Firewall

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Firewall provides a whole variety of tools necessary for safe and successful exchange of information between hosts in networks

Firewall - history

Note: The term firewall originally referred to a wall intended to confine a fire or potential fire within a building

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The need for firewall emerged in the late 1980s

- Morris Worm in 1988

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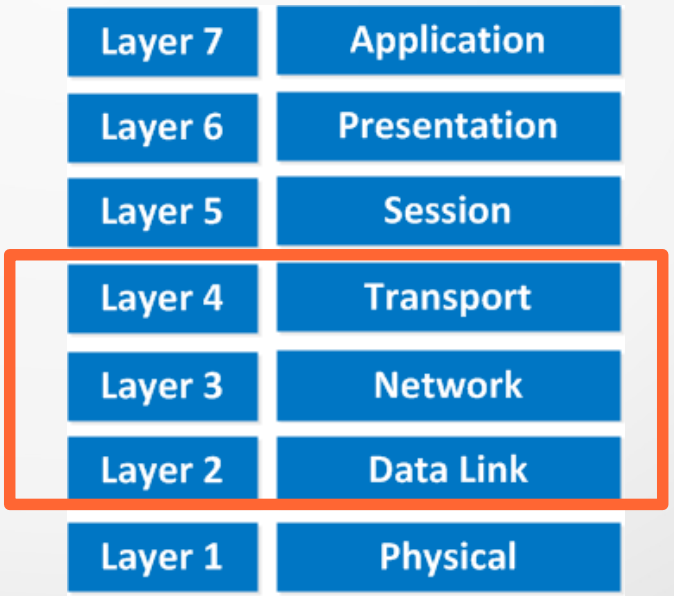

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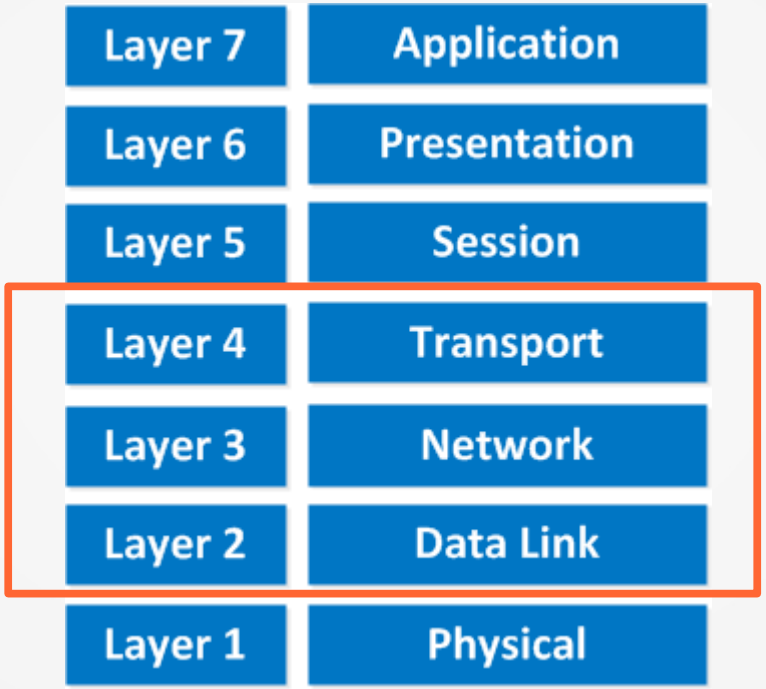

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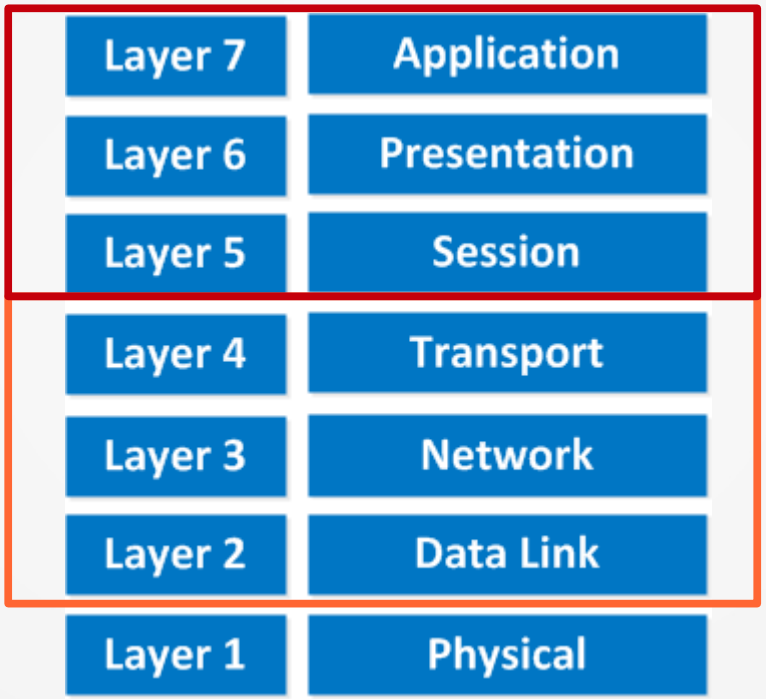

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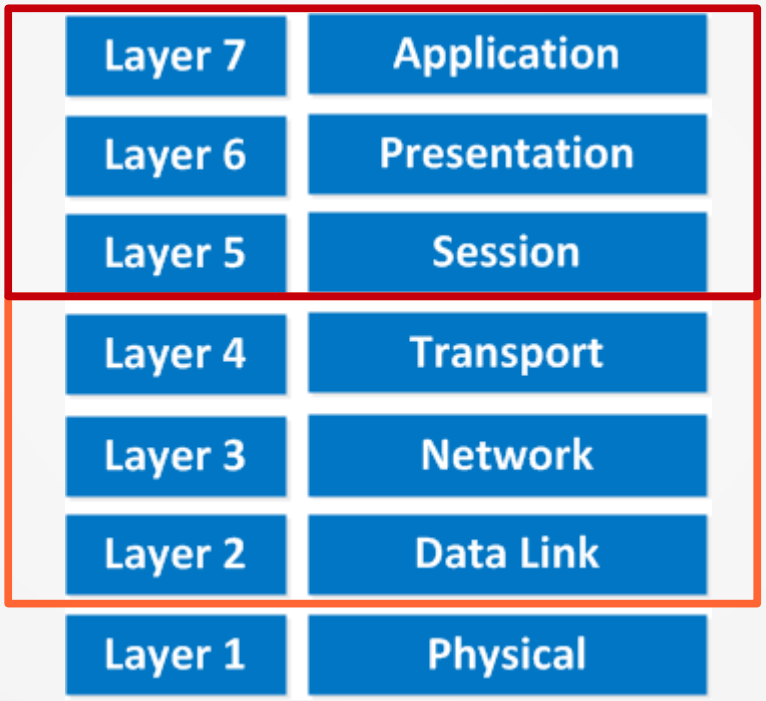
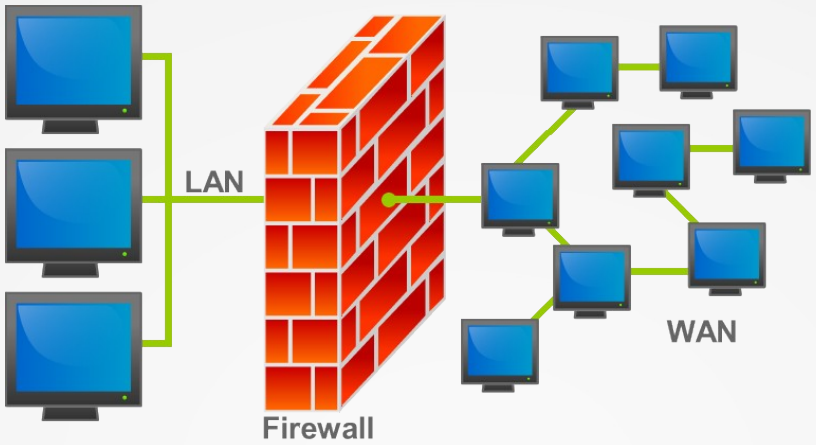


- Able to control network traffic regarding a specific application or sevice
  - AppArmor, Kerio Control

Firewall - concepts



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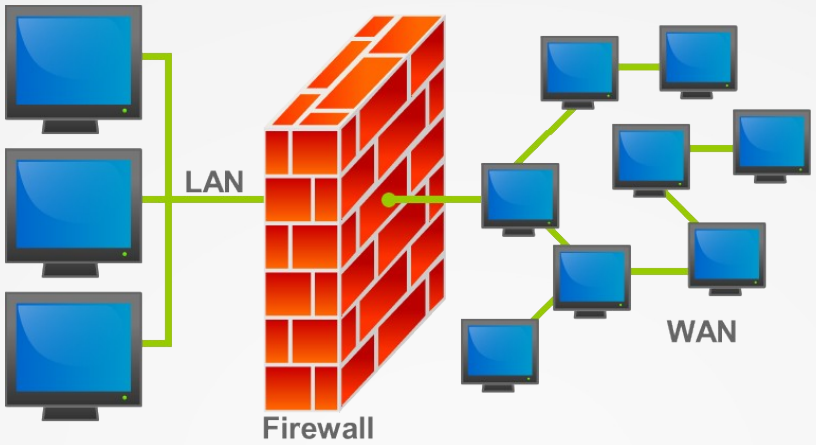

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  1. Filtering of frames and ARP messages (in OSI layer 2) and packets (in OSI layer 3)

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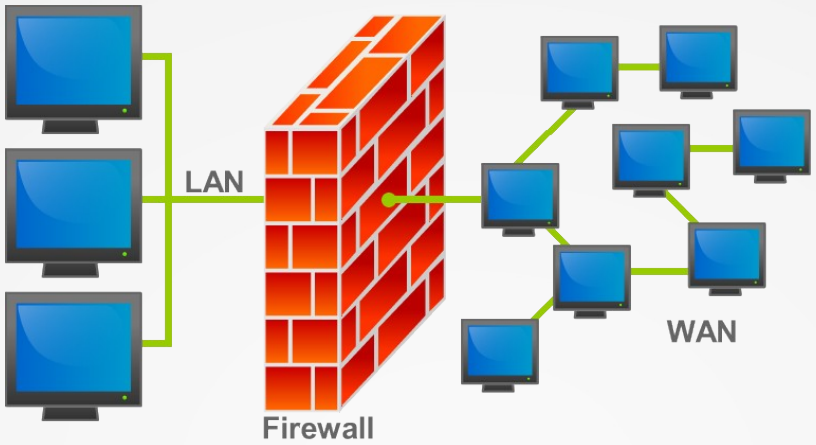

