关于本文档

文档名称：《Linux 防火墙》

使用协议：《知识共享公共许可协议(CCPL)》

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文档协议

致谢

本文档中，部分素材参考了相关项目的文档，以及通过搜索引擎获得的内容，这里先一并向相关的贡献者表示感谢。

Linux 防火墙

本章内容

- **防火墙的概念**
- **Linux 防火墙技术**
- **iptables的基本认识**

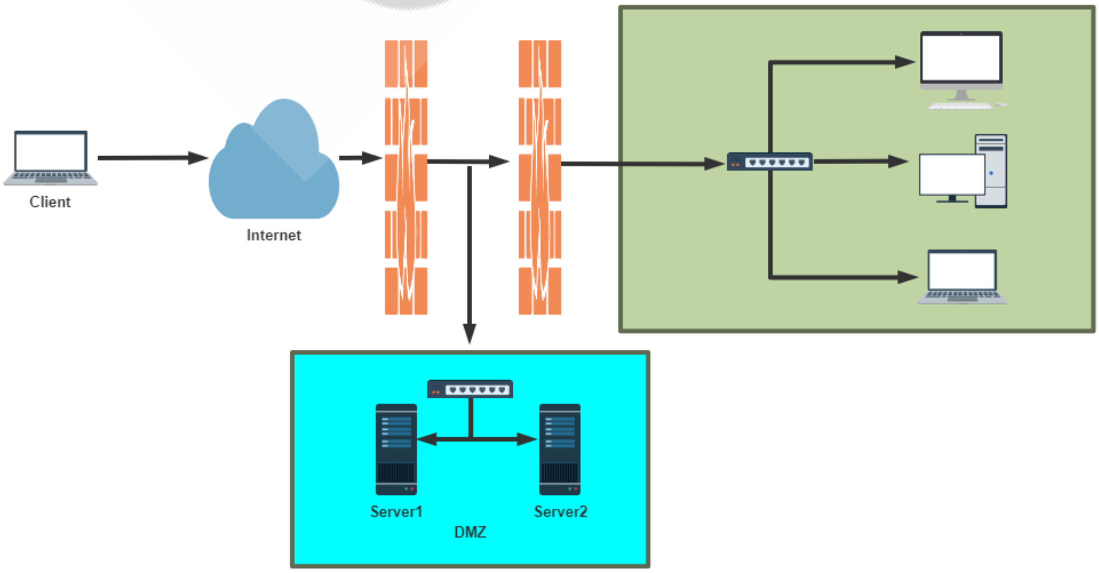
- **iptables的组成**
- **iptables的基本语法**
- **iptables之forward的概念**
- **iptables之地址转换法则**
- **SNAT源地址转换的具体实现**
- **DNAT目标地址转换的具体实现**
- **firewalld介绍和基本配置**

1 安全技术和防火墙

1.1 安全技术

- 入侵检测系统（Intrusion Detection Systems）：特点是不阻断任何网络访问，量化、定位来自内外网络的威胁情况，主要以提供报警和事后监督为主，提供有针对性的指导措施和安全决策依据,类似于监控系统一般采用旁路部署方式
- 入侵防御系统（Intrusion Prevention System）：以透明模式工作，分析数据包的内容如：溢出攻击、拒绝服务攻击、木马、蠕虫、系统漏洞等进行准确的分析判断，在判定为攻击行为后立即予以阻断，主动而有效的保护网络的安全，一般采用在线部署方式
- 防火墙（FireWall）：隔离功能，工作在网络或主机边缘，对进出网络或主机的数据包基于一定的规则检查，并在匹配某规则时由规则定义的行为进行处理的一组功能的组件，基本上的实现都是默认情况下关闭所有的通过型访问，只开放允许访问的策略,会将希望外网访问的主机放在DMZ (demilitarized zone)网络中.

```
防水墙
广泛意义上的防水墙：防水墙（Waterwall），与防火墙相对，是一种防止内部信息泄漏的安全产品。网络、外设接口、存储介质和打印机构成信息泄漏的全部途径。防水墙针对这四种泄密途径，在事前、事中、事后进行全面防护。其与防病毒产品、外部安全产品一起构成完整的网络安全体系。
```



1.2 防火墙的分类

按保护范围划分：

- 主机防火墙：服务范围为当前一台主机
- 网络防火墙：服务范围为防火墙一侧的局域网

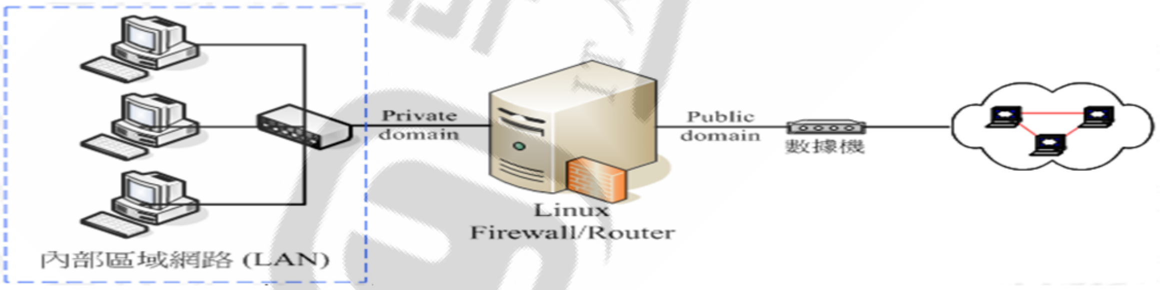
按实现方式划分：

- 硬件防火墙：在专用硬件级别实现部分功能的防火墙；另一个部分功能基于软件实现，如：华为，山石hillstone,天融信，启明星辰，绿盟，深信服，PaloAlto , fortinet飞塔, Cisco, Checkpoint，NetScreen(2004年被 Juniper 用40亿美元收购)等
- 软件防火墙：运行于通用硬件平台之上的防火墙的应用软件，Windows 防火墙 ISA --> Forefront TMG

