UNIVERSITY OF MANITOBA | Computer Science

Firewall Software for UNIX

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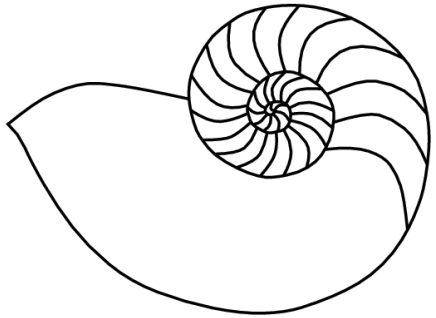
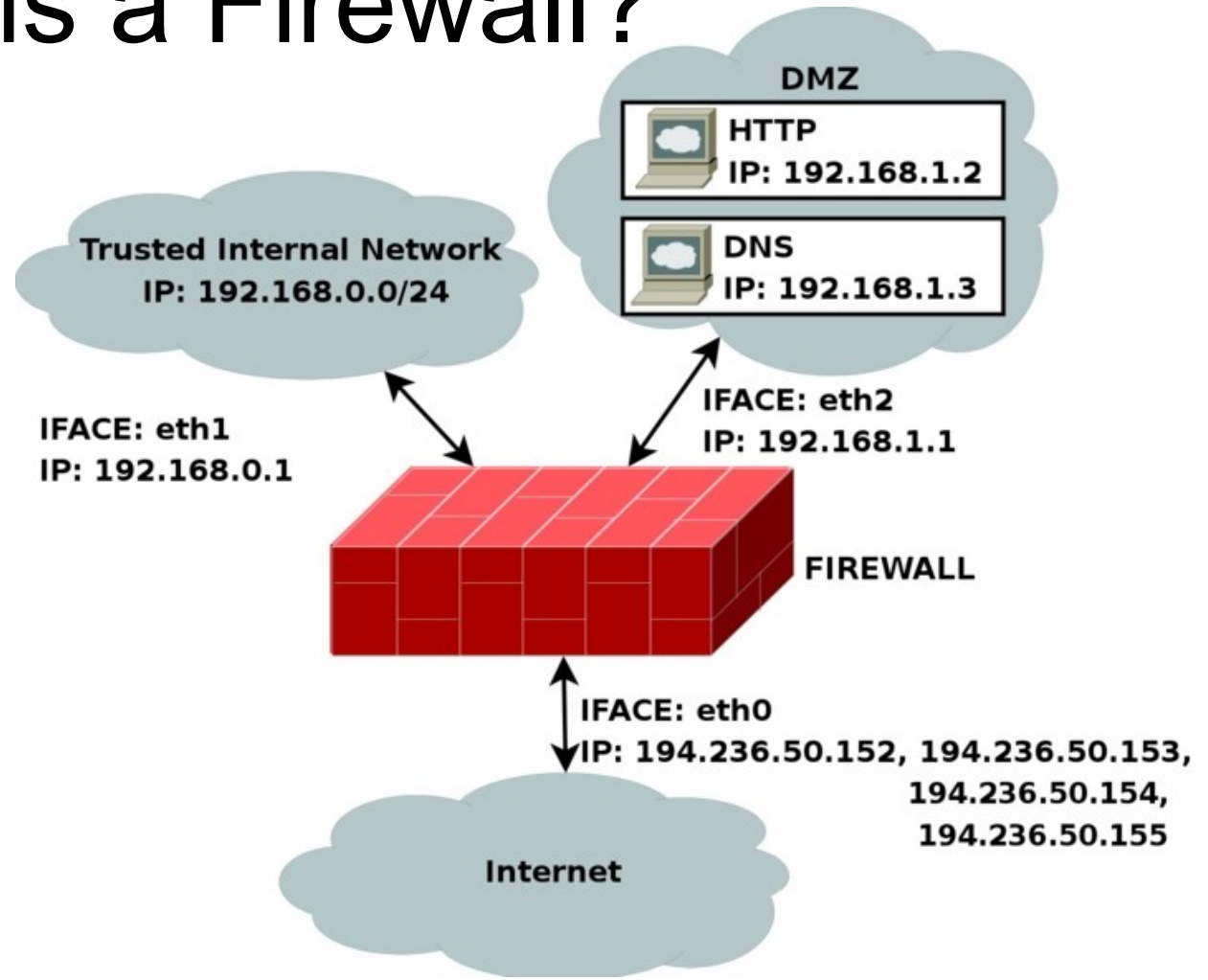
MUUG Meeting



What is a Firewall?

- Typically, a dedicated box
- Can either be special hardware or a generic computer
- Mediates network traffic between internal network and external (Internet)
- Blocks undesirable traffic (in one or both directions)

What is a Firewall?



Enterprise Firewall Limitations

- No protection from internal attacks
  - E.g. internal hosts compromised by virus
- Hard to protect DMZ hosts
- Hard to deal with complex networks
  - E.g. campuses with lots of servers
  - Performance issues under high traffic loads

