
```

```
3        0     0 DROP     icmp --  *      *     0.0.0.0/0
  0.0.0.0/0
```

# Deleting Rules

Delete rule by index:

```
$ sudo iptables -D INPUT 3
```

Delete rule by target:

```
$ sudo iptables -D INPUT -p icmp -j ACCEPT
```

Check the results:

```
$ sudo iptables -L INPUT -nv --line-numbers
```

```
Chain INPUT (policy ACCEPT 9 packets, 835 bytes)
```

```
num   pkts bytes target     prot opt in     out     source
  destination
```

```
1        0     0 DROP       icmp --  *      *       0.0.0.0/0
  0.0.0.0/0
```

# Persistent Rules

What happens when you reboot?

# Persistent Rules

What happens when you reboot?

The rules that we created are only in the kernel's memory. They will be lost on reboot.

How can we make them permanent? Could be as simple as:

```
/sbin/iptables-save > /etc/default/iptables
```

```
/sbin/iptables-restore < /etc/default/iptables
```

Or install `iptables-persistent` which automates this a little.

# Connection Tracking

Every packet is tracked by default (made into a connection).

You can see them with `conntrack -L`:

```
sudo /usr/sbin/conntrack -L
```

```
tcp      6 431999 ESTABLISHED src=196.200.216.99
  dst=196.200.219.140 sport=58516 dport=22
```

```
src=196.200.219.140 dst=196.200.216.99 sport=22 dport=58516
  [ASSURED] mark=0 use=1
```

What does this mean?

# Connection Tracking

```
sudo /usr/sbin/conntrack -L
```

```
tcp      6 431999 ESTABLISHED src=196.200.216.99
  dst=196.200.219.140 sport=58516 dport=22
```

```
src=196.200.219.140 dst=196.200.216.99 sport=22 dport=58516
  [ASSURED] mark=0 use=1
```

- ESTABLISHED is the connection state
  - What are valid states?
- src=196.200.216.99 is the source address of the tracked connection
- dst=196.200.219.140 is the destination address
  - Which one is the address of this host? Will it always be?
- sport=58516: source port
- dport=22: destination port
- Another set of addresses: what is this?

# Connection Tracking

How do we use it?

- `iptables -A INPUT -m state --state ESTABLISHED -j ACCEPT`
  - You normally want this!

Can you see any problems?

# Connection Tracking Problems

What happens if someone hits your server with this?

```
sudo hping3 --faster --rand-source -p 22 196.200.219.140 --syn
```

Or if you run a server that has thousands of clients?

# Connection Tracking Problems

Add a rule to block all connection tracking to a particular port:

```
sudo /sbin/iptables -t raw -A PREROUTING -p tcp --dport 22 -j
  NOTRACK
```

Write your rules so that connection tracking is **not needed** (allow traffic both ways).

You probably want to do this for your DNS server. How?

# Connection Tracking Problems

Add a rule to block all connection tracking to a particular port:

```
sudo /sbin/iptables -t raw -A PREROUTING -p tcp --dport 22 -j
  NOTRACK
```

Write your rules so that connection tracking is **not needed** (allow traffic both ways).

You probably want to do this for your DNS server. How?

```
sudo /sbin/iptables -t raw -A PREROUTING -p udp --dport 53 -j
  NOTRACK
```

# Standard simple rule set

This is one of the first things I set up on any new box:

```
iptables -P INPUT ACCEPT
iptables -F INPUT
iptables -A INPUT -m state --state ESTABLISHED -j ACCEPT
iptables -A INPUT -i lo -j ACCEPT
iptables -A INPUT -p icmp --icmp-type echo-request -j ACCEPT
iptables -A INPUT -p tcp --dport 22 -j ACCEPT
iptables -A INPUT -m limit --limit 5/min -j LOG --log-prefix
  'Rejected INPUT '
```

Check that I can access the server without triggering a "Rejected INPUT" message in the logs, and then lock it down:

```
iptables -P INPUT DROP
```

# Exercise

Install `nmap`:

```
sudo apt install nmap
```

Scan your system:

```
sudo nmap -sS pcXX.sse.ws.afnog.org
```

- Which ports are open?
- How would you block them?

You will probably lock yourself out of your PC. That is OK, we can fix it :)

- As long as the changes have NOT been made permanent, we can reboot the system to restore access.

# Exercise

The correct answer is:

```
iptables -I INPUT 2 -p tcp --dport 22 -j DROP
```

Which prevents new connections, but as long as rule 1 allows ESTABLISHED connections you will not be locked out (unless you lose your connection).

The output of `iptables -L -nv` should look like:

```
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target prot opt in out source    destination
  151 11173 ACCEPT all  --  *  *   0.0.0.0/0 0.0.0.0/0   state
 ESTABLISHED
    0     0        tcp  --  *  *   0.0.0.0/0 0.0.0.0/0   tcp
 dpt:22
```

# FIN

Any questions?

(yeah, right!)