How to do NAT + DHCP + IPFW in FreeBSD

Firewalls

Firewalls

- Firewall
  - Choke point between secured and unsecured network
  - Filter incoming and outgoing traffic that flows through your system
- How can it be used to do
  - To protect your system from unwanted traffic coming in from the public Internet
    - Such as telnet, NetBIOS
  - To limit or disable access from hosts of the internal network to services of the public Internet
    - Such as MSN, ssh, ftp
  - To support NAT (Network Address Translation)

Firewall rules

- Two ways to create firewall rulesets
  - **Exclusive**
    - Allow all traffic through except for the traffic matching the rulesets
  - **Inclusive**
    - Allow traffic matching the rulesets and blocks everything else
    - Safer than exclusive one
      - reduce the risk of allowing unwanted traffic to pass
      - Increase the risk to block yourself with wrong configuration

Firewall Software

- FreeBSD
  - IPFILTER (known as IPF)
  - IPFIREWALL (known as IPFW)
- Solaris
  - IPF
- Linux
  - ipchains
  - iptables

IPFW on FreeBSD (1)

> Enable ipfw in /etc/rc.conf

```
# ipfw options
firewall_enable="YES"
firewall_script="/etc/firewall/rules"
```

> Compile following options into kernel

```
options IPFIREWALL
options IPFIREWALL_VERBOSE
options IPFIREWALL_DEFAULT_TO_ACCEPT
```

> Rebuild the kernel

```
65534 deny log ip from any to any
65535 allow ip from any to any
```

IPFW on FreeBSD (2)

> ipfw command

- Add or delete firewall rule manually while it is running
- The ipfw creates a counter for each rule that counts each packet that matches the rule

% ipfw list	(list all rules in sequence)
% ipfw –t list	(list all rules with last time matched)
% ipfw –a list	(list all rules with counter)
% ipfw zero	(zero the counters)
% ipfw flush	(flush all rules)

IPFW on FreeBSD (3)

- ipfw ruleset
  - A ruleset is a group of rules to allow or deny packets based on the value contained in the packet
  - From number 1 to 65535
  - Packets are passed to ipfw to match the rule
  - It is recommended to specify firewall rules in a file and load in boot time

IPFW on FreeBSD (4)

> Rule Syntax

ipfw add [*rule_num*] *action* [*logging*] *body*

> rule_num

- **Rules are checked sequentially by rule number**

> action

- **allow | accept | pass | permit**
  - allow packets that match the rule to exit the firewall rule processing
- **deny | drop**
  - discard packets that match this rule
- **reset**
  - discard packets and try to send a TCP reset for TCP packet
- **skipto *num***
- **unreach *code***
  - Discard packets and try to send an ICMP unreachable with code
- **forward, divert for NAT**

```
Ex: /sbin/ipfw add 65534 deny log all from any to any
```

IPFW on FreeBSD (5)

> Rule Syntax

ipfw add [*rule_num*] *action* [*logging*] *body*

> Logging

- **log**
  - a message will be logged to syslogd with a facility name of SECURITY when the rule is matched

```
# in /etc/syslogd.conf
security.*                          /var/log/security
```

IPFW on FreeBSD (6)

- Rule Syntax

  ipfw add [*rule_num*] *action* [*logging*] *body*

- Body syntax

  [*proto* from *src* to *dst* [*port*]] [*options*]

- Proto
  - **all | tcp | udp | icmp …**
    - See /etc/protocols
- from src to dst
  - **src and dst are addresses**
    - any | me
    - 140.113.209.37
    - 140.113.209.0/24

```
# deny multicast
Ex: /sbin/ipfw add deny all from any to 224.0.0.0/8
```

IPFW on FreeBSD (7)

> Rule Syntax

ipfw add [*rule_num*] *action* [*logging*] *body*

> Body syntax

[*proto* from *src* to *dst* [*port*]] [*options*]

> options

- **established**
  - Match TCP packets that have RST or ACK on
- **frag**
  - Matches packets that are fragments and not the first fragment of an IP datagram
- **setup**
  - Match TCP packets that have SYN on but no ACK
- **icmptyps *type***
- **in | out**
  - Incoming or outgoing packets
- **via| recv | xmit interface**
  - Match packets going through, received, transmitted