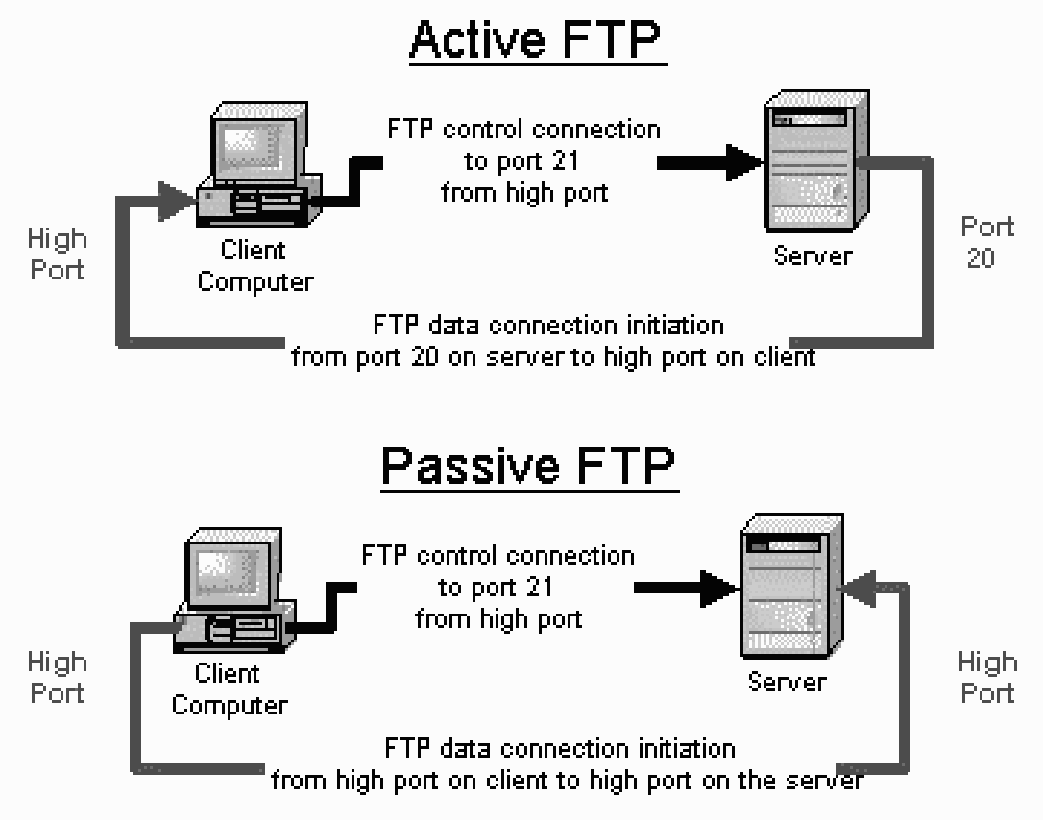
What is a Software Firewall?

- Typically, an in-kernel packet filter
- Configured via user-mode
  - Commands
  - Configuration files
  - Possibly with a GUI front-end
- Rules to match IP source/dest *address*, s/d *port*, *proto*, *direction* (in/out), *interface*, etc.
- Allow/accept/pass/permit desirable packets
- Block/deny/drop undesirable packets, or…
- Reject/return packets
- Stateless or stateful operation

What is Connection Tracking?

- State tracking
  - Remember src/dest addr/port/proto of desired traffic in one direction
  - Allow replies to these through as well
- This isn’t enough…
  - What about broadcast requests?
  - What about related connections on other ports?

Why is FTP a Problem?



What Else Is a Problem?

- Broadcast-based traffic
  - NetBIOS Name Services (e.g. in Samba)
- Other services with related connections
  - Amanda backup service
  - IRC
  - H323, SCTP, SIP
  - PPTP
- NAT

IPFilter (or “ipf”)

- Included in Solaris 10 and OpenSolaris
- Available for Linux, BSD-based & other UNIX flavours
- Rules read from one file (ipf.conf)
- ***Last*** matching rule is applied
  - Can use “**quick**” keyword to stop search
- No GUI in Solaris, but fwbuilder available

IPFilter Rules (ipf.conf)

- **block/pass in/out** [**log**] [**quick**] [**on** *if/f*] [**proto tcp/udp/icmp**] [**all**]/[**from** *addr* [**port =** *port*] **to** *addr* [**port =** *port*]] [**flags** *f*] [**with** *opt*] [**keep state**]
- Examples:
  - pass in quick on lo0 all
  - block in on bge0 all
  - pass out proto tcp/udp from any to any keep state

IPFilter Example Rules (ipf.conf)

```
# Block any packets which are too short to be real
block in log quick all with short
# drop and log any IP packets with options set in them.
block in log all with ipopts
# Allow all traffic on loopback.
pass in quick on lo0 all
pass out quick on lo0 all
# Public Network.   Block everything not explicitly allowed.
block in all
#block out all
# Allow ICMP in/out.
pass in quick proto icmp all keep state
pass out quick proto icmp all keep state
# Allow outbound state related packets.
pass out quick proto tcp/udp from any to any keep state
# allow ssh from anywhere
pass in quick proto tcp from any to any port = 22 flags S keep state
```

What About NetBIOS Name Service Request Broadcasts?

- State table contains outbound request to a broadcast address
- Incoming replies will be to our own address
- Crude ipf.conf solution:
  - pass in quick proto udp from 192.168.1.0/24 to any port = 137
  - pass in quick proto udp from 192.168.1.0/24 port = 137 to any
  - pass out quick proto udp from any to any port = 137

What About FTP Server (Passive Mode)?

- Problem: Need to accept incoming data connections from/to unknown port numbers
- Restrict port range in FTP server, e.g. vsftpd:
  - pasv_min_port=7000
  - pasv_max_port=7999
- Crude ipf.conf solution:
  - pass in quick proto tcp from any to <thishost> port = 21 flags S keep state
  - pass in quick proto tcp from any to <thishost> port 6999 >< 8000 flags S keep state

Enabling IPFilter on Solaris

- Make sure package is installed…
  - Solaris 10: **SUNWipfu**, **SUNWipfr**
  - OpenSolaris: **SUNWipf**
- Edit **/etc/ipf/ipf.conf**
- **# svcadm enable network/ipfilter**
- To reload after file change:
  - **# svcadm refresh network/ipfilter**
  - **# /lib/svc/method/ipfilter reipf**

Monitoring IPFilter

- To check hit counts *(summary or by rule)*:
  - # **ipfstat –h**[**io**][**n**]
- To view state table *(statistics or list)*:
  - # **ipfstat -s**[**l**]
  - # **ipfstat -t**[**C**] *(state top mode)*
- To monitor log device:
  - # **ipmon**

IPFilter Resources

- General:
  - http://en.wikipedia.org/wiki/IPFilter
  - http://coombs.anu.edu.au/~avalon/ip-filter.html
  - http://www.phildev.net/ipf/
  - http://www.obfuscation.org/ipf/
  - http://home.claranet.nl/users/guido/bsdcon2000/index.html
- Solaris:
  - http://docs.sun.com/app/docs/doc/819-3000/eupsq?a=view
  - http://docs.sun.com/app/docs/doc/819-3000/etmhi?a=view
  - http://www.softpanorama.org/Net/Network_security/Firewalls/ip_filter.shtml
  - http://www.homepage.montana.edu/~unixuser/031705/create_solaris_ipf.html
  - http://ma.yer.at/fwbuilder/