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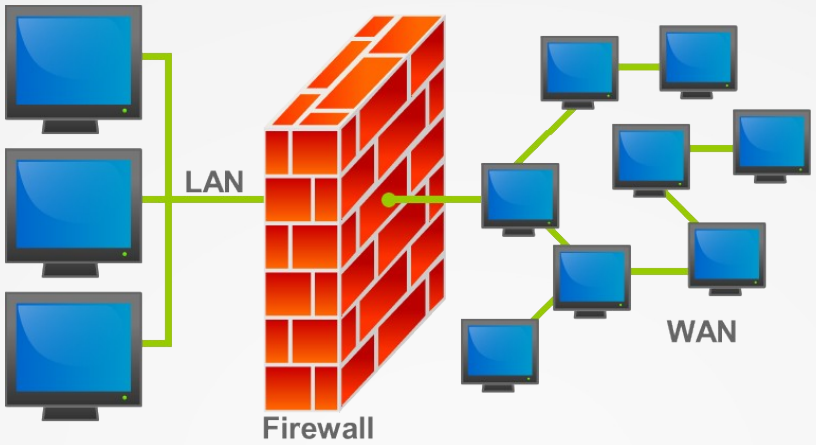

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  3. Modification of payload

Firewall – filtering

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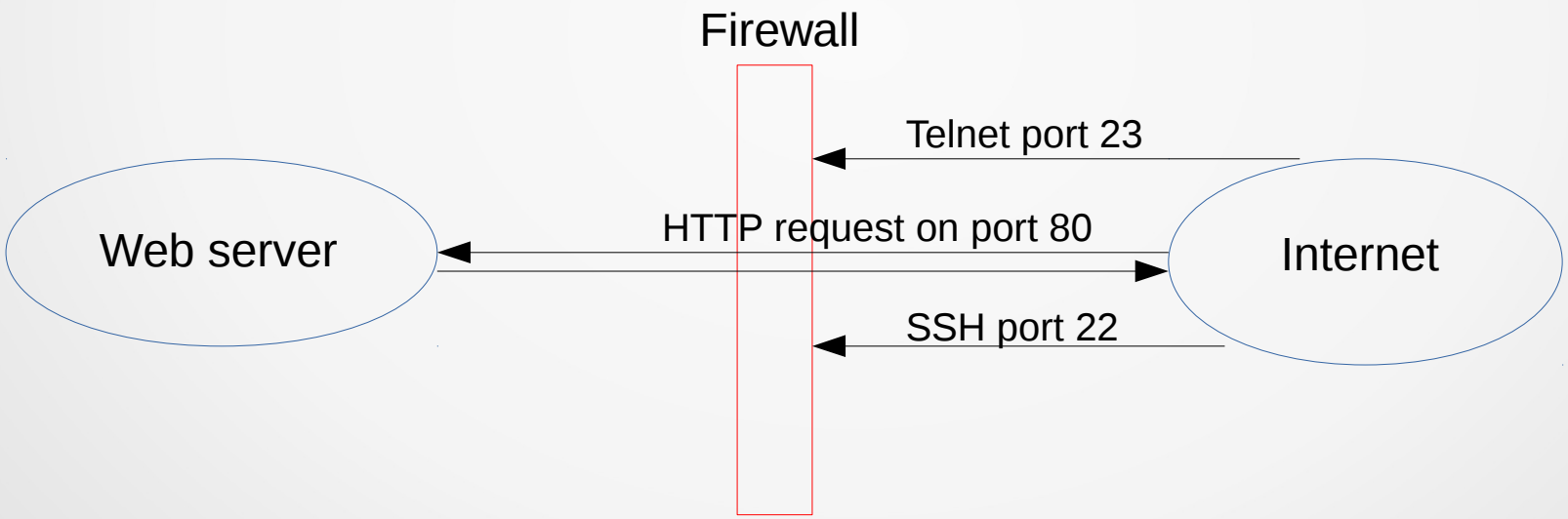
- Example usage: filtering packets based on their destination ports



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- If it doesn't match, then the next rule is checked (if it exists)
- If packet or frame doesn't match any of the rules, then is it rejected without any notification

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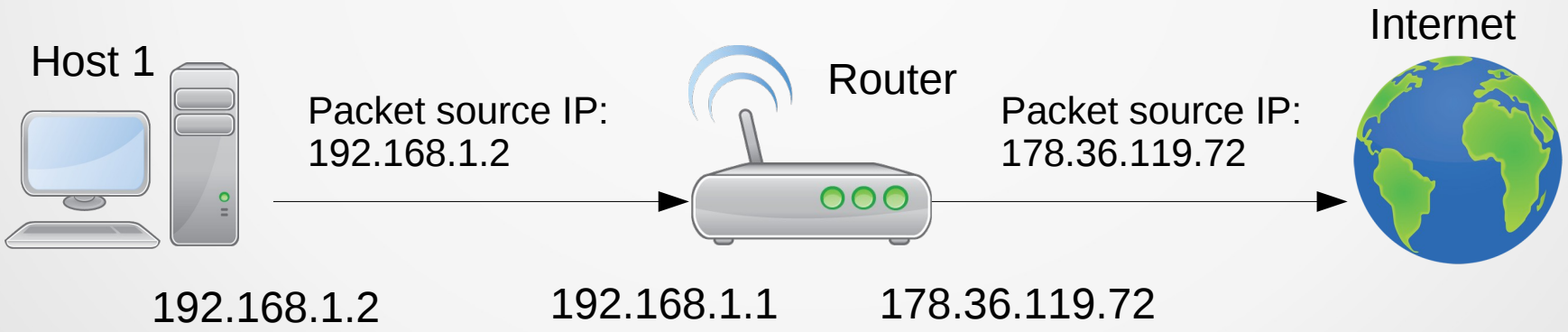

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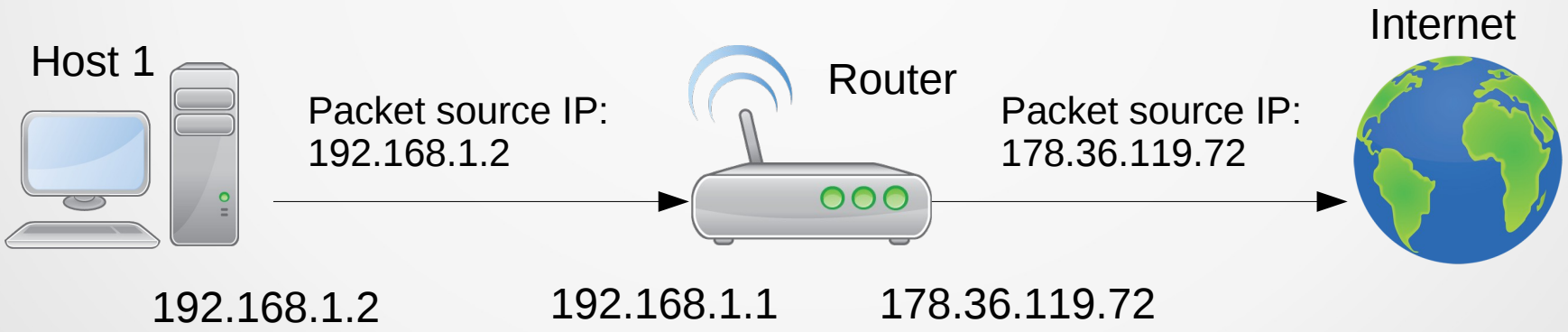

IP Masquerading was performed inside 'Router', where source IP of a packet sent from Host 1 was changed.

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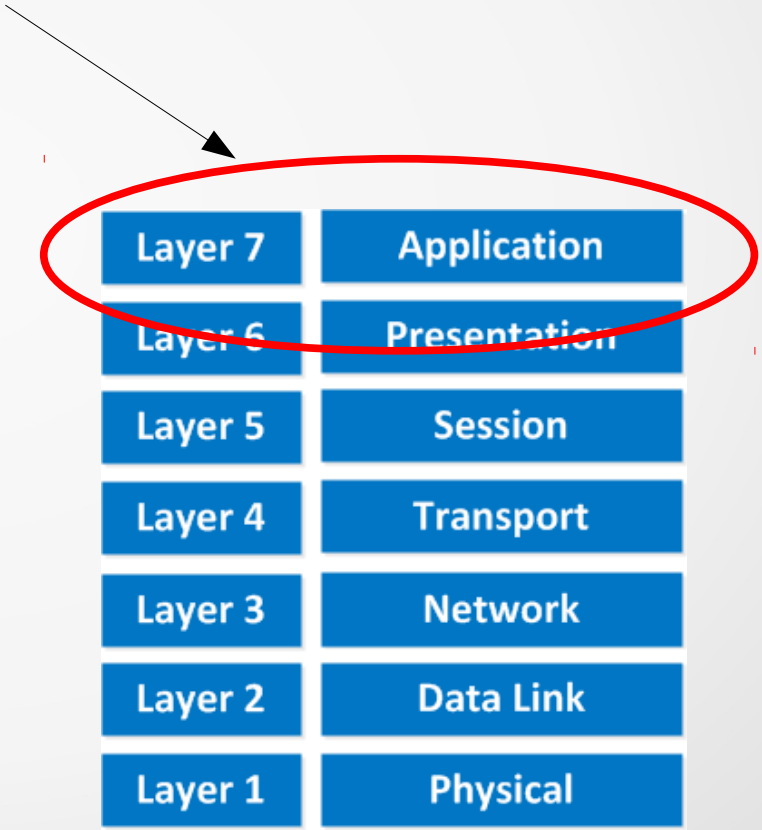