按网络协议划分：

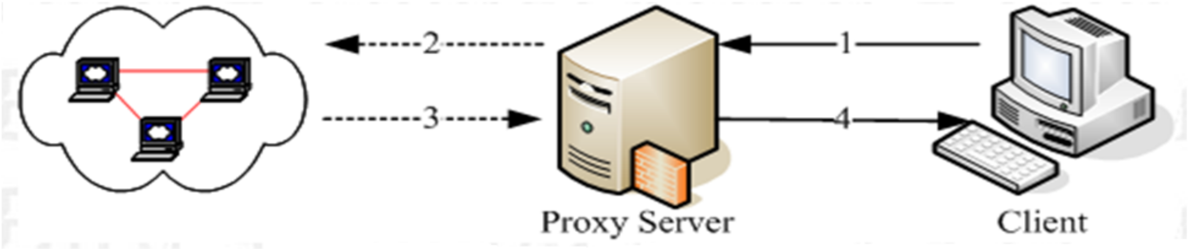
- 网络层防火墙：OSI模型下四层，又称为包过滤防火墙
- 应用层防火墙/代理服务器：proxy 代理网关，OSI模型七层

包过滤防火墙



网络层对数据包进行选择，选择的依据是系统内设置的过滤逻辑，被称为访问控制列表（ACL），通过检查数据流中每个数据的源地址，目的地址，所用端口号和协议状态等因素，或他们的组合来确定是否允许该数据包通过
优点：对用户来说透明，处理速度快且易于维护
缺点：无法检查应用层数据，如病毒等

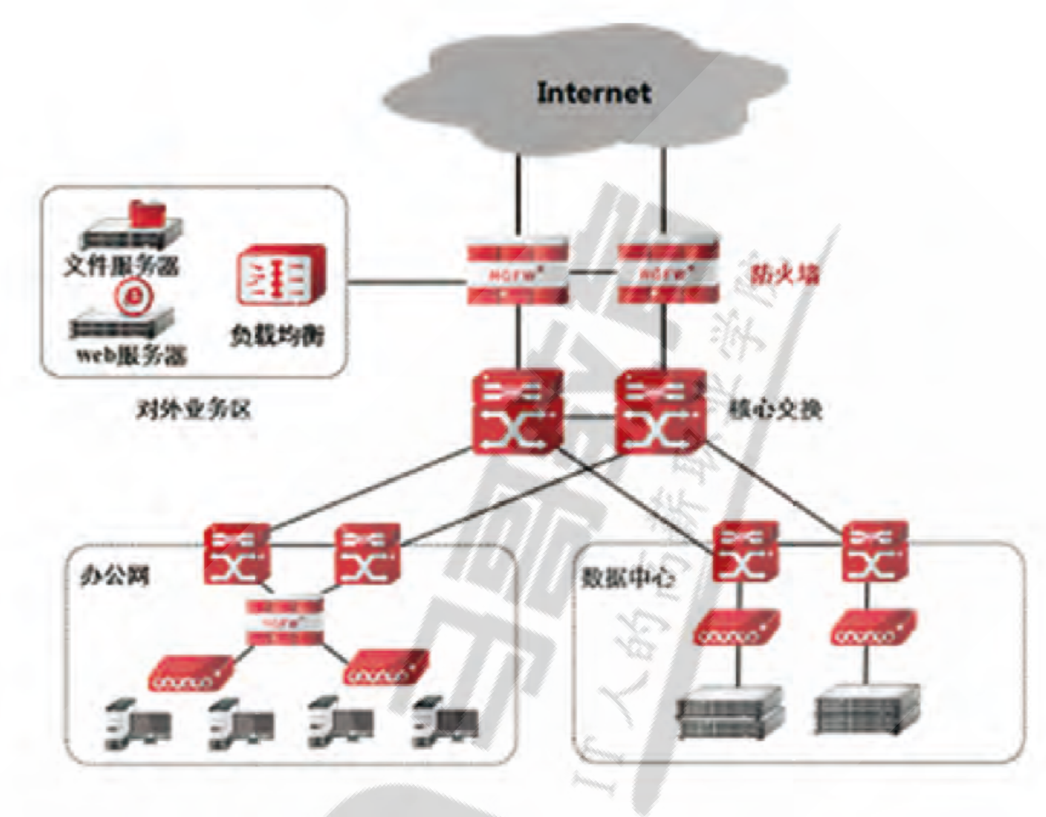
应用层防火墙



应用层防火墙/代理服务型防火墙，也称为代理服务器（Proxy Server）
将所有跨越防火墙的网络通信链路分为两段
内外网用户的访问都是通过代理服务器上的“链接”来实现
优点：在应用层对数据进行检查，比较安全
缺点：增加防火墙的负载

提示：现实生产环境中所使用的防火墙一般都是二者结合体，即先检查网络数据，通过之后再送到应用层去检查

1.3 网络架构



2 Linux 防火墙的基本认识

2.1 Netfilter

netfilter
firewalling, NAT, and packet mangling for linux

Linux防火墙是由Netfilter组件提供的，Netfilter工作在内核空间，集成在linux内核中

Netfilter 是Linux 2.4.x之后新一代的Linux防火墙机制，是linux内核的一个子系统。Netfilter采用模块化设计，具有良好的可扩充性，提供扩展各种网络服务的结构化底层框架。Netfilter与IP协议栈是无缝契合，并允许对数据报进行过滤、地址转换、处理等操作