IPFW on FreeBSD (8)

> Rule Syntax

ipfw add [*rule_num*] *action* [*logging*] *body*

> Body syntax

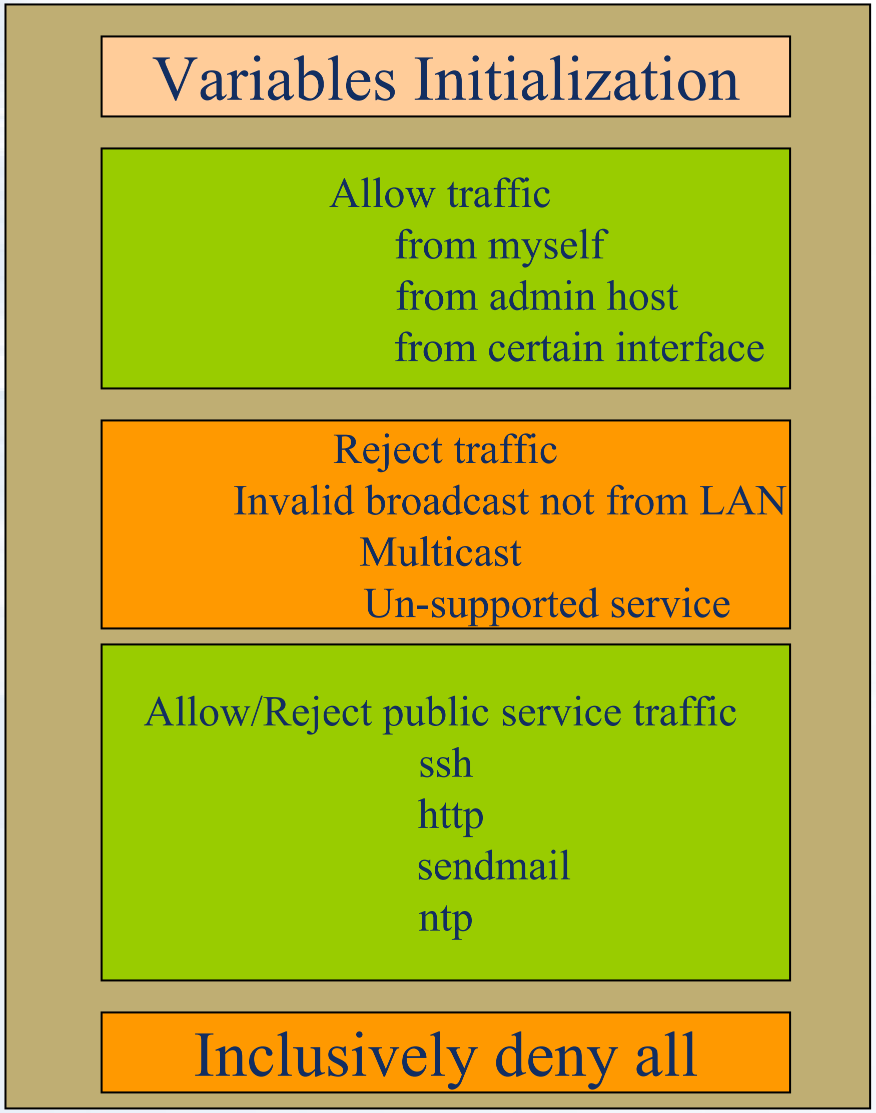
[*proto* from *src* to *dst* [*port*]] [*options*]

> Options

- **MAC *dst-mac src-mac* (with "any")**
- **ipoptions *option***
  - *ssrr, lsrr, rr, ts*
- **iptos, iplen, ipttl, ipversion**
- **dst-ip, dst-port, src-ip, src-port**

IPFW on FreeBSD (9)

> Your Rule Script



IPFW on FreeBSD (10)