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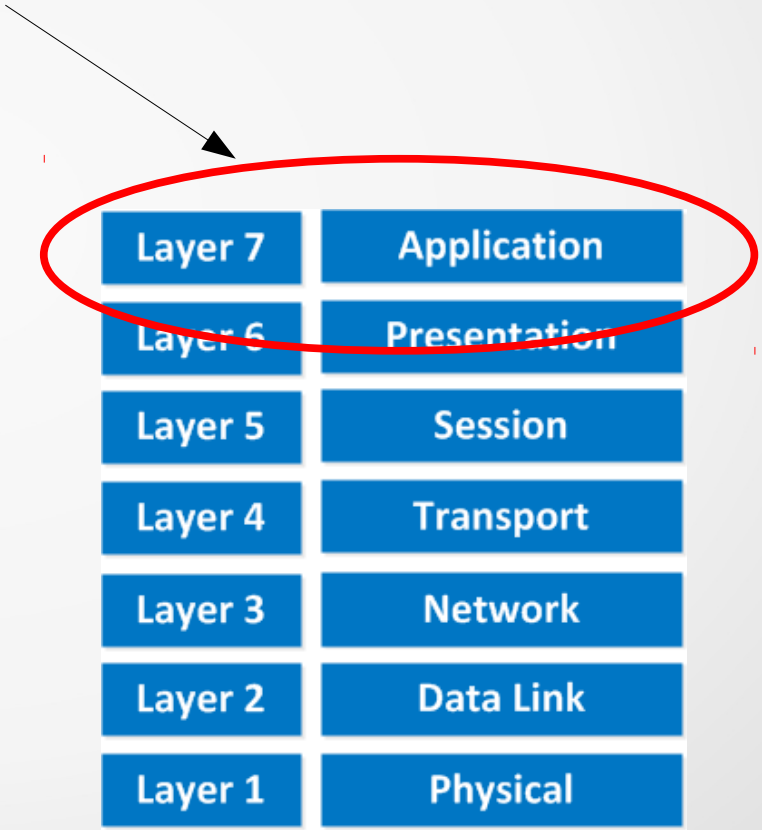
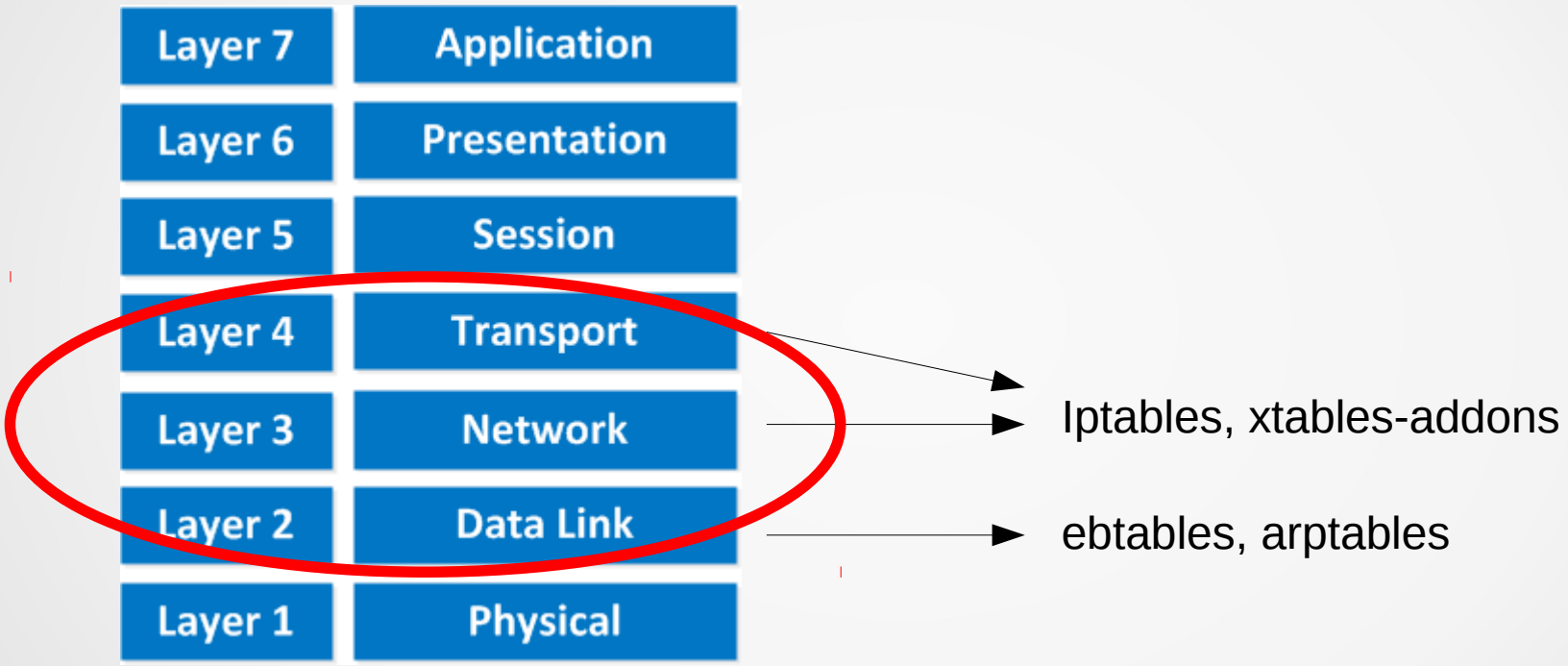
- NFQUEUE



Firewall – OSI model



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- MAC NAT - ability to change the MAC Ethernet source and destination address
- Brouting – bridge can act as bridge and router. Using firewall rules we can decide if frame should be routed to higher OSI layers or should it be bridged (OSI layer 3)

Firewall – ebtables – tables

Ebtables uses rules to decide what action to perform with frames
Ebtables divides rules into 3 tables:

1. filter
   In this table we place rules which filter frames
2. nat
   In this table we place rules which should modify frame headers
3. broute
   In this table we place rules which should route frames

Rules inside these tables are separated into chains

Firewall – ebtables – tables

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Ebtables divides rules into 3 tables:

1. filter

   In this table we place rules which filter frames

   Frames are directed to chain:

   - INPUT - if the destination MAC address of the frame is on the bridge itself
   - FORWARD - for frames being forwared by the bridge
   - OUTPUT - if the frames are generated locally or for brouted frames

2. nat

   In this table we place rules which should modify frame headers

   - PREROUTING – frames are modified as soon as they came in
   - OUTPUT - for modifying locally generated or (b)routed frames before they are bridged
   - POSTROUTING - for altering frames as they are about to go out

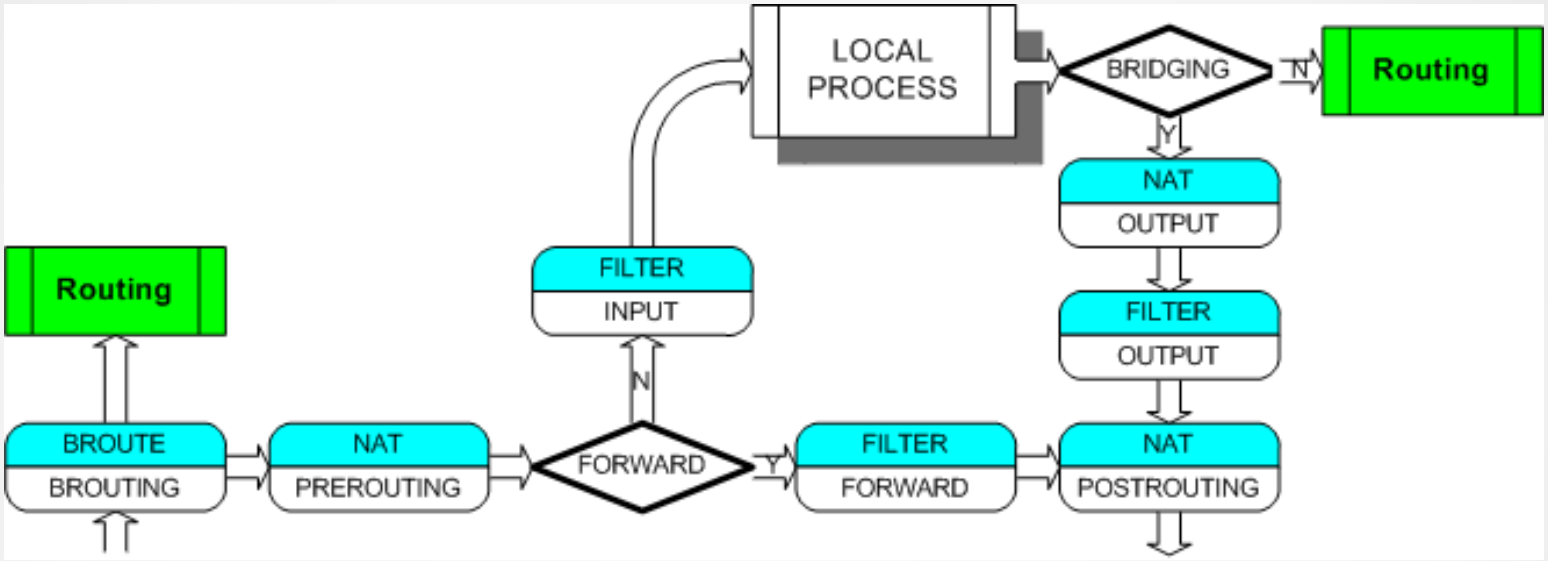
3. broute

   In this table we place rules which should route frames

   - BROUTING

Users can also define their own chains

Firewall – ebtables – tables



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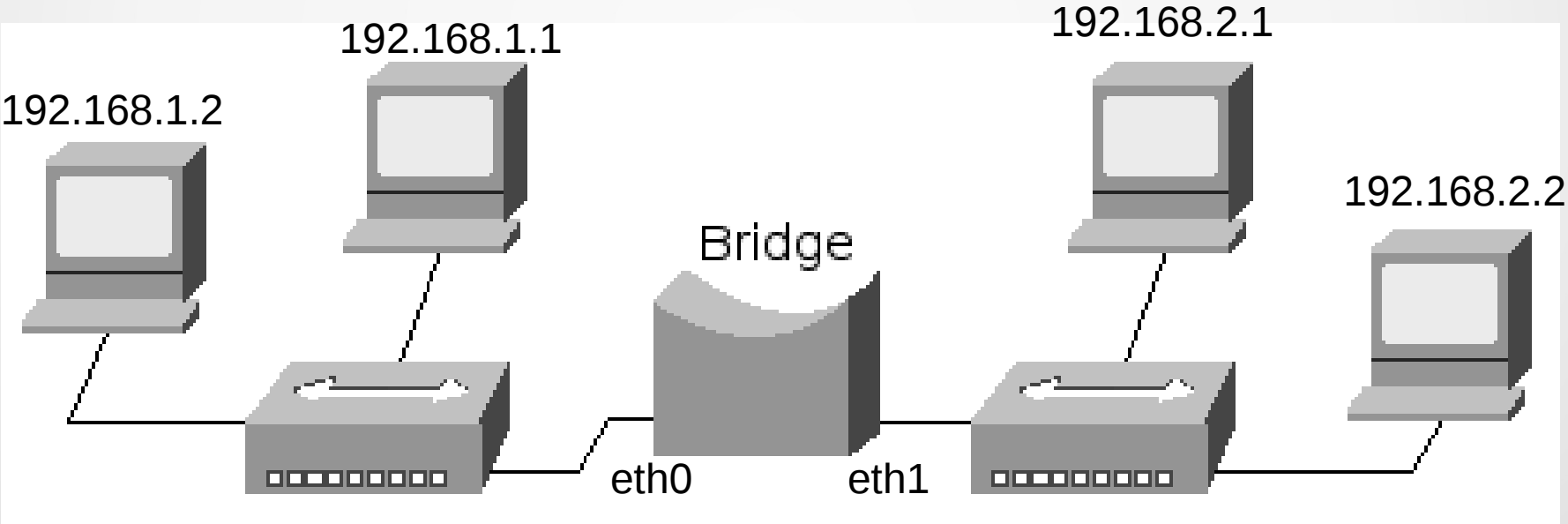