Netfilter官网文档：https://netfilter.org/documentation/

```
[root@centos8 ~]#grep -m 10 NETFILTER /boot/config-4.18.0-193.el8.x86_64
CONFIG_NETFILTER=y
CONFIG_NETFILTER_ADVANCED=y
CONFIG_BRIDGE_NETFILTER=m
CONFIG_NETFILTER_INGRESS=y
```

```
CONFIG_NETFILTER_NETLINK=m
CONFIG_NETFILTER_FAMILY_BRIDGE=y
CONFIG_NETFILTER_FAMILY_ARP=y
# CONFIG_NETFILTER_NETLINK_ACCT is not set
CONFIG_NETFILTER_NETLINK_QUEUE=m
CONFIG_NETFILTER_NETLINK_LOG=m

[root@centos7 ~]#grep -m 10 NETFILTER /boot/config-3.10.0-1127.el7.x86_64
CONFIG_NETFILTER=y
# CONFIG_NETFILTER_DEBUG is not set
CONFIG_NETFILTER_ADVANCED=y
CONFIG_BRIDGE_NETFILTER=m
CONFIG_NETFILTER_NETLINK=m
CONFIG_NETFILTER_NETLINK_ACCT=m
CONFIG_NETFILTER_NETLINK_QUEUE=m
CONFIG_NETFILTER_NETLINK_LOG=m
CONFIG_NETFILTER_NETLINK_QUEUE_CT=y
CONFIG_NETFILTER_SYNPROXY=m

[root@centos6 ~]#grep -m 10 NETFILTER /boot/config-2.6.32-754.el6.x86_64
CONFIG_NETFILTER=y
# CONFIG_NETFILTER_DEBUG is not set
CONFIG_NETFILTER_ADVANCED=y
CONFIG_BRIDGE_NETFILTER=y
CONFIG_NETFILTER_NETLINK=m
CONFIG_NETFILTER_NETLINK_QUEUE=m
CONFIG_NETFILTER_NETLINK_LOG=m
CONFIG_NETFILTER_TPROXY=m
CONFIG_NETFILTER_XTABLES=y
CONFIG_NETFILTER_XT_TARGET_AUDIT=m

[root@ubuntu2004 ~]#grep -m 10 NETFILTER /boot/config-5.4.0-33-generic
CONFIG_NETFILTER=y
CONFIG_NETFILTER_ADVANCED=y
CONFIG_BRIDGE_NETFILTER=m
CONFIG_NETFILTER_INGRESS=y
CONFIG_NETFILTER_NETLINK=m
CONFIG_NETFILTER_FAMILY_BRIDGE=y
CONFIG_NETFILTER_FAMILY_ARP=y
CONFIG_NETFILTER_NETLINK_ACCT=m
CONFIG_NETFILTER_NETLINK_QUEUE=m
CONFIG_NETFILTER_NETLINK_LOG=m

[root@ubuntu1804 ~]#grep -m 10 NETFILTER /boot/config-4.15.0-29-generic
CONFIG_NETFILTER=y
CONFIG_NETFILTER_ADVANCED=y
CONFIG_BRIDGE_NETFILTER=m
CONFIG_NETFILTER_INGRESS=y
CONFIG_NETFILTER_NETLINK=m
CONFIG_NETFILTER_NETLINK_ACCT=m
CONFIG_NETFILTER_NETLINK_QUEUE=m
CONFIG_NETFILTER_NETLINK_LOG=m
CONFIG_NETFILTER_NETLINK_GLUE_CT=y
CONFIG_NETFILTER_SYNPROXY=m
```

2.2 防火墙工具介绍

2.2.1 iptables

由软件包iptables提供的命令行工具，工作在用户空间，用来编写规则，写好的规则被送往netfilter，告诉内核如何去处理信息包

```
[root@centos8 ~]#rpm -qi iptables
Name        : iptables
Version     : 1.8.2
Release     : 9.el8
Architecture: x86_64
Install Date: Wed 25 Sep 2019 09:29:06 PM CST
Group       : Unspecified
Size        : 2050086
License     : GPLv2 and Artistic 2.0 and ISC
Signature   : RSA/SHA256, Tue 02 Jul 2019 06:50:00 AM CST, Key ID
05b555b38483c65d
Source RPM  : iptables-1.8.2-9.el8.src.rpm
Build Date  : Sat 11 May 2019 10:21:57 PM CST
Build Host  : x86-01.mbox.centos.org
Relocations : (not relocatable)
Packager    : CentOS Buildsys <bugs@centos.org>
Vendor      : CentOS
URL         : http://www.netfilter.org/
Summary     : Tools for managing Linux kernel packet filtering capabilities
Description :
The iptables utility controls the network packet filtering code in the
Linux kernel. If you need to set up firewalls and/or IP masquerading,
you should either install nftables or this package.

Note: This package contains the nftables-based variants of iptables and
ip6tables, which are drop-in replacements of the legacy tools.


[root@centos8 ~]# iptables --version
iptables v1.8.2 (nf_tables)
[root@centos8 ~]#ll /usr/sbin/iptables
lrwxrwxrwx. 1 root root 17 May 11  2019 /usr/sbin/iptables -> xtables-nft-multi

[root@centos7 ~]#ll /usr/sbin/iptables
lrwxrwxrwx. 1 root root 13 Dec  9  2018 /usr/sbin/iptables -> xtables-multi
[root@centos7 ~]# iptables --version
iptables v1.4.21

[root@centos6 ~]#iptables --version
iptables v1.4.7
[root@centos6 ~]#ll /sbin/iptables
lrwxrwxrwx. 1 root root 33 Dec 12  2018 /sbin/iptables ->
/etc/alternatives/iptables.x86_64
[root@centos6 ~]#ll /etc/alternatives/iptables.x86_64
lrwxrwxrwx. 1 root root 20 Dec 12  2018 /etc/alternatives/iptables.x86_64 ->
/sbin/iptables-1.4.7
[root@centos6 ~]#ll /sbin/iptables
lrwxrwxrwx. 1 root root 33 Dec 12  2018 /sbin/iptables ->
/etc/alternatives/iptables.x86_64
```