> Simplest rule

```
/sbin/ipfw -f flush

/sbin/ipfw –q add pass all from any to any via lo0
/sbin/ipfw –q add pass all from 140.113.235.4 to any
/sbin/ipfw –q add pass all from any to any established
#/sbin/ipfw –q add pass all from any to any via fxp1

/sbin/ipfw –q add deny all from any to any 137-139 in
/sbin/ipfw –q add deny all from any to any 21

/sbin/ipfw –q add pass tcp from any to any 22
/sbin/ipfw –q add pass tcp from any to any 80

/sbin/ipfw –q add 65534 deny all from any to any
```

IPFW on FreeBSD (11)

> Rule script

Variables Initialization

```
#!/bin/sh

fwcmd="/sbin/ipfw -q‟

${fwcmd} -f flush

myip="140.113.235.4"
myip2="192.168.1.254"
bcast_ip=“140.113.235.235”
bcast_ip2=“192.168.1.255”
net_235=“140.113.235.0”
net_192=“192.168.1.0”
```

IPFW on FreeBSD (12)

> Rule script

Allow traffic
- from myself
- from admin host
- from certain interface

```
#!/bin/sh

fwcmd="/sbin/ipfw -q"

${fwcmd} -f flush

myip="140.113.235.4"
myip2="192.168.1.254"
bcast_ip="140.113.235.235"
bcast_ip2="192.168.1.255"
net_235="140.113.235.0"
net_192="192.168.1.0"
```

```
${fwcmd} add pass all from any to any via fxp1
${fwcmd} add pass all from ${myip} to any
${fwcmd} add pass all from ${myip2} to any
${fwcmd} add pass all from 140.113.209.6 to me
echo -n "Out and admin traffic"
```

IPFW on FreeBSD (13)

> Rule script

Reject traffic
Invalid broadcast not from LAN
Multicast
Un-supported service

```
${fwcmd} add pass all from ${net_235}/24 to ${net_235}
${fwcmd} add pass all from ${net_235}/24 to ${bcast_ip}
${fwcmd} add pass all from ${net_192}/24 to ${net_192}
${fwcmd} add pass all from ${net_192}/24 to ${bcast_ip2}
${fwcmd} add deny all from any to ${net_235}
${fwcmd} add deny all from any to ${net_192}
${fwcmd} add deny all from any to ${bcast_ip}
${fwcmd} add deny all from any to ${bcast_ip2}
echo -n "Deny-Broadcast (.0 .255 only valid from LAN) "

# Avoid multicast packets
${fwcmd} add deny all from any to 224.0.0.0/8
echo -n "Deny-Multicast "

# Avoid some special packets
${fwcmd} add reject udp from any to any 67
${fwcmd} add reject udp from any to any 68
${fwcmd} add reject tcp from any to any 139
${fwcmd} add reject icmp from any to any icmptypes 4

# Allow TCP through if setup succeeded
${fwcmd} add pass tcp from any to any established
${fwcmd} add deny log all from any to any frag
echo -n "Established "
```

IPFW on FreeBSD (14)

> Rule script

Allow/Reject public service traffic
- ssh
- http
- sendmail
- ntp

```
# Allow HTTP/HTTPS
${fwcmd} add pass tcp from any to me 80 setup
${fwcmd} add pass tcp from any to me 443 setup
echo -n "HTTP/HTTPS "

# FTP/SSH access control
${fwcmd} add pass tcp from 140.113.209.6 to any 21 setup
${fwcmd} add pass tcp from any to any 22 setup
echo -n "FTP/SSH "

# Allow setup of portmap
${fwcmd} add pass udp from ${net_235}/24 to me 111
${fwcmd} add reject log udp from any to any 111
echo -n "portmap "
```

IPFW on FreeBSD (15)

> Rule script

Inclusively deny all

```
# Avoid logging too much
${fwcmd} add 64000 deny tcp from any to 0.0.0.0/32

# Default to deny
${fwcmd} add 65500 deny log tcp from any to any
${fwcmd} add 65501 deny log udp from any to any
${fwcmd} add 65502 deny log icmp from any to any
${fwcmd} add 65534 deny all from any to any
```