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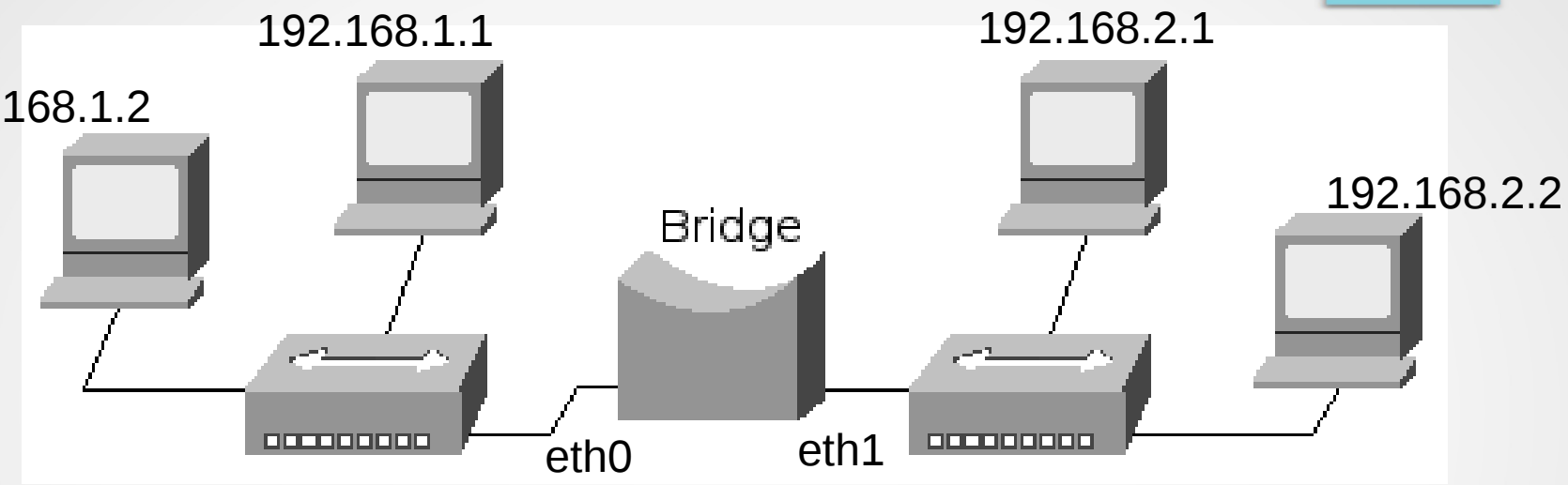

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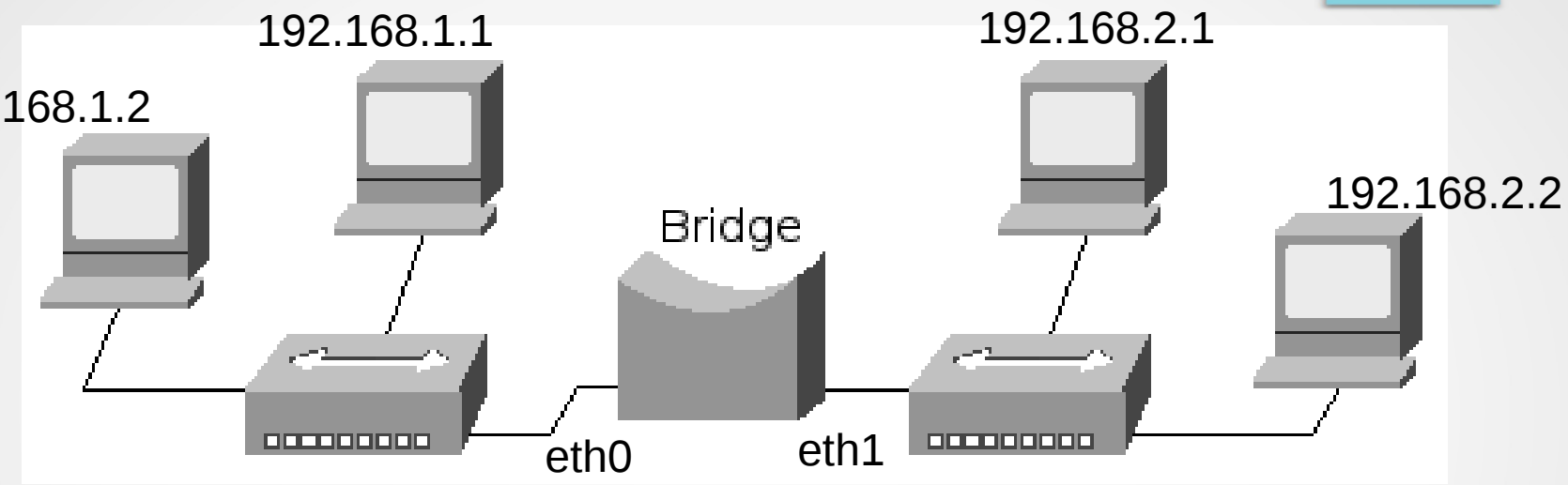


```
root@Bridge:# ifconfig eth0 0.0.0.0
root@Bridge:# ifconfig eth1 0.0.0.0
root@Bridge:# brctl addbr br0
root@Bridge:# brctl addif br0 eth0
root@Bridge:# brctl addif br0 eth1
root@Bridge:# ifconfig br0 up
```

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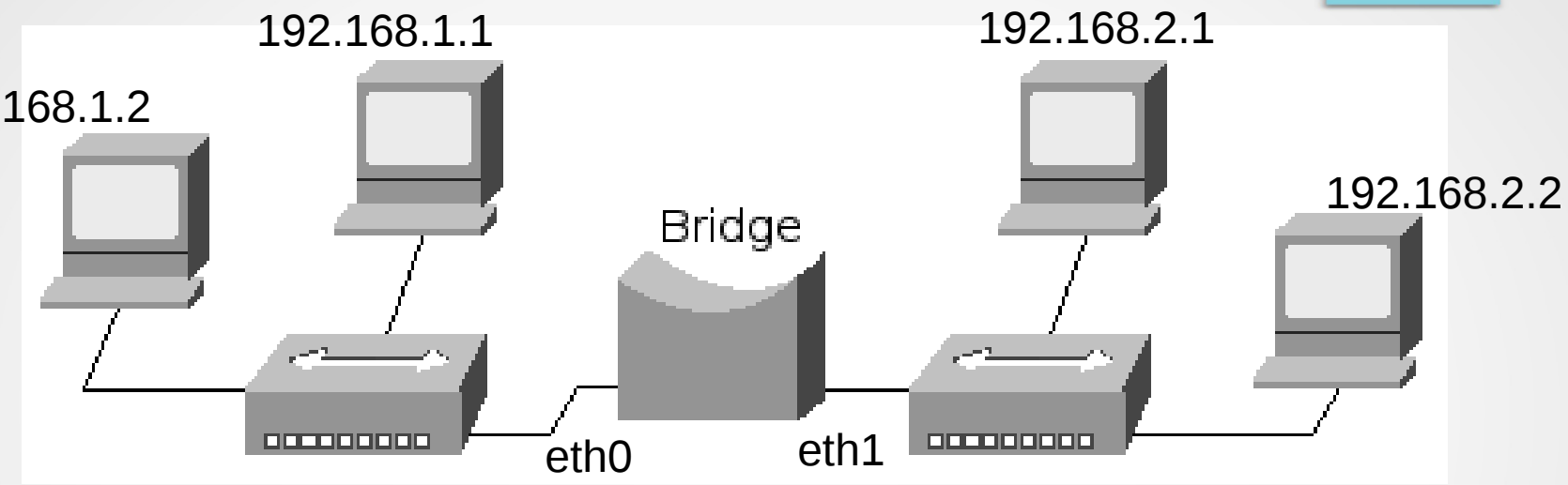


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```
root@Bridge:# brctl showmacs br0
port no mac addr                is local?       ageing timer
  1     00:10:4b:b6:c6:e4       no              119.25
  1     00:a0:24:d0:4c:d6       yes               0.00
  1     00:a0:24:f0:22:71       no                5.81
  4     08:00:09:fb:39:a1       no               27.24
  4     08:00:09:fc:92:2c       no               53.13
  4     08:00:09:fc:d2:11       yes               0.00
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Firewall – ebtables – installation & rules

Installation:

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```
Bridge table: filter

Bridge chain: INPUT, entries: 0, policy: ACCEPT

Bridge chain: FORWARD, entries: 0, policy: ACCEPT

Bridge chain: OUTPUT, entries: 0, policy: ACCEPT
```

Firewall – ebtables – commands

Append the rule to the end of the chain: iptables -A *rule_specification* -j *target*

root@Harvey:# iptables -A INPUT --dport 80 -j DROP

List rules in chain: iptables -L [chain]

root@Harvey:# iptables -L

Flush (delete all) rules in chain: iptables -F *chain*

root@Harvey:# iptables -F OUTPUT

To delete a rule: ebtables -D *chain start_nr*[:*end_nr*]

root@Bridge:# ebtables -D FORWARD 1

To create a user-defined chain: ebtables -N *chain_name [-P policy]*

root@Bridge*:*# ebtables -D new_chain -P ACCEPT

To specify the destination MAC address: ebtables -A *chain* -s *mac_address* -j *TARGET*

root@Bridge:# ebtables -A FORWARD -s *b8:88:e3:79:1a:b1* -j DROP

To specify the source MAC address: ebtables -A *chain* -s *mac_address* -j *TARGET*

root@Bridge:# ebtables -A FORWARD -s *b8:88:e3:79:1a:b1* -j DROP

Firewall – ebtables – rule specifications (matches)

Rule specifications:

-p *protocol* - protocol responsible for creating the frame

-i *interface* - the interface the frame was originally received from

-o *interface* - the interface by which the frame is going to be sent

-s *source* - source MAC address

-d *destination* - destination MAC address

Firewall – ebtables – targets

TARGET specifies what happens to a frame after it matched a rule.

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In Ebtables we can choose from 5 targets:
1) ACCEPT – let the frame through
2) DROP – the frame will be dropped
3) CONTINUE – next rule will be checked
4) RETURN – go back to the previous chain and check the next rule
5) Jump to user defined chain

Firewall – ebtables – basic configuration

ebtables -P FORWARD DROP
ebtables -A FORWARD -p IPv4 -j ACCEPT
ebtables -A FORWARD -p ARP -j ACCEPT
ebtables -P INPUT DROP
ebtables -A INPUT -p IPv4 -j ACCEPT
ebtables -A INPUT -p ARP -j ACCEPT
ebtables -P OUTPUT DROP
ebtables -A OUTPUT -p IPv4 -j ACCEPT
ebtables -A OUTPUT -p ARP -j ACCEPT

This is a basic filter configuration which will only let frames made by the protocols IP version 4 and ARP through

Firewall – ebtables – MAC NAT

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root@Bridge:# ebtables -t nat -A PREROUTING -d 00:11:22:33:44:55 -i eth0 -j dnat --to-destination 54:44:33:22:11:00

Firewall – ebtables – MAC NAT

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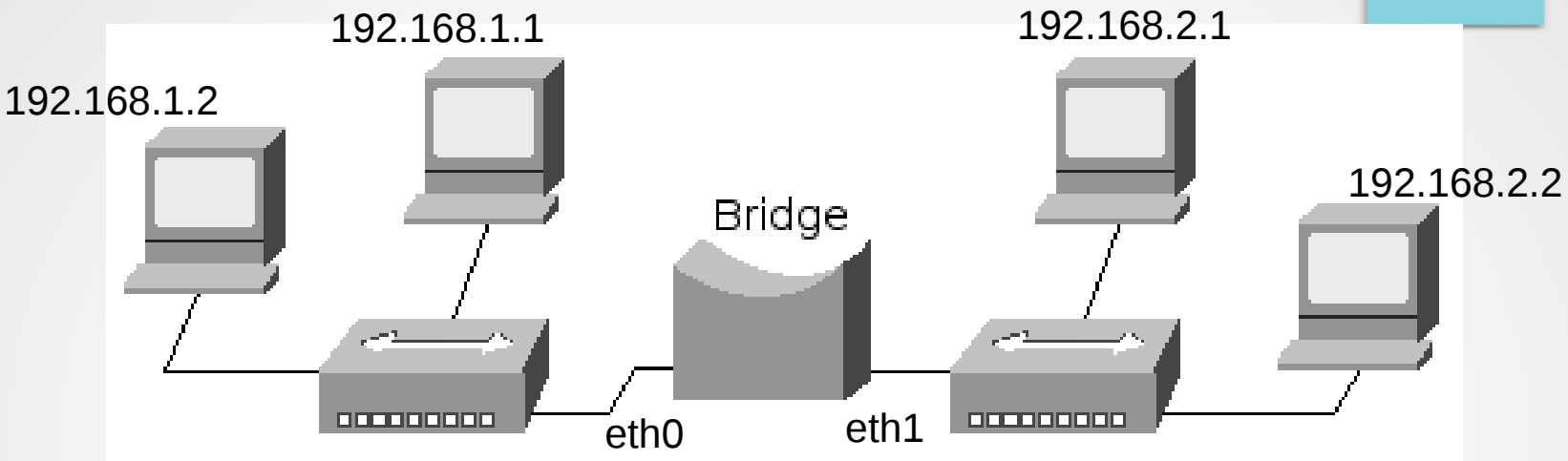
This will make all frames destined to 00:11:22:33:44:55 that arrived on interface eth0 be transferred to 54:44:33:22:11:00 instead

Firewall – ebtables - example



- Example: we want to block ARP messages going through the bridge

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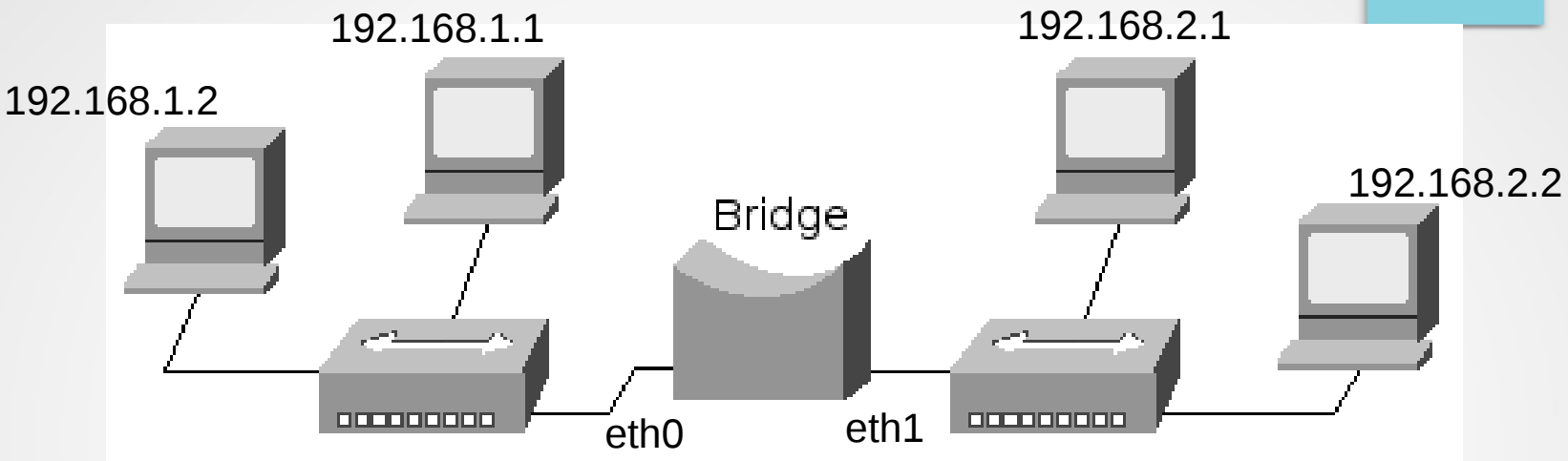

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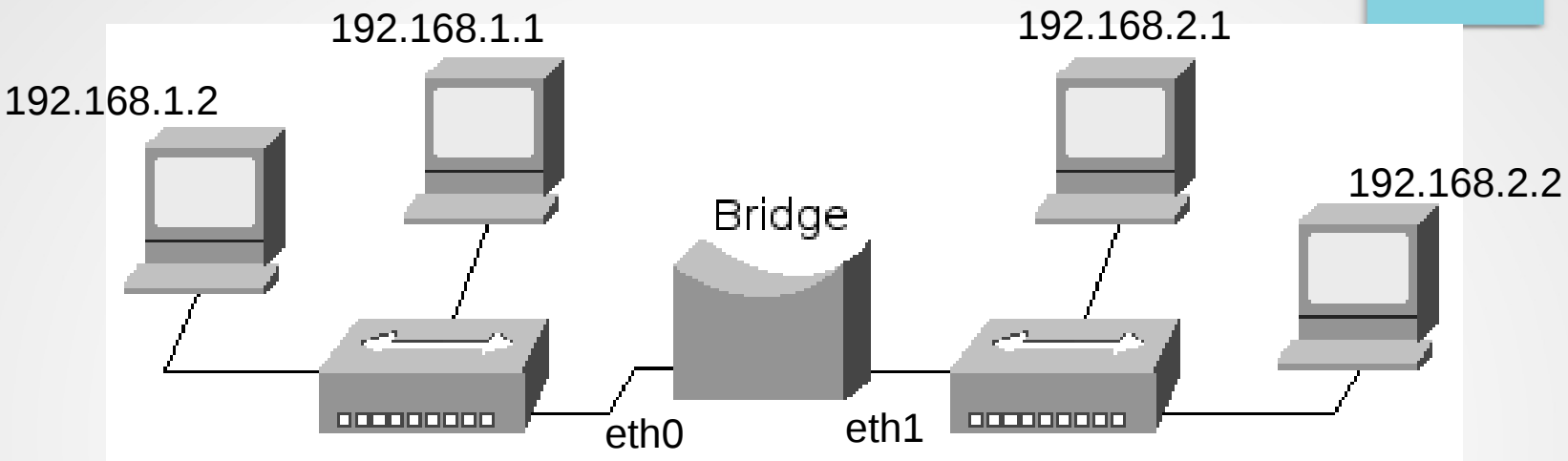

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root@Bridge:# ebtables -t filter -A FORWARD -p ARP -j DROP

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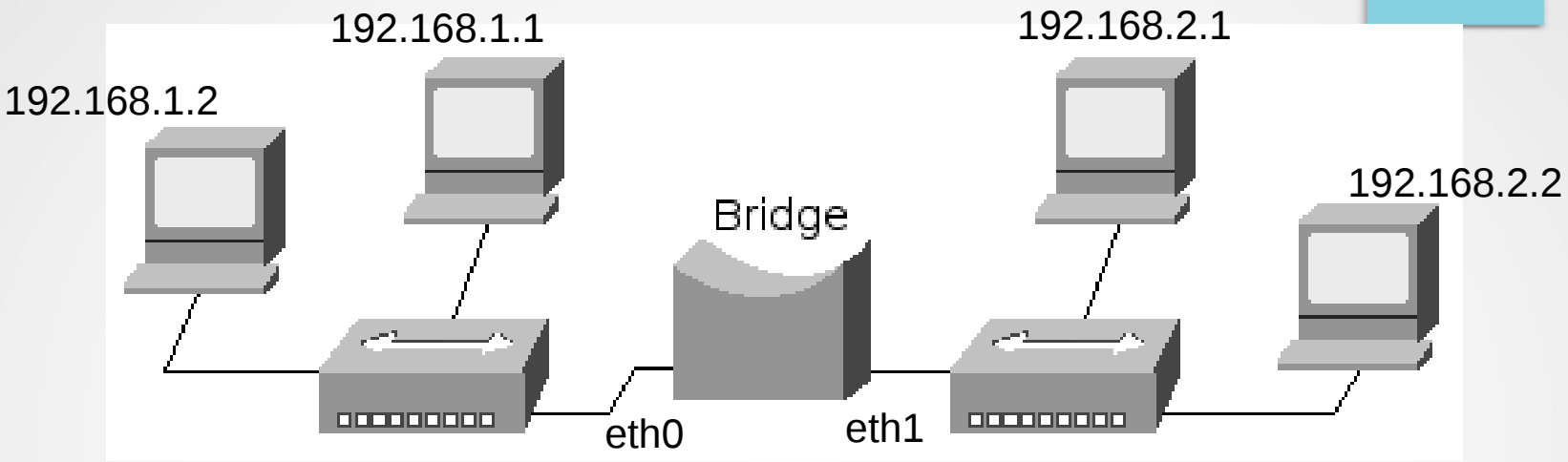

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root@Bridge:# ebtables -t filter -A FORWARD -p ARP -j DROP

root@192.168.1.2:# arping 192.168.2.1 -c 5
ARPING 192.168.2.1 from 192.168.1.2 eth0
Sent 5 probes (5 broadcast(s))
Received 0 response(s)
```