IPFirewall (or “ipfw”)

- Included in Mac OS X 10.3 and later
- Available for FreeBSD
- Ported to Windows 2000 & later (**wipfw**)
- Rules added by command or config files
- Rule # specified to determine order
- Different GUI for different Mac OS X version
- Third-party GUI’s also available

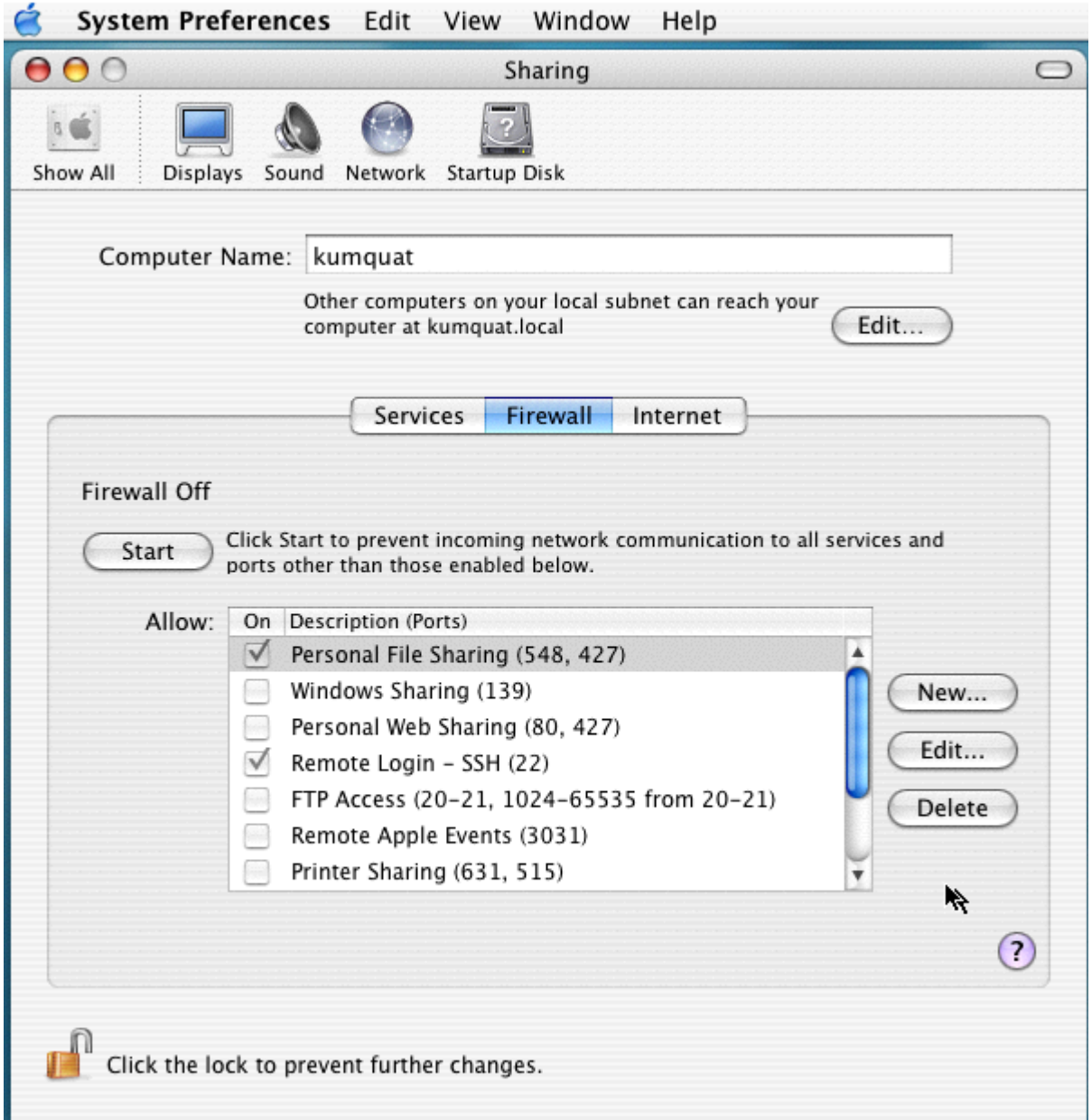
IPFW Rules

- **add** *rulenum*
  allow/**accept**/**pass**/**permit**/**deny**/**drop** [**log**]
  [*proto* **from** *addr* [*port*] **to** *addr* [*port*]] [*options*]
- Examples:
  - add 1000 allow all from any to any via lo0
  - add 12300 allow tcp from any to any established
  - add 12301 allow tcp from any to any out
  - add 12302 allow tcp from any to any 22
  - add 12303 allow udp from any to any out keep-state
  - add 65534 deny log ip from any to any