NAT –
Network Address Translation

Private Address

- Private addresses space defined by RFC1918
  - **24-bit block (Class A)**
    - 10.0.0.0/8
  - **20-bit block (16 contiguous Class B)**
    - 172.16.0.0/12 ~ 172.31.0.0/12
  - **16-bit block (256 contiguous Class C)**
    - 192.168.0.0/16 ~ 192.168.255.0/16
- Operation consideration
  - **Router should set up filters for both inbound and outbound private network traffic**

NAT (1)

> NAT

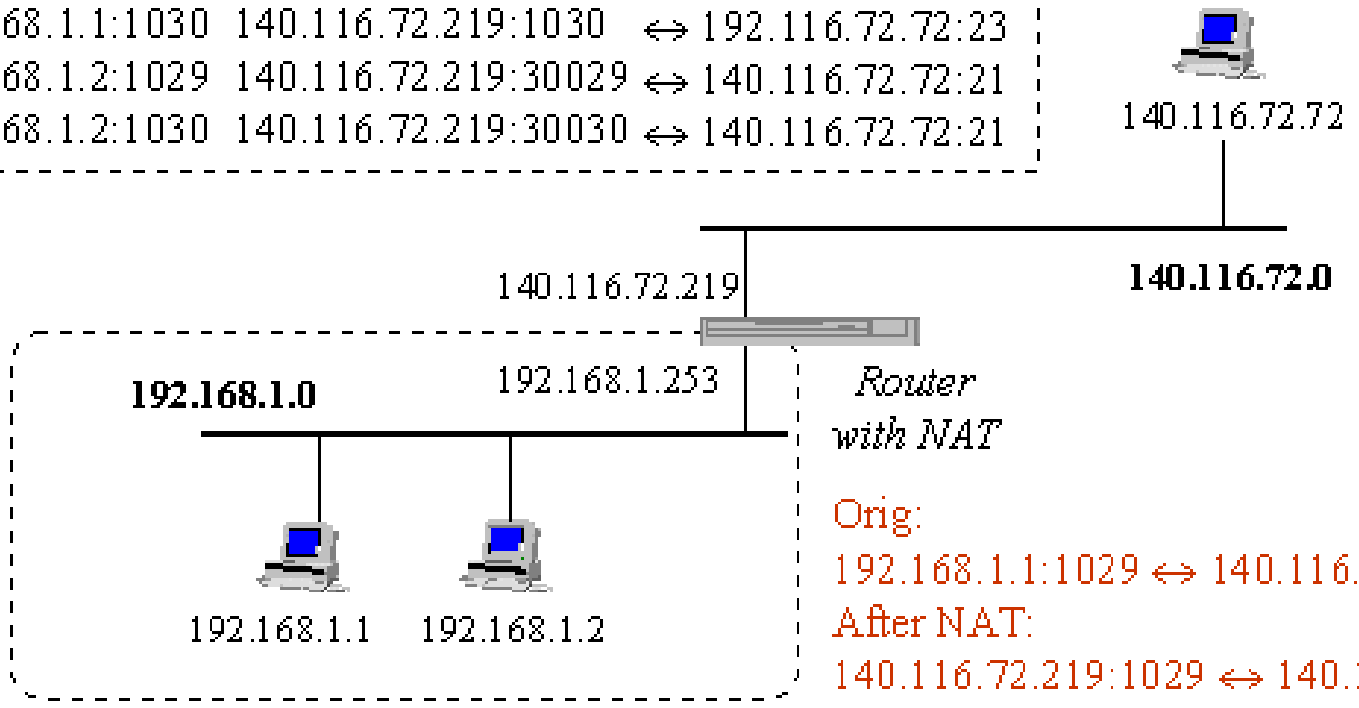
- Network Address Translation
- Allow users in private address space to go to Internet
- What NAT do:
  - NAT intercepts packets addressed with these private addresses and
  - Private IP <-> external IP
  - Original port <-> external port
- NAT box will exchange data on behalf of all private hosts across the Internet

NAT (2)

> NAT ex:

NAT mapping table

Orig	Alias		Remote
192.168.1.1:1029	140.116.72.219:1029	⇔	140.116.72.72:23
192.168.1.1:1030	140.116.72.219:1030	⇔	192.116.72.72:23
192.168.1.2:1029	140.116.72.219:30029	⇔	140.116.72.72:21
192.168.1.2:1030	140.116.72.219:30030	⇔	140.116.72.72:21