Firewall - arptables

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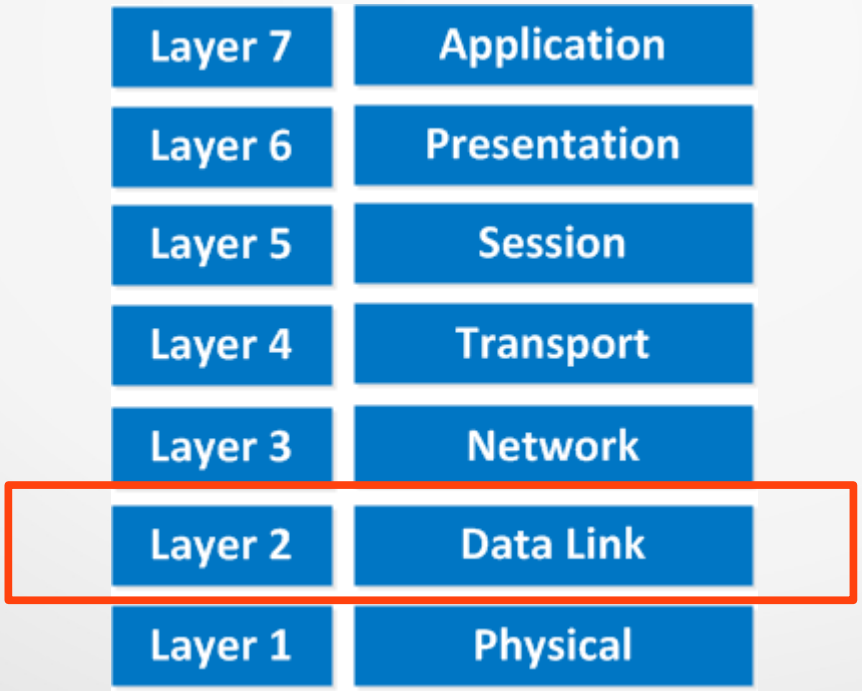

Firewall – arptables – tables

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- One *filter* table
  1) INPUT chain - for frames destined for the host
  2) OUTPUT chain - for locally-generated frames
  3) FORWARD chain - for frames being forwarded by the bridge (this chain is not available in Linux kernel 2.4.X)

Firewall – arptables – rule building & commands

Rule building:

arptables [-t table] command rule-specification [options]

- Option -t can be omitted

To add a new rule to a specific chain:
arptables -A *chain rule_specification*

To delete a rule from chain:
arptables -D *chain rule_specification*
or
arptables -D *chain start_nr[:end_nr]*

To set the policy for the chain: (only for built-in chains)
arptables -P *chain policy* (ACCEPT/DROP/RETURN)

To add a new user-defined chain:
arptables -N *chain_name*

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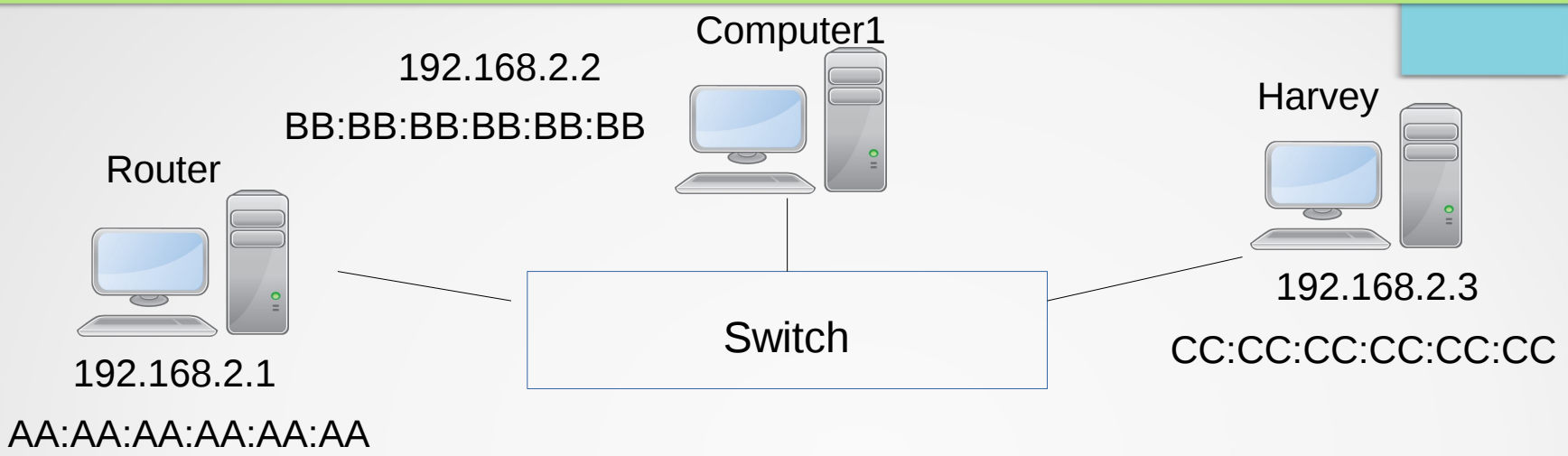
Firewall – arptables – rule specifications

Rule specifications:

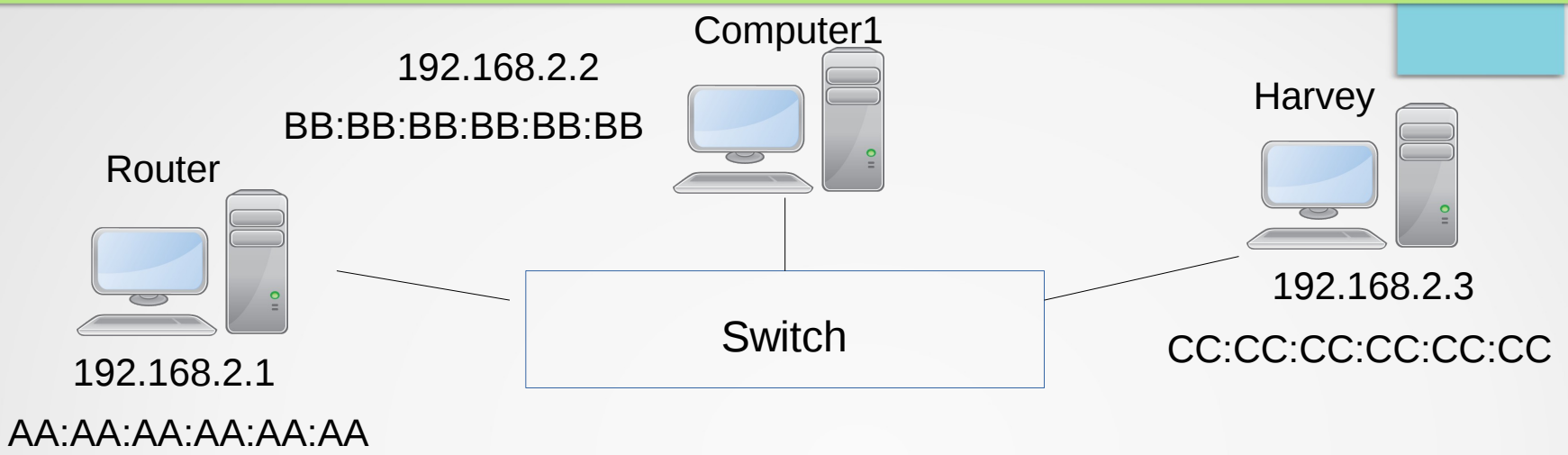
- '-s *address[/mask]*' - the Source IP specification
- '-d *address[/mask]*' - the Destination IP specification
- *'*--source-mac *mac_address'* - the source mac address
- *'*--destination-mac *mac_address'* - the destination mac address
- *'*-i *name'* - the interface via which a frame is received (for the INPUT and FORWARD chains)
- '-o *name'* - the interface via which a frame is going to be sent (for the OUTPUT and FORWARD chains)