范例：安装iptables的service包

```
[root@centos8 ~]#dnf -y install iptables-services
[root@centos8 ~]#rpm -ql iptables-services
/etc/sysconfig/ip6tables
/etc/sysconfig/iptables
/usr/lib/systemd/system/ip6tables.service
/usr/lib/systemd/system/iptables.service
/usr/libexec/initscripts/legacy-actions/ip6tables
/usr/libexec/initscripts/legacy-actions/ip6tables/panic
/usr/libexec/initscripts/legacy-actions/ip6tables/save
/usr/libexec/initscripts/legacy-actions/iptables
/usr/libexec/initscripts/legacy-actions/iptables/panic
/usr/libexec/initscripts/legacy-actions/iptables/save
/usr/libexec/iptables
/usr/libexec/iptables/ip6tables.init
/usr/libexec/iptables/iptables.init
```

2.2.2 firewalld

从CentOS 7 版开始引入了新的前端管理工具

软件包：

- firewalld
- firewalld-config

管理工具：

- firewall-cmd 命令行工具
- firewall-config 图形工作

2.2.3 nftables

此软件是CentOS 8 新特性,Nftables最初在法国巴黎的Netfilter Workshop 2008上发表，然后由长期的netfilter核心团队成员和项目负责人Patrick McHardy于2009年3月发布。它在2013年末合并到Linux内核中，自2014年以来已在内核3.13中可用。

它重用了netfilter框架的许多部分，例如连接跟踪和NAT功能。它还保留了命名法和基本iptables设计的几个部分，例如表，链和规则。就像iptables一样，表充当链的容器，并且链包含单独的规则，这些规则可以执行操作，例如丢弃数据包，移至下一个规则或跳至新链。

从用户的角度来看，nftables添加了一个名为nft的新工具，该工具替代了iptables，arptables和ebtables中的所有其他工具。从体系结构的角度来看，它还替换了内核中处理数据包过滤规则集运行时评估的那些部分。

范例：查看软件包

```
[root@centos8 ~]#rpm -qi nftables
Name        : nftables
Epoch       : 1
Version     : 0.9.0
Release     : 8.el8
Architecture: x86_64
Install Date: Wed 25 Sep 2019 09:29:06 PM CST
Group       : Unspecified
Size        : 758622
License     : GPLv2
```

```
Signature   : RSA/SHA256, Tue 02 Jul 2019 08:19:09 AM CST, Key ID
05b555b38483c65d
Source RPM  : nftables-0.9.0-8.el8.src.rpm
Build Date  : Sat 11 May 2019 11:06:46 PM CST
Build Host  : x86-01.mbox.centos.org
Relocations : (not relocatable)
Packager    : CentOS Buildsys <bugs@centos.org>
Vendor      : CentOS
URL         : http://netfilter.org/projects/nftables/
Summary     : Netfilter Tables userspace utillites
Description :
Netfilter Tables userspace utilities.
```

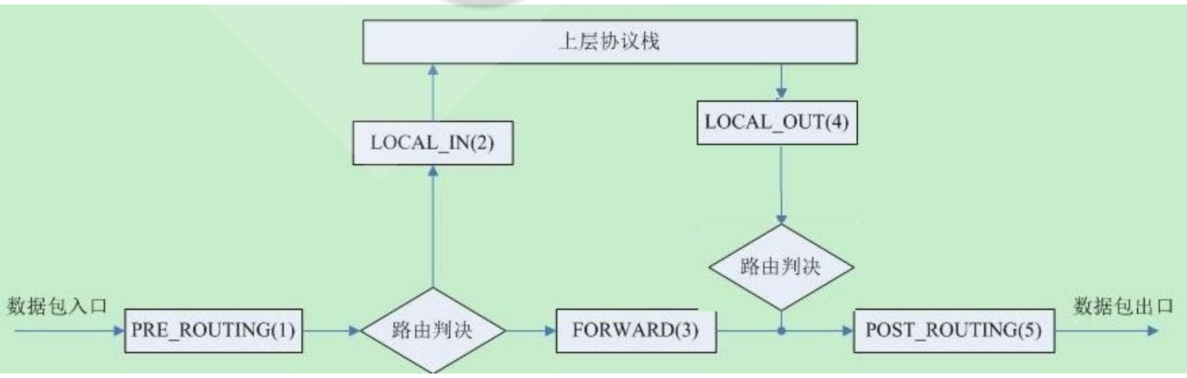
范例：CentOS 8 支持三种防火墙服务

```
[root@centos8 ~]#systemctl status iptables.service
● iptables.service - IPv4 firewall with iptables
   Loaded: loaded (/usr/lib/systemd/system/iptables.service; disabled; vendor
preset: disabled)
   Active: inactive (dead)
[root@centos8 ~]#systemctl status firewalld.service
● firewalld.service - firewalld - dynamic firewall daemon
   Loaded: loaded (/usr/lib/systemd/system/firewalld.service; disabled; vendor
preset: enabled)
   Active: inactive (dead)
     Docs: man:firewalld(1)
[root@centos8 ~]#systemctl status nftables.service
● nftables.service - Netfilter Tables
   Loaded: loaded (/usr/lib/systemd/system/nftables.service; disabled; vendor
preset: disabled)
   Active: inactive (dead)
     Docs: man:nft(8)
```