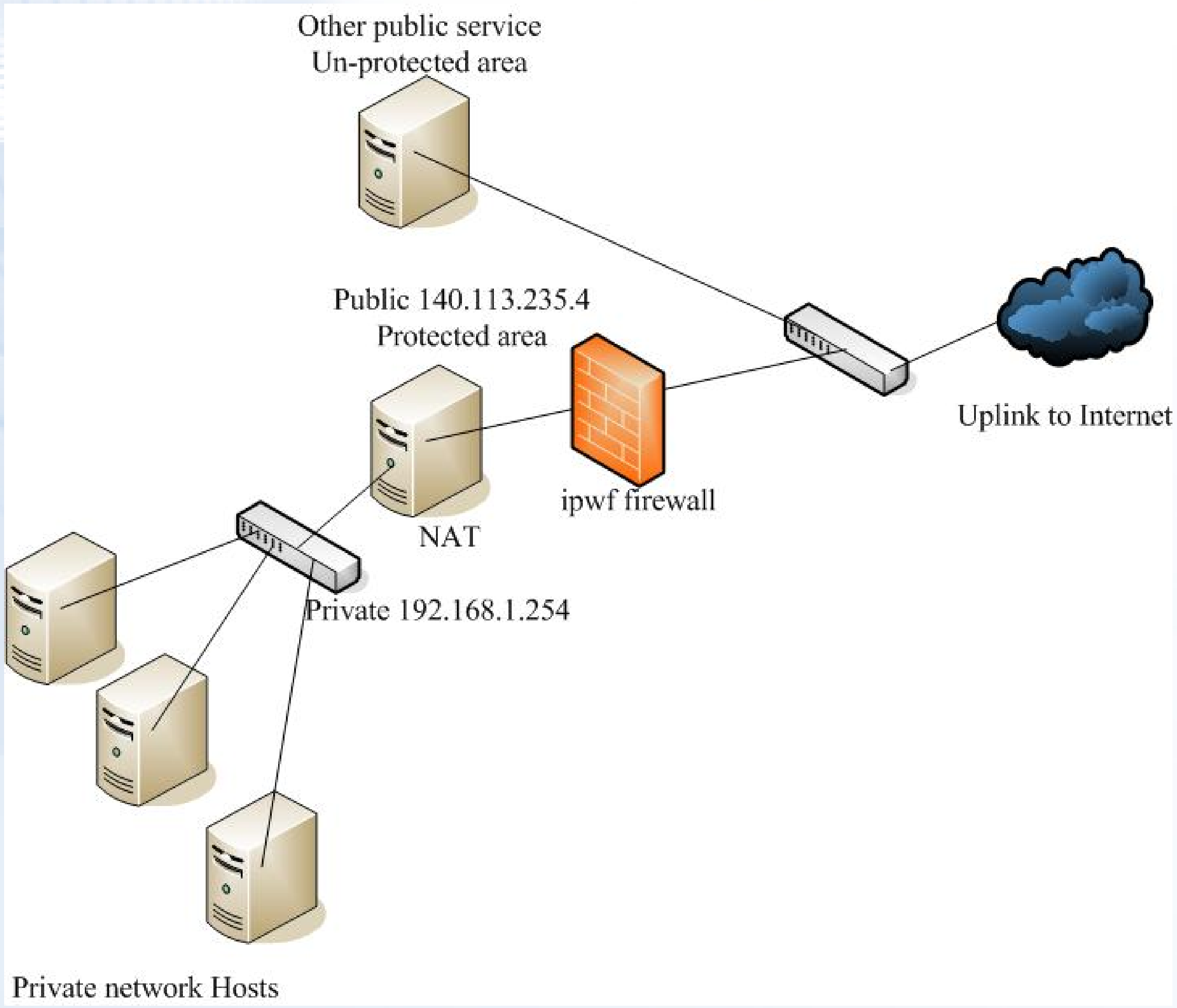


Orig:
192.168.1.1:1029 ⇔ 140.116.72.72:23
After NAT:
140.116.72.219:1029 ⇔ 140.116.72.72:23