'!' option before the specification inverts the test for that specification

Firewall - arptables - example



Firewall - arptables - example



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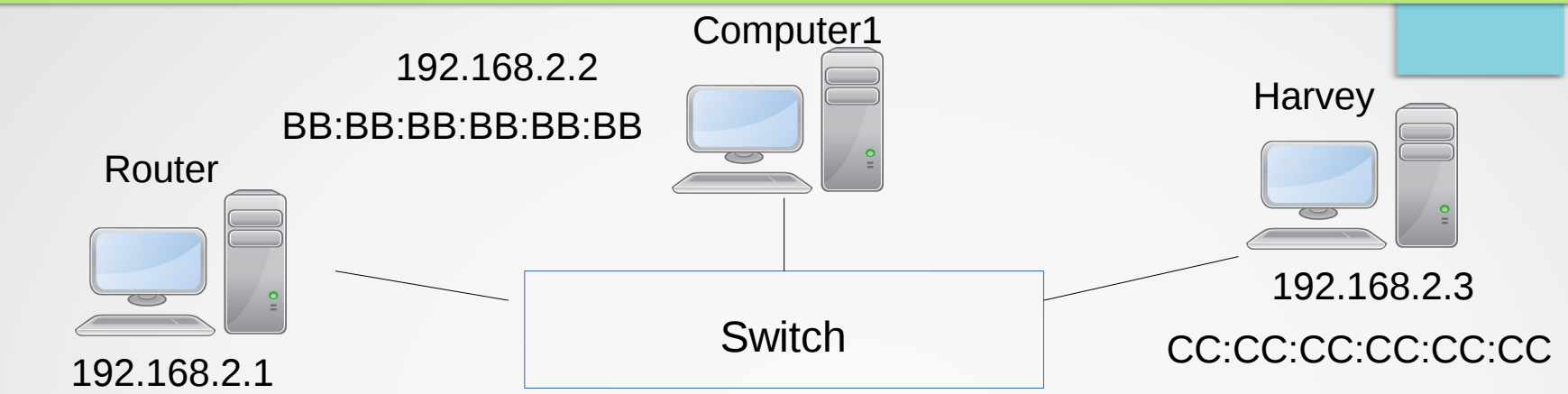
Firewall - arptables - example



- Harvey sends valuable data to Router and wants to protect himself from Computer1 ARP Spoofing

root@Harvey:# arptables -A INPUT -s 192.168.2.1 --source-mac ! AA:AA:AA:AA:AA:AA -j DROP
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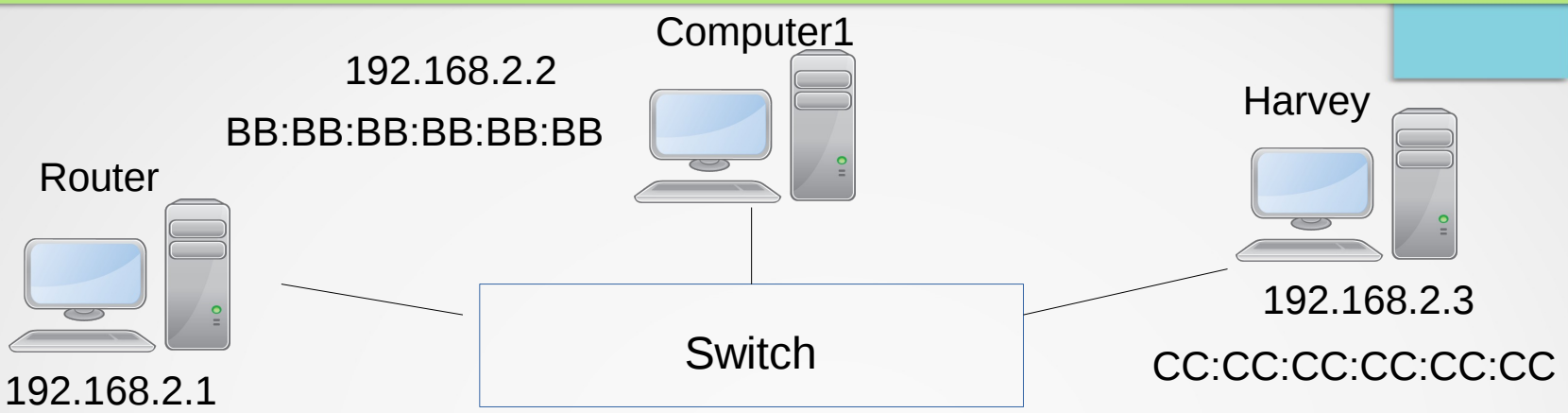

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Chain FORWARD (policy ACCEPT)
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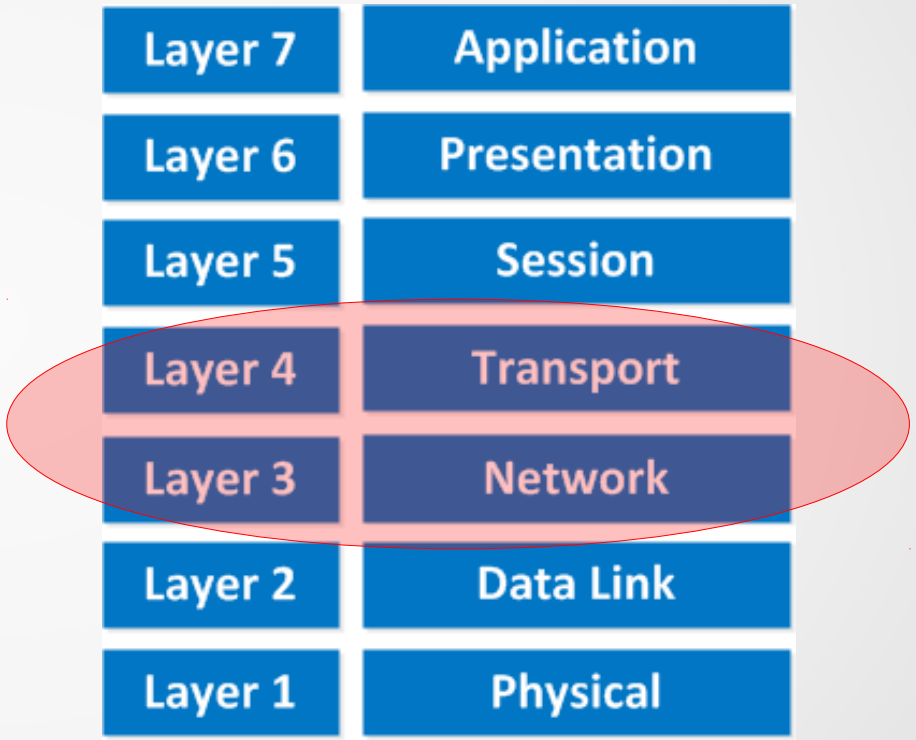
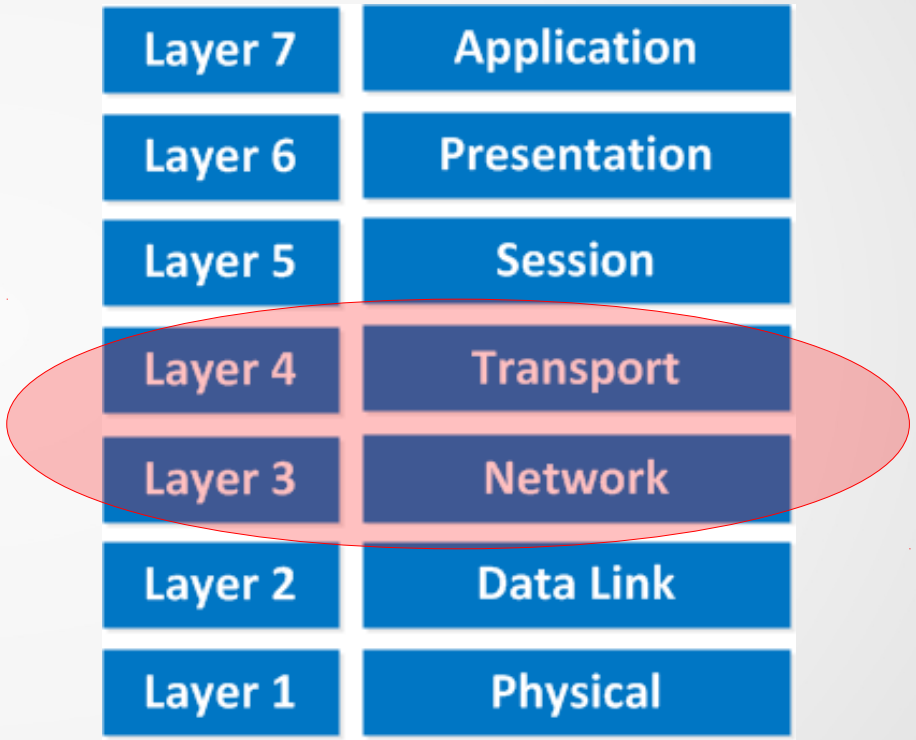
Firewall - iptables

- Iptables is a firewall for OSI layer 3 and 4



Firewall - iptables

- Iptables is a firewall for OSI layer 3 and 4
- successor of ipchains and ipfilter



Firewall - iptables - tables

- filter
  - INPUT
  - FORWARD
  - OUTPUT
- nat
  - PREROUTING
  - OUTPUT
  - POSTROUTING
- mangle
  - PREROUTING
  - INPUT
  - OUTPUT
  - FORWARD
  - POSTROUTING
- raw
  - PREROUTING
  - OUTPUT

Firewall - iptables - tables

- mangle - This table is used for specialized packet modification (e.g. change Type Of Service field in a packet)
- raw - handled before connection tracking takes place

Firewall - iptables - rule specifications (matches)

- Other matches:
  - -m or --match
    - -m conntrack
      Allows filter rules to match based on connection state. Permits the use of the --ctstate option.

    - --ctstate
      Example: iptables -A INPUT -p tcp -m conntrack --ctstate NEW -j ACCEPT

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    - -m limit - Require the rule to match only a limited number of times. Allows the use of the --limit option. Useful for limiting logging rules.