2.3 netfilter 中五个勾子函数和报文流向

Netfilter在内核中选取五个位置放了五个hook(勾子) function(INPUT、OUTPUT、FORWARD、PREROUTING、POSTROUTING)，而这五个hook function向用户开放，用户可以通过一个命令工具（iptables）向其写入规则

由信息过滤表（table）组成，包含控制IP包处理的规则集（rules），规则被分组放在链（chain）上



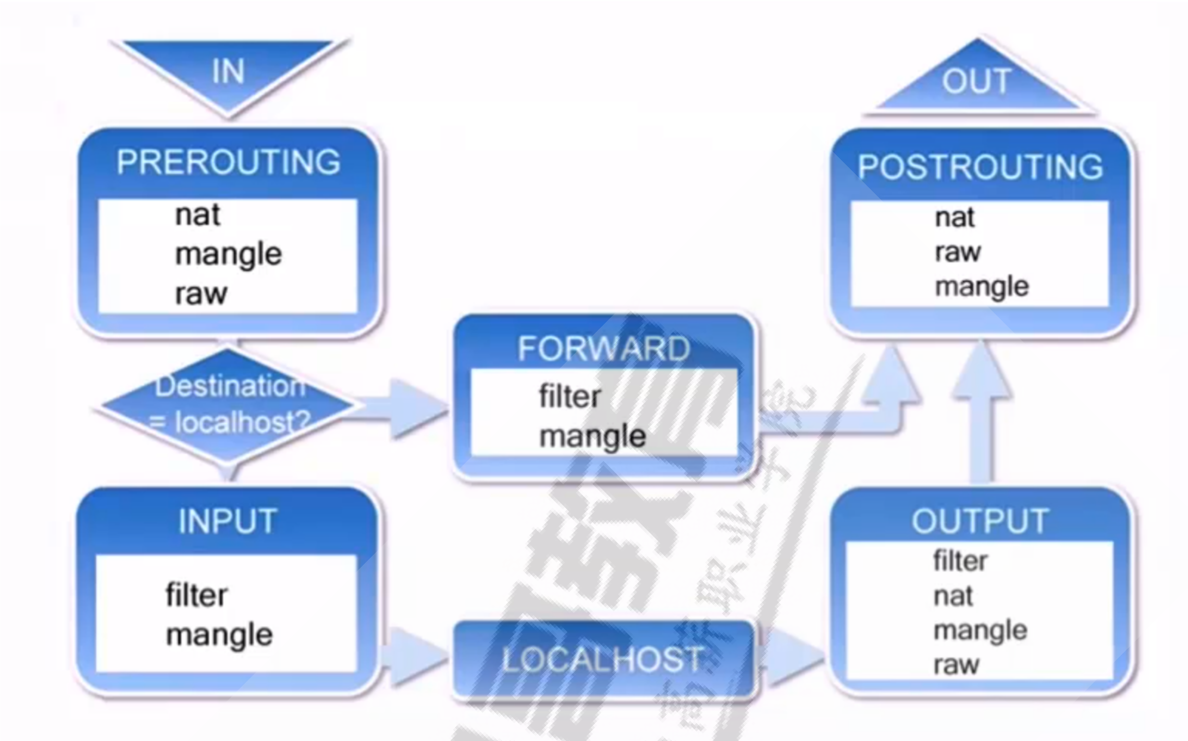
提示：从 Linux kernel 4.2 版以后，Netfilter 在prerouting 前加了一个 ingress 勾子函数。可以使用这个新的入口挂钩来过滤来自第2层的流量，这个新挂钩比预路由要早，基本上是 tc 命令（流量控制工具）的替代品

三种报文流向

- 流入本机：PREROUTING --> INPUT-->用户空间进程
- 流出本机：用户空间进程 -->OUTPUT--> POSTROUTING
- 转发：PREROUTING --> FORWARD --> POSTROUTING

2.4 iptables的组成

iptables由五个表table和五个链chain以及一些规则组成



链 chain：

- 内置链：每个内置链对应于一个钩子函数
- 自定义链：用于对内置链进行扩展或补充，可实现更灵活的规则组织管理机制；只有Hook钩子调用自定义链时，才生效

五个内置链chain:

```
INPUT,OUTPUT,FORWARD,PREROUTING,POSTROUTING
```

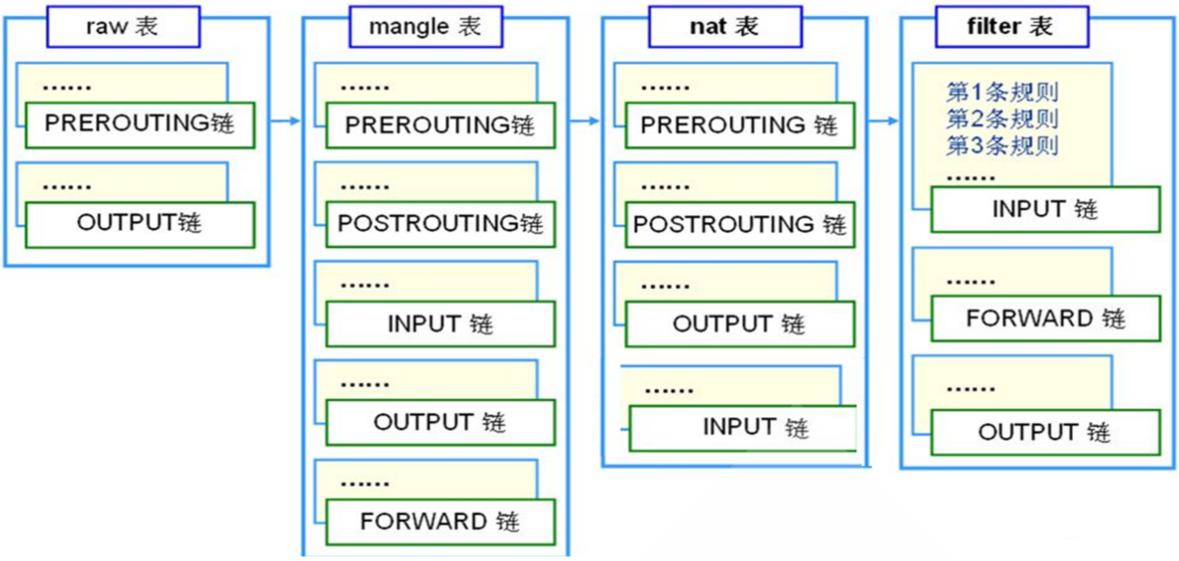
五个表table： filter、nat、mangle、raw、security