NAT on FreeBSD (1)

- NAT daemon
  - natd
- Setup
  - Network topology
  - configuration
  - Advanced redirection configuration

Setup – Network Topology



192.168.1.1
Web server

192.168.1.2
Ftp Server

192.168.1.101
PC1

Setup – configuration (1)

> Enable ipfw in /etc/rc.conf

```
ifconfig_fxp0="inet 140.113.235.4  netmask 255.255.255.0 media autoselect"
ifconfig_fxp1="inet 192.168.1.254  netmask 255.255.255.0 media autoselect“
defaultrouter="140.113.235.254"

# ipfw options
firewall_enable=“YES”
firewall_script=“/etc/firewall/rules”

# nat options
gateway_enable=“YES”
natd_enable=“YES”
natd_interface=“fxp0”
natd_flags=“-f /etc/natd.conf”
```

Setup – configuration (2)

> Compile following options into kernel

```
options IPFIREWALL
options IPFIREWALL_VERBOSE
options IPFIREWALL_DEFAULT_TO_ACCEPT

options IPDIVERT
```

> Rebuild the kernel

> /etc/firewall/rules

```
/sbin/ipfw -q add divert natd all from any to any via fxp0
```

Setup – redirection (1)

> Port redirection

– Syntax

```
redirect_port proto targetIP:targetPort Port
```

Ex:

```
redirect_port tcp 192.168.1.1:80          80
redirect_port tcp 192.168.1.2:23          23
redirect_port tcp 192.168.1.101:5800   5800
```

Setup – redirection (2)

> Address Redirection (Static NAT)

– Used if several external IP addresses are available

– Syntax

```
redirect_address localIP publicIP
```

Ex:

```
redirect_address     192.168.1.1      140.113.235.5
redirect_address     192.168.1.2      140.113.235.6
```

DHCP –
Dynamic Host Configuration Protocol

DHCP introduction

- DHCP
  - Dynamic Host Configuration Protocol
  - A system can connect to a network and obtain the necessary information dynamically
- Client-Server architecture
  - DHCP client broadcasts request fro configuration info.
    - UDP port 68
  - DHCP server reply on UDP port 67, including
    - IP, netmask, DNS, router

DHCP server on FreeBSD (1)

- Kernel support

device bpf	(FreeBSD 5.x)
pseudo-device bpf	(FreeBSD 4.x)

- Install DHCP server
  - /usr/ports/net/isc-dhcp3-server/
  - % cd /usr/local/etc
  - % cp dhcpd.conf.sample dhcpd.conf

DHCP server on FreeBSD (2)

> Option definitions

```
option domain-name "csie.nctu.edu.tw";
option domain-name-servers 140.113.17.5, 140.113.1.1;

default-lease-time 600;
max-lease-time 7200;
ddns-update-style none;
log-facility local7;
```

$\left\{ \begin{array}{l} \text{/etc/syslogd.conf} \\ \text{/etc/newsyslog.conf} \end{array} \right.$

DHCP server on FreeBSD (3)

- Subnet definition

```
subnet 192.168.1.0 netmask 255.255.255.0 {
    range 192.168.1.101 192.168.1.200;
    option domain-name "csie.nctu.edu.tw";
    option routers 192.168.1.254;
    option broadcast-address 192.168.1.255;
    option domain-name-servers 140.113.209.1, 140.113.17.5;
    default-lease-time 3600;
    max-lease-time 21600;
}
```

- Host definition

```
host fantasia {
    hardware ethernet 08:00:07:26:c0:a5;
    fixed-address 192.168.1.30;
}
host denyClient {
    hardware ethernet 00:07:95:fd:12:13;
    deny booting;
}
```

DHCP server on FreeBSD (4)

- Important files
  - /usr/local/sbin/dhcpd
  - /usr/local/etc/dhcpd.conf
  - /var/db/dhcpd.leases (leases issued)
  - /usr/local/etc/rc.d/isc-dhcpd.sh

```
#!/bin/sh

/usr/local/sbin/dhcpd -cf /usr/local/etc/dhcpd.conf fxp1
```