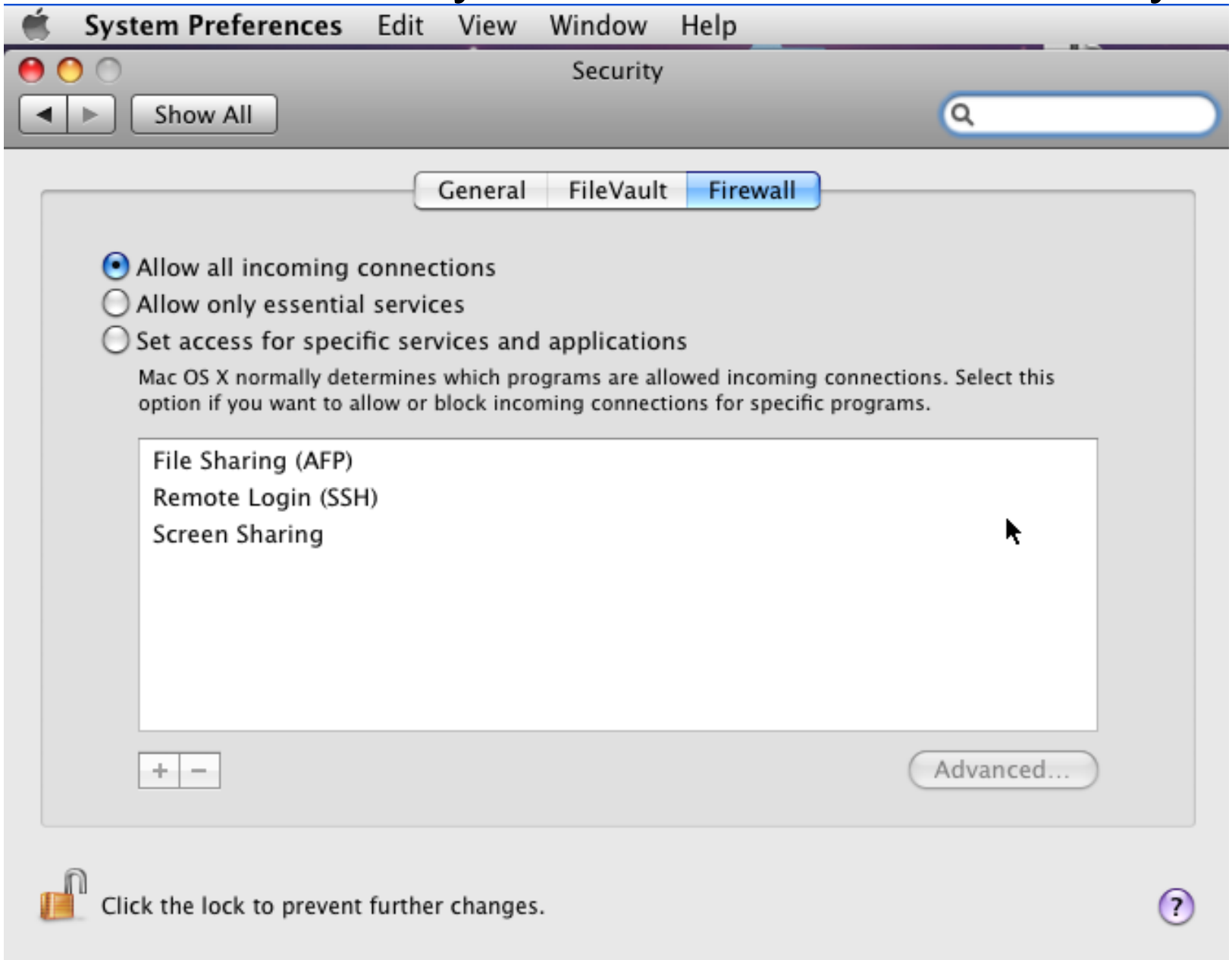
IPFW Features & Limitations

- Similar functionality to IPFilter
- State table mechanism has similar limitations:
  - No connection tracking for related ports
  - Replies to broadcast requests also won't match saved state
- Rules can match in/out packets (or both)
- Ranges & lists allowed for IP addresses & ports:
  - add 12334 allow tcp from any to any 5900-5906

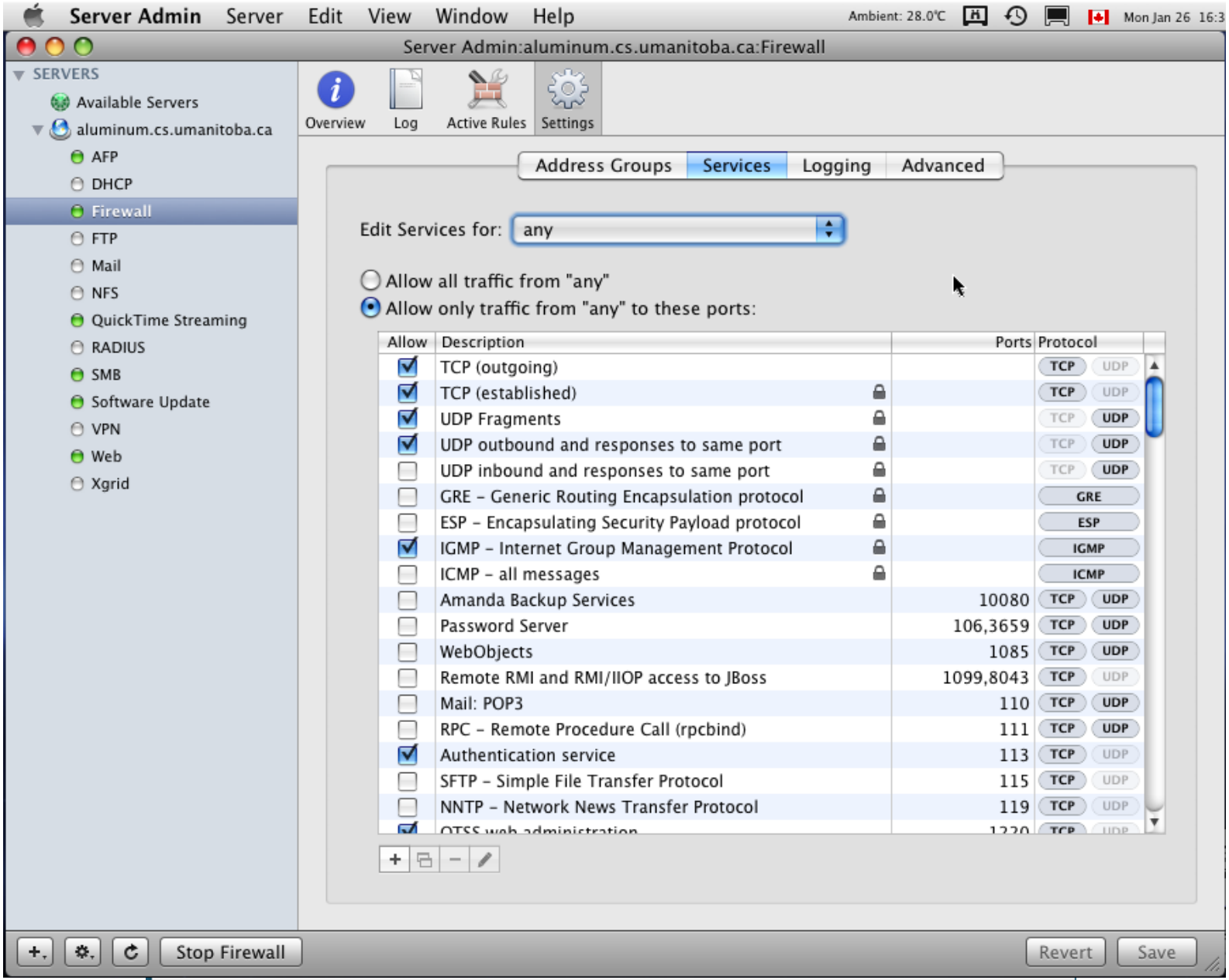
Mac OS X 10.3: System Preferences / Sharing