      - --limit and --limit-burst
        Example: iptables -A INPUT -p icmp -m limit --limit 1/min --limit-burst 5 -j DROP

Firewall - iptables - features

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Firewall - iptables - features

- stateless packet filtering (IPv4 and IPv6)
- stateful packet filtering (IPv4 and IPv6)
  - iptables can distinguish the connection state of a packet
  - this adds a new packet filtering capability based on the connection state
- NAPT - network address and port translation (IPv4 and IPv6)
  - iptables can modify packet headers including IP addresses and ports

Firewall - iptables - connection state

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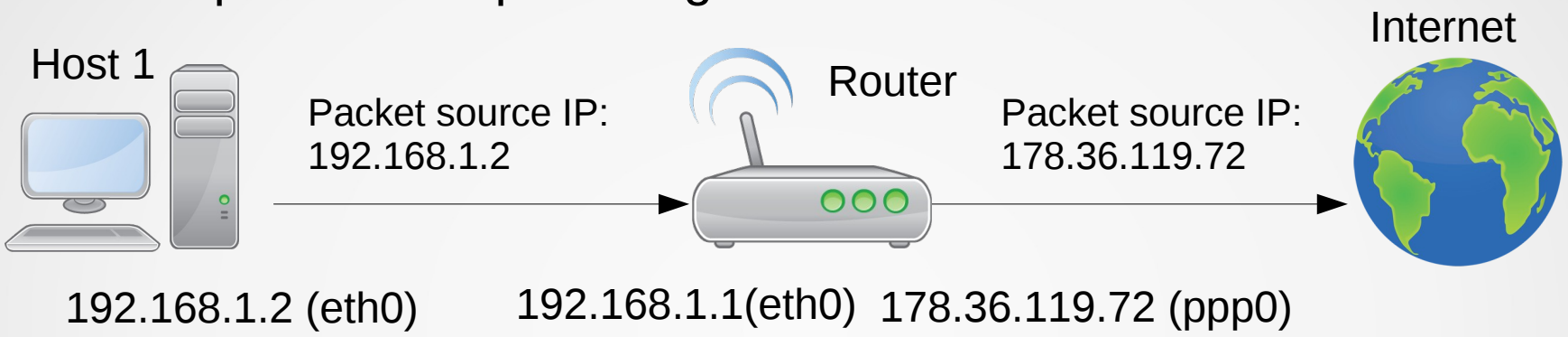
  iptables -t nat -A PREROUTING -i eth0 --dport 80 -j DNAT --to-destination 192.168.1.200:8080

Firewall - iptables - more examples

- 1st Example: IP Masquerading



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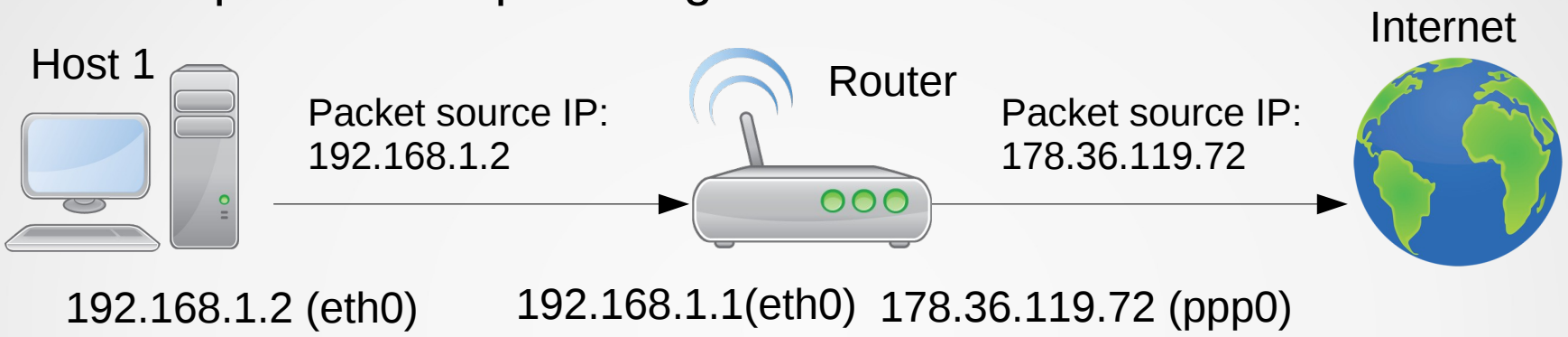


```
root@Router:# echo 1 > /proc/sys/net/ipv4/ip_forward
root@Router:# iptables -t nat -A POSTROUTING -o ppp0 -j MASQUERADE
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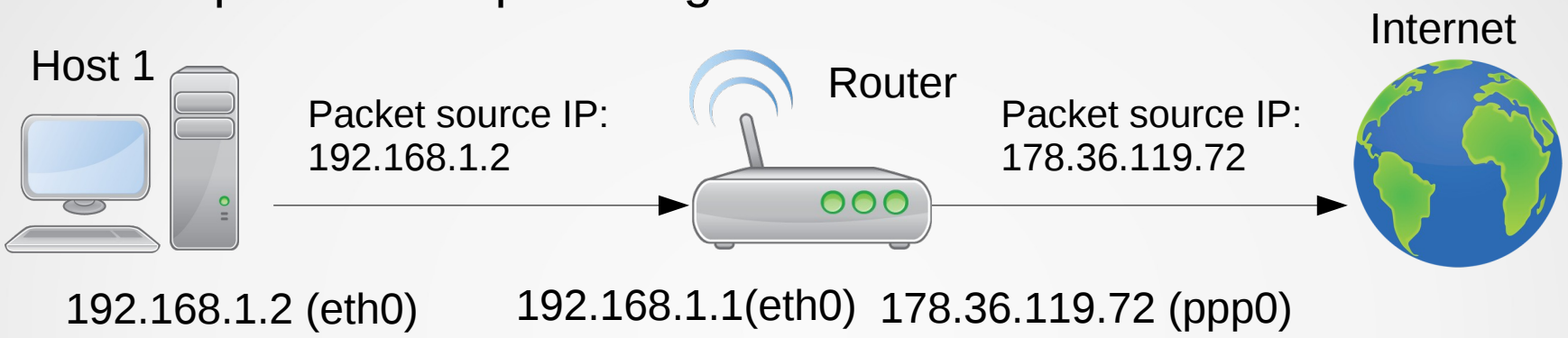


```
root@Router:# echo 1 > /proc/sys/net/ipv4/ip_forward
root@Router:# iptables -t nat -A POSTROUTING -o ppp0 -j MASQUERADE

root@Host1:# ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data.
64 bytes from 8.8.8.8: icmp_seq=1 ttl=46 time=34.5ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=46 time=34.0ms
```

Firewall - iptables - more examples

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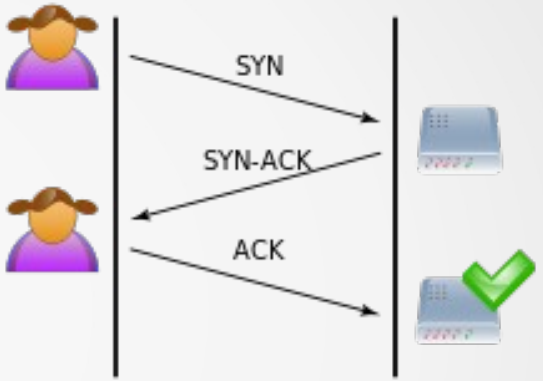

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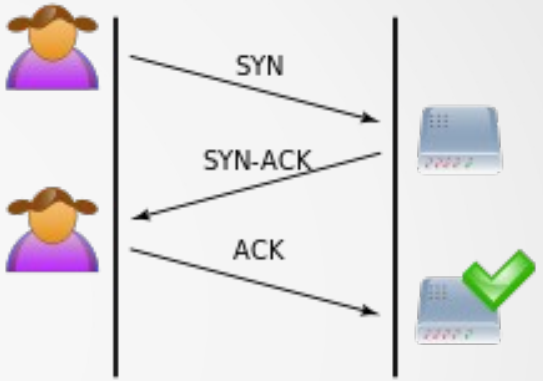

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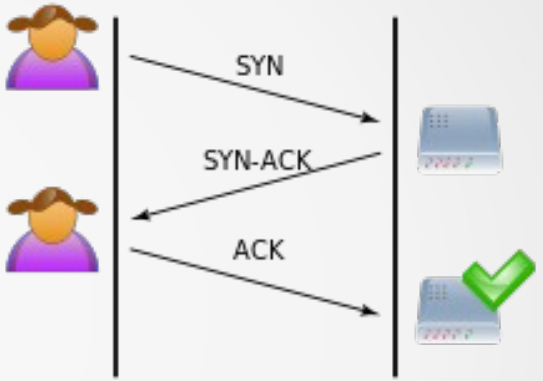


```
root@Computer:# iptables -N syn_flood
root@Computer:# iptables -I INPUT 1 -p tcp -j syn_flood
```

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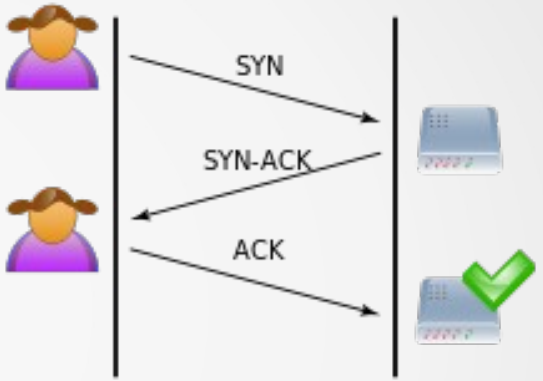


```
root@Computer:# iptables -N syn_flood
root@Computer:# iptables -I INPUT 1 -p tcp -j syn_flood
root@Computer:# iptables -A syn_flood --syn -m limit --limit 1/s --limit-burst 3 -j RETURN
root@Computer:# iptables -A syn_flood -j DROP
root@Computer:# iptables -L
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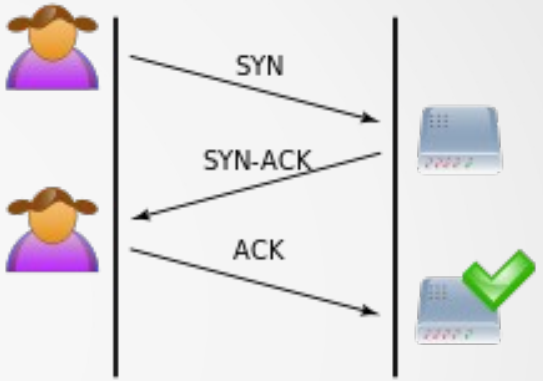


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```
Chain INPUT (policy ACCEPT)
target     prot opt source               destination
syn_flood  tcp  --  anywhere             anywhere
ufw-before-logging-input  all  --  anywhere             anywhere

Chain syn_flood (1 references)
target     prot opt source               destination
RETURN     all  --  anywhere             anywhere             limit: avg 1/sec burst 3
DROP       all  --  anywhere             anywhere
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  - geoip
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  - tarpit
    - extends tcp matching functionality
  - account
    - provides statistics for packets (counting packets etc)