- filter：过滤规则表，根据预定义的规则过滤符合条件的数据包,默认表
- nat：network address translation 地址转换规则表
- mangle：修改数据标记位规则表
- raw：关闭启用的连接跟踪机制，加快封包穿越防火墙速度
- security：用于强制访问控制（MAC）网络规则，由Linux安全模块（如SELinux）实现

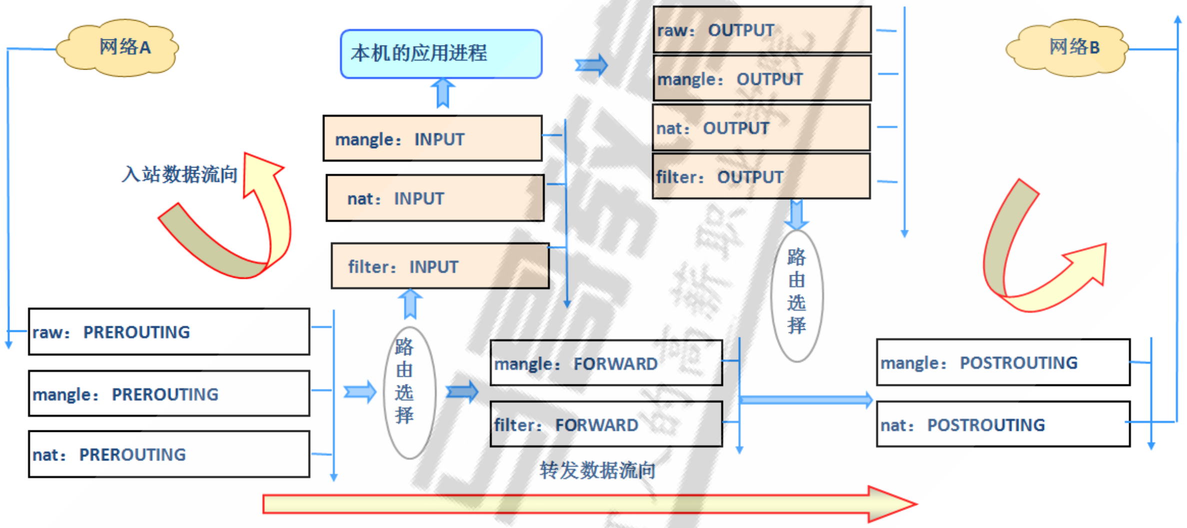
优先级由高到低的顺序为：

```
security -->raw-->mangle-->nat-->filter
```

表和链对应关系



数据包过滤匹配流程



内核中数据包的传输过程

- 当一个数据包进入网卡时，数据包首先进入PREROUTING链，内核根据数据包目的IP判断是否需要转送出去
- 如果数据包是进入本机的，数据包就会沿着图向下移动，到达INPUT链。数据包到达INPUT链后，任何进程都会收到它。本机上运行的程序可以发送数据包，这些数据包经过OUTPUT链，然后到达POSTROUTING链输出
- 如果数据包是要转发出去的，且内核允许转发，数据包就会向右移动，经过FORWARD链，然后到达POSTROUTING链输出

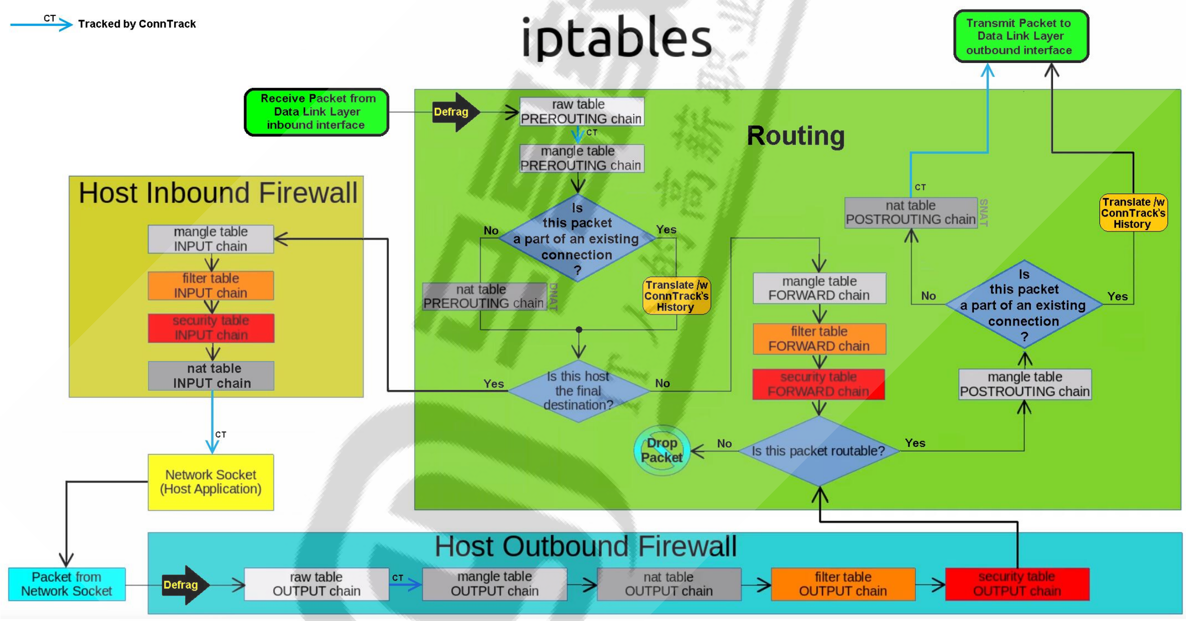
范例：

```
root@centos8 ~]#iptables -vnL -t filter
Chain INPUT (policy ACCEPT 0 packets, 0 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 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination

```

```
[root@centos8 ~]#iptables -vnL -t nat
Chain PREROUTING (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination

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

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

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


[root@centos8 ~]#iptables -vnL -t mangle
Chain PREROUTING (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination

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

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


[root@centos8 ~]#iptables -vnL -t raw
Chain PREROUTING (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination

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

[root@centos8 ~]#iptables -vnL -t security
Chain INPUT (policy ACCEPT 0 packets, 0 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 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination


#CentOS 6 nat表不支持INPUT链
[root@centos6 ~]#iptables -vnL -t nat
Chain PREROUTING (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination


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


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

2.5 netfilter 完整流程



CT Tracked by ConnTrack
iptables
Transmit Packet to Data Link Layer outbound interface
Receive Packet from Data Link Layer inbound interface
Defrag
raw table PREROUTING chain
CT
mangle table PREROUTING chain
Routing
Host Inbound Firewall
mangle table INPUT chain
filter table INPUT chain
security table INPUT chain
nat table INPUT chain
No
Is this packet a part of an existing connection ?
Yes
nat table PREROUTING chain
DNAT
Translate /w ConnTrack's History
CT
nat table POSTROUTING chain
SNAT
Translate /w ConnTrack's History
mangle table FORWARD chain
filter table FORWARD chain
security table FORWARD chain
No
Is this packet a part of an existing connection ?
Yes
mangle table POSTROUTING chain
Yes
Is this host the final destination?
No
Drop Packet
No
Is this packet routable?
Yes
CT
Network Socket (Host Application)
Host Outbound Firewall
Packet from Network Socket
Defrag
raw table OUTPUT chain
CT
mangle table OUTPUT chain
nat table OUTPUT chain
filter table OUTPUT chain
security table OUTPUT chain

3 iptables

3.1 iptables 规则说明

3.1.1 iptables 规则组成

规则rule：根据规则的匹配条件尝试匹配报文，对匹配成功的报文根据规则定义的处理动作作出处理，规则在链接上的次序即为其检查时的生效次序

匹配条件：默认为与条件，同时满足

基本匹配：IP，端口，TCP的Flags（SYN,ACK等）

扩展匹配：通过复杂高级功能匹配

处理动作：称为target，跳转目标

- 内建处理动作：ACCEPT,DROP,REJECT,SNAT,DNAT,MASQUERADE,MARK,LOG...
- 自定义处理动作：自定义chain，利用分类管理复杂情形

规则要添加在链上，才生效；添加在自定义链上不会自动生效

白名单:只有指定的特定主机可以访问,其它全拒绝

黑名单:只有指定的特定主机拒绝访问,其它全允许,默认方式

3.1.2 iptables规则添加时考量点

- 要实现哪种功能：判断添加在哪张表上
- 报文流经的路径：判断添加在哪个链上
- 报文的流向：判断源和目的
- 匹配规则：业务需要

3.1.3 本章学习环境准备

CentOS 7，8：

```
systemctl stop firewalld.service
systemctl disable  firewalld. service

#或者
systemctl disable --now  firewalld. service
```

CentOS 6：

```
service iptables stop
chkconfig iptables off
```

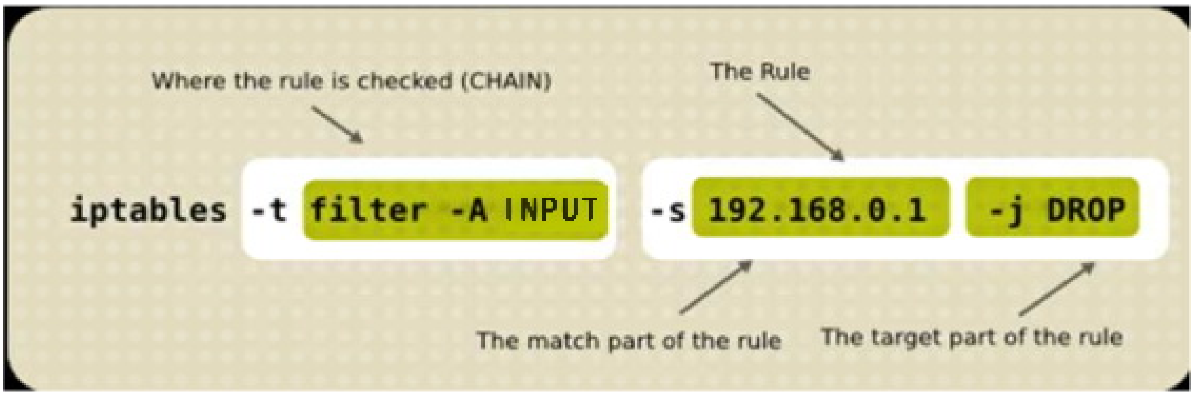
3.2 iptables 用法说明

帮助：man 8 iptables

格式：