Mac OS X 10.5: System Preferences / Security



Mac OS X 10.5 Server: Server Admin / Firewall



Enabling IPFW on MacOS X Server

- Use Server Admin / Firewall GUI
  - Modifies **/etc/ipfilter/ipfw.conf.apple**
  - Starts/stops daemon
- Add manual overrides to **/etc/ipfilter/ipfw.conf**
- To reload after file changes:
  - **# ipfw flush**
  - **# ipfw /etc/ipfilter/ipfw.conf.apple**
  - **# ipfw /etc/ipfilter/ipfw.conf**

Monitoring IPFW on MacOS X Server

- Use Server Admin / Firewall GUI
- To check rule hit counts:
  - # **ipfw show**
- To view dynamic (state table) rules too:
  - # **ipfw -d** [**-e**] **show**
- To monitor log:
  - # **tail -f /var/log/ipfw.log**

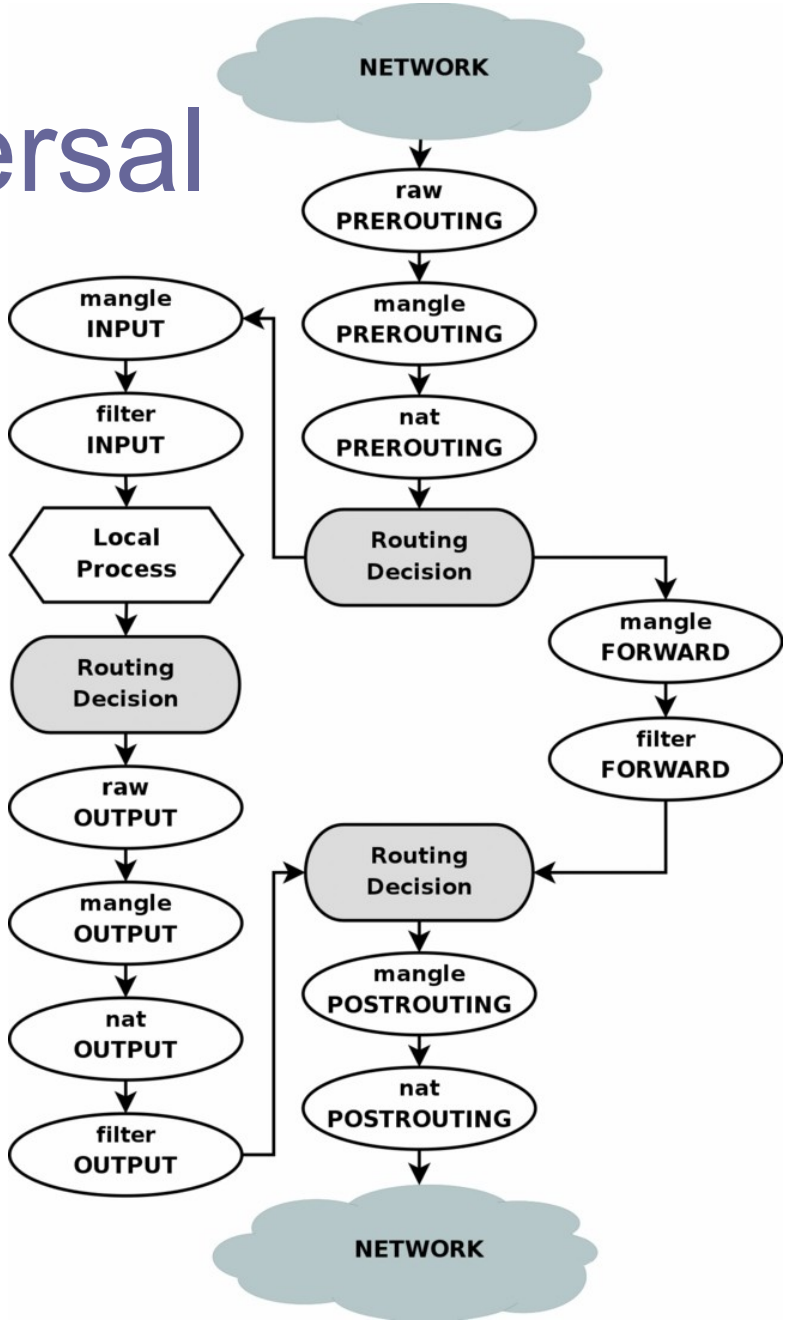
IPFirewall Resources

- http://en.wikipedia.org/wiki/Ipfirewall
- http://www.freebsd-howto.com/HOWTO/Ipfw-HOWTO
- http://securosis.com/2007/11/16/ipfw-rules-20071116-revision/
- http://www.hanynet.com/waterroof/
- http://wipfw.sourceforge.net/

Netfilter/iptables

- Included in Linux 2.4 or later kernels
- Replaces older **ipchains** filter
- Maintains state information *and* does related-connection tracking
- Can add filter rules to pre-defined chains for **INPUT**, **OUTPUT**, *and* **FORWARD**
- Can also add user-specified chains (like subroutines)
- Also supports other tables/chains for more complex operations, such as NAT support

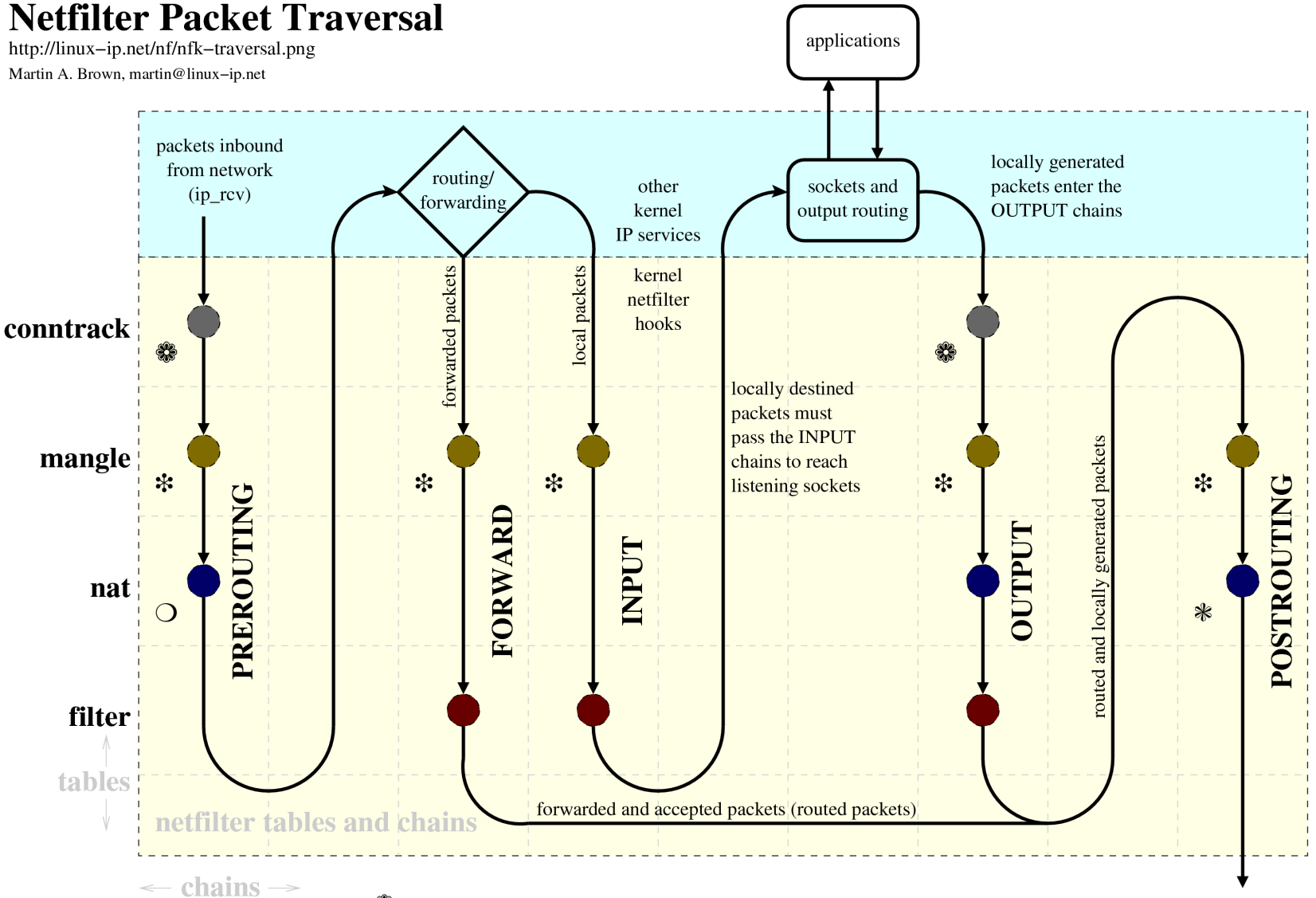
Packet Traversal



Netfilter Packet Traversal

http://linux-ip.net/nf/nfk-traversal.png

Martin A. Brown, martin@linux-ip.net



❁ The conntrack table is used (if the module is loaded) and is not directly user-manipulable.

❇ The targets MARK, TOS, and TTL are available only in the mangle table.

❍ The nat PREROUTING table supports the DNAT target.

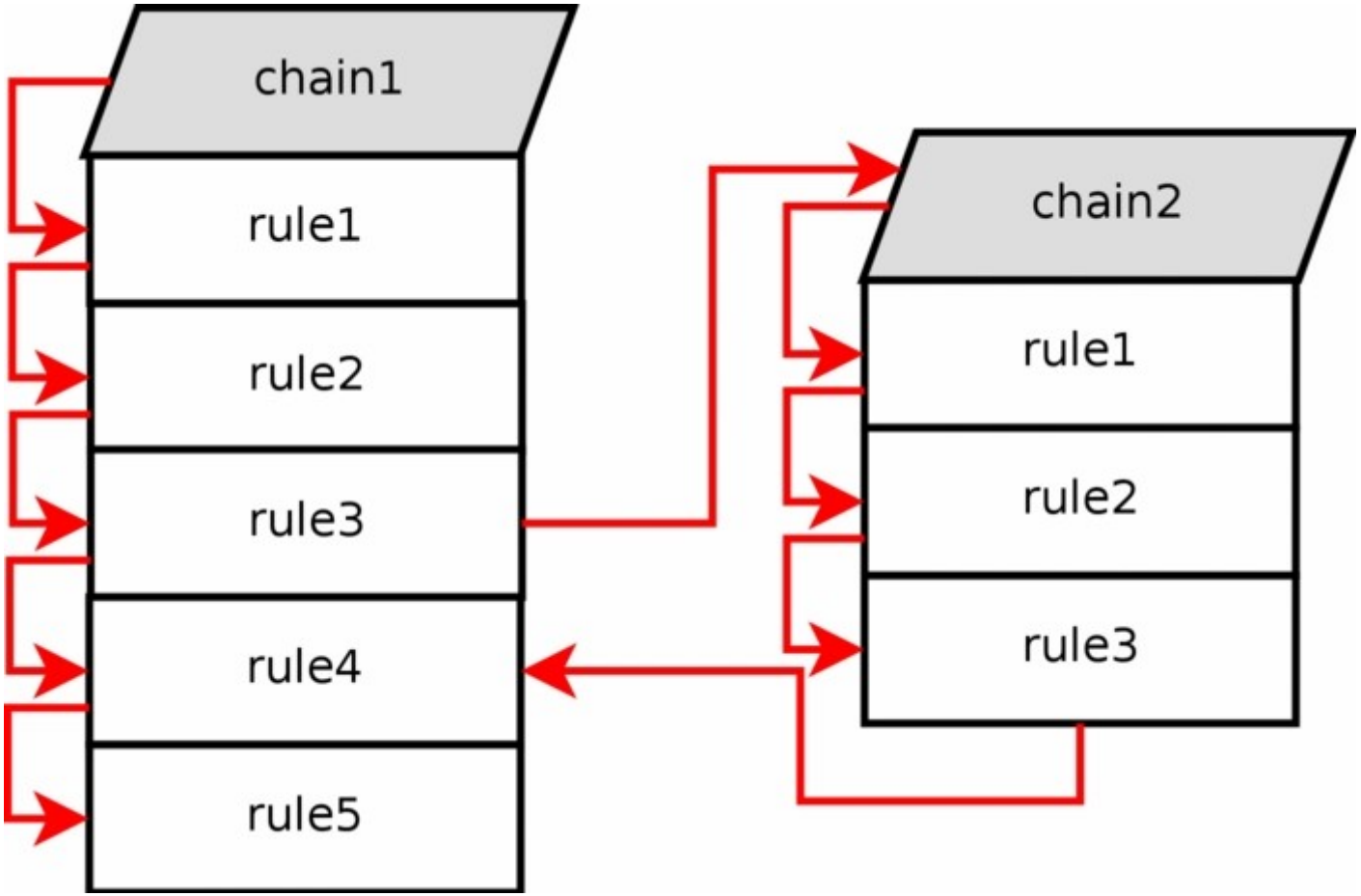
❋ The nat POSTROUTING table supports SNAT and MASQUERADE targets.

cf. http://www.docum.org/qos/kptd/

cf. http://open-source.arkoon.net/kernel/kernel_net.png

cf. http://iptables-tutorial.frozentux.net/

User-Specified Chains



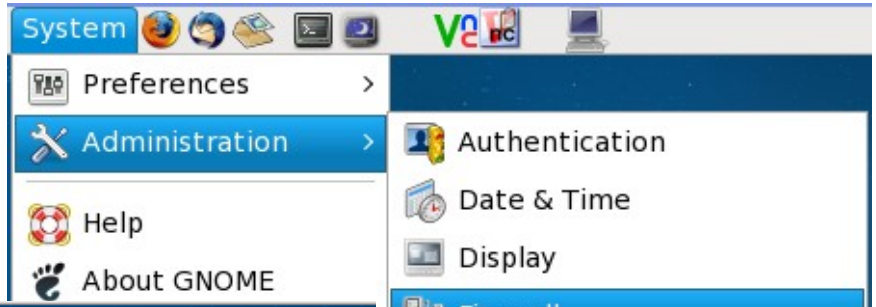
Iptables commands

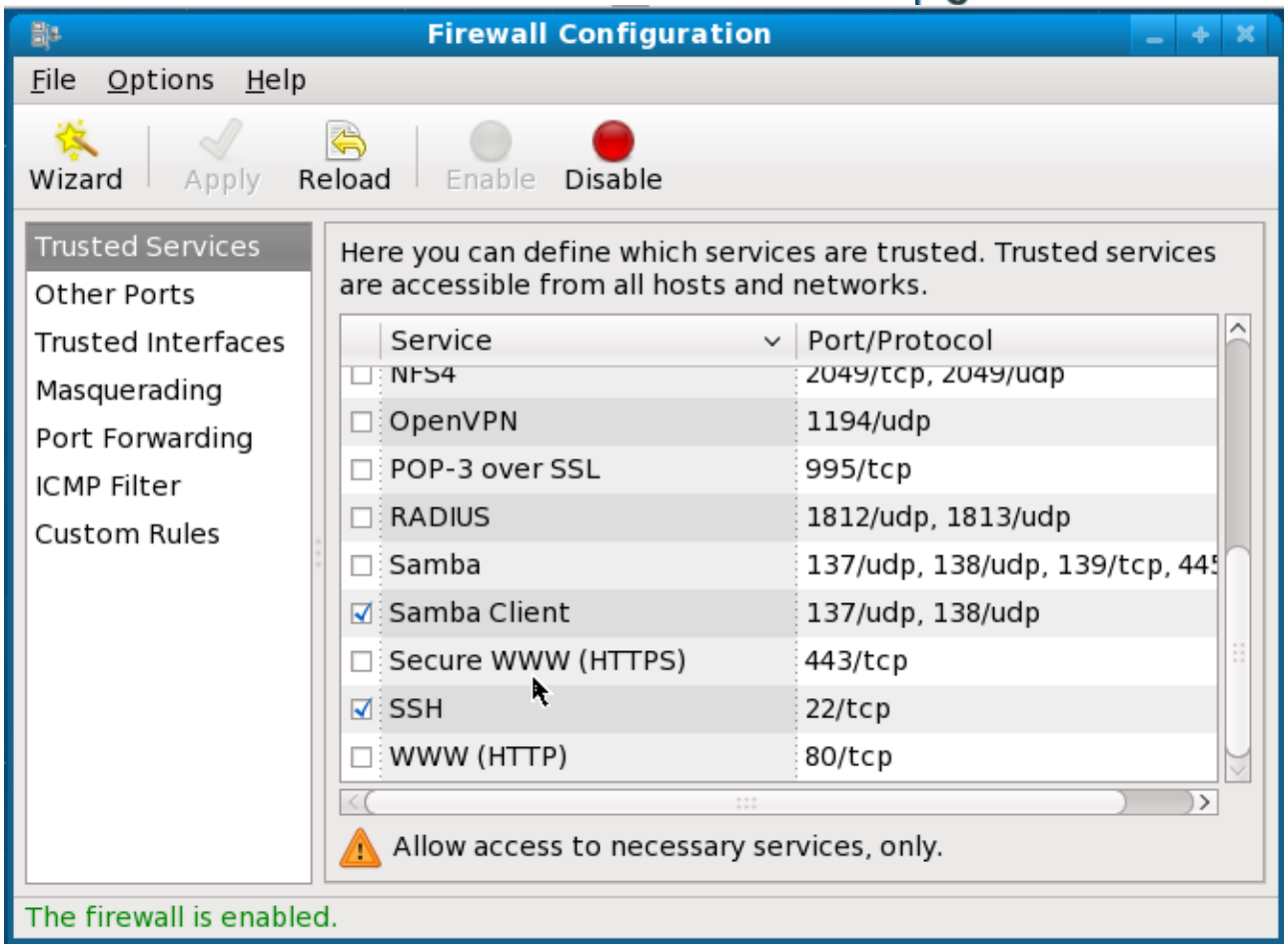
- Add a chain:
  - # **iptables** [**-t**/**--table** *table*] **-N**/**--new-chain** *chain*
- Set policy (default action) on a chain:
  - # **iptables** [**-t** *table*] **-P** *chain target* [*options*]
- Append/insert a rule to a chain:
  - # **iptables** [**-t** *table*] **-A**/**I** *chain rule-specification* [*options*]
- Rule specification:
  - [**-p** *proto*] [**-s** *addr*[*/mask*]] [**-d** *addr*[*/mask*]] [**-i**/**o** *interface*] [**-j** *target*]
- Rules can include extended packet matching modules:
  - E.g.: **-m tcp** [**--source-port** *port*[**:***port*]] [**--dport** *port*[**:***port*]]
- Target is either a user-specified chain or…
  - **ACCEPT**, **DROP**, **RETURN**, **REJECT**, *or* **LOG**

iptables-save and **iptables-restore**

- Save a defined set of tables/chains:
  - # **iptables-save** [**-c**] [**-t** *table*] **>** *file*
- Restore a saved set:
  - # **iptables-restore** [**-c**] [**-n**] **<** *file*
- **-c** to save/restore packet & byte counters
- **-n** to not flush previous table contents
- **-t** to limit output to named table (default is all tables)

Fedora Firewall Configuration GUI





/etc/sysconfig/iptables

```
# Firewall configuration written by system-config-firewall
# Manual customization of this file is not recommended.
*filter
:INPUT ACCEPT [0:0]
:FORWARD ACCEPT [0:0]
:OUTPUT ACCEPT [0:0]
-A INPUT -m state --state ESTABLISHED,RELATED -j ACCEPT
-A INPUT -p icmp -j ACCEPT
-A INPUT -i lo -j ACCEPT
-A INPUT -p ah -j ACCEPT
-A INPUT -p esp -j ACCEPT
-A INPUT -m state --state NEW -m udp -p udp --dport 5353 -d 224.0.0.251 -j ACCEPT
-A INPUT -m state --state NEW -m udp -p udp --dport 631 -j ACCEPT
-A INPUT -m state --state NEW -m udp -p udp --dport 137 -j ACCEPT
-A INPUT -m state --state NEW -m udp -p udp --dport 138 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 22 -j ACCEPT
-A INPUT -j REJECT --reject-with icmp-host-prohibited
-A FORWARD -j REJECT --reject-with icmp-host-prohibited
COMMIT
```

Iptables Connection Tracking

- Handled by (application-specific) kernel modules:
  - **# modprobe ip_conntrack_ftp**
  - **# modprobe ip_conntrack_netbios_ns**
- RedHat/Fedora: define in **/etc/sysconfig/iptables-config**:
  - **IPTABLES_MODULES="ip_conntrack_ftp ip_conntrack_netbios_ns"**

Enabling iptables in RedHat/Fedora

- Use the Firewall Configuration GUI
  - Start Configuration Wizard or
    Load Default Configuration (**Options** menu)
  - Define trusted services, etc.
  - Enable/Disable Firewall service
- Edit **/etc/sysconfig/iptables**{,**-config**}
- Reload after file changes:
  - # **service iptables restart** *…or…*
  - # **iptables -F INPUT ; **
    iptables-restore /etc/sysconfig/iptables

Monitoring iptables in RedHat/Fedora

- To view rules with packet & byte counters:
  - # **iptables-save -c** [**-t** *table*]
- To view logs:
  - # **tail -f /var/log/messages | fgrep kernel:**
- To view connection-tracking state info:
  - # **less /proc/net/ip_conntrack** *…or…*
  - # **less /proc/net/nf_conntrack**
    (depending on kernel version)

Getting Fancy: SSH probe filtering

```
-A INPUT -m state --state NEW -m tcp -p tcp --dport 22
    -m recent --name sshprobe --set
-A INPUT -m state --state NEW -m tcp -p tcp --dport 22
    -m recent --name sshprobe --rcheck --seconds 60
    --hitcount 8 -j DROP
-A INPUT -m state --state NEW -m tcp -p tcp --dport 22
    -m recent --name sshprobe --rcheck --seconds 60
    --hitcount 4 -j LOG --log-prefix "SSH-REJECT: "
-A INPUT -m state --state NEW -m tcp -p tcp --dport 22
    -m recent --name sshprobe --rcheck --seconds 60
    --hitcount 4 -j REJECT --reject-with tcp-reset
-A INPUT -m state --state NEW -m tcp -p tcp --dport 22
    -j ACCEPT
```

Netfilter/iptables Resources

- http://en.wikipedia.org/wiki/Netfilter/iptables
- http://en.wikipedia.org/wiki/Iptables
- http://www.netfilter.org/
- http://iptables-tutorial.frozentux.net/
- http://security.maruhn.com/
- http://linux-ip.net/nf/
- http://ornellas.apanela.com/dokuwiki/pub:firewall_and_adv_routing
- http://easyfwgen.morizot.net/gen/
- http://www.muug.mb.ca/pub/muuglines/pdf/muug0804.pdf
- http://www.teaparty.net/technotes/ssh-rate-limiting.html
- http://www.linuxjournal.com/video/mastering-iptables-part-i
- http://www.linuxjournal.com/video/mastering-iptables-part-2
- http://www.linuxjournal.com/video/mastering-iptables-final-installment

Questions?