```
iptables [-t table] {-A|-C|-D} chain rule-specification
iptables [-t table] -I chain [rulenum] rule-specification
iptables [-t table] -R chain rulenum rule-specification
iptables [-t table] -D chain rulenum
iptables [-t table] -S [chain [rulenum]]
iptables [-t table] {-F|-L|-Z} [chain [rulenum]] [options...]
iptables [-t table] -N chain
iptables [-t table] -X  [chain]
iptables [-t table] -P chain target
iptables [-t table] -E old-chain-name new-chain-name

rule-specification = [matches...]  [target]
match = -m matchname [per-match-options]
target = -j targetname [per-target-options]
```

范例：Filter表中INPUT规则


Where the rule is checked (CHAIN)
The Rule
iptables -t filter -A INPUT -s 192.168.0.1 -j DROP
The match part of the rule
The target part of the rule

iptables命令格式详解：

```
iptables   [-t table]   SUBCOMMAND   chain   [-m matchname [per-match-options]]
-j targetname [per-target-options]
```

1、-t table：指定表

raw, mangle, nat, [filter]默认

2、SUBCOMMAND：子命令

链管理类：

```
-N：new，自定义一条新的规则链
-E：重命名自定义链；引用计数不为0的自定义链不能够被重命名，也不能被删除
-X：delete，删除自定义的空的规则链

-P：Policy，设置默认策略；对filter表中的链而言，其默认策略有：ACCEPT：接受，DROP：丢弃
```

范例：自定义链

```
[root@centos8 ~]#iptables -N web_chain
[root@centos8 ~]#iptables -N web_chain -t nat
[root@centos8 ~]#iptables -X web_chain -t nat
[root@centos8 ~]#iptables -E web_chain WEB_CHAIN
[root@centos8 ~]#iptables -A WEB_CHAIN -s 10.0.0.6 -p tcp -m multiport  --dports
80,443 -j REJECT
[root@centos8 ~]#iptables -R WEB_CHAIN 1  -s 10.0.0.6 -p tcp -m multiport  --
dports 80,443,8080 -j REJECT
[root@centos8 ~]#iptables -vnL  WEB_CHAIN
Chain WEB_CHAIN (1 references)
 pkts bytes target     prot opt in     out     source               destination

    1    60 REJECT     tcp  --  *      *       10.0.0.6             0.0.0.0/0
         multiport dports 80,443,8080 reject-with icmp-port-unreachable

[root@centos8 ~]#iptables -AINPUT -j WEB_CHAIN
[root@centos8 ~]#iptables -X WEB_CHAIN
iptables v1.8.2 (nf_tables):  CHAIN_USER_DEL failed (Device or resource busy):
chain WEB_CHAIN
[root@centos8 ~]#iptables -F  WEB_CHAIN
[root@centos8 ~]#iptables -X WEB_CHAIN
iptables v1.8.2 (nf_tables):  CHAIN_USER_DEL failed (Device or resource busy):
chain WEB_CHAIN
```

```
[root@centos8 ~]#iptables -D INPUT 1
[root@centos8 ~]#iptables -X WEB_CHAIN
```

范例: 创建自定义链实现WEB的访问控制

```
[root@centos8 ~]#iptables -N web_chain
[root@centos8 ~]#iptables -E web_chain  WEB_CHAIN
[root@centos8 ~]#iptables -A WEB_CHAIN  -p tcp -m multiport --dports 80,443,8080
-j ACCEPT
[root@centos8 ~]#iptables -IINPUT 3 -s 10.0.0.0/24 -j WEB_CHAIN
[root@centos8 ~]#iptables -AWEB_CHAIN -p icmp -j ACCEPT
[root@centos8 ~]#iptables -IWEB_CHAIN 2 -s 10.0.0.6 -j RETURN

[root@centos8 ~]#iptables -vnL --line-numbers
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
1       10   867 ACCEPT     all  --  lo     *       0.0.0.0/0
 0.0.0.0/0
2     5637  423K ACCEPT     all  --  *      *       10.0.0.1
0.0.0.0/0
3      248 20427 WEB_CHAIN  all  --  *      *       10.0.0.0/24
 0.0.0.0/0
4     4278  248K REJECT     all  --  *      *       0.0.0.0/0
 0.0.0.0/0            reject-with icmp-port-unreachable

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

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

Chain WEB_CHAIN (1 references)
num   pkts bytes target     prot opt in     out     source
destination
1       36  2619 ACCEPT     tcp  --  *      *       0.0.0.0/0
 0.0.0.0/0            multiport dports 80,443,8080
2       16  1344 RETURN     all  --  *      *       10.0.0.6
0.0.0.0/0
3      184 15456 ACCEPT     icmp --  *      *       0.0.0.0/0
 0.0.0.0/0



[root@centos6 ~]#curl  10.0.0.8
centos8 website
[root@centos6 ~]#curl  10.0.0.8
centos8 website
[root@centos6 ~]#ping -c1 10.0.0.8
PING 10.0.0.8 (10.0.0.8) 56(84) bytes of data.
From 10.0.0.8 icmp_seq=1 Destination Port Unreachable

--- 10.0.0.8 ping statistics ---
1 packets transmitted, 0 received, +1 errors, 100% packet loss, time 1ms
```

```
[root@centos7 ~]#ping 10.0.0.8 -c1
PING 10.0.0.8 (10.0.0.8) 56(84) bytes of data.
64 bytes from 10.0.0.8: icmp_seq=1 ttl=64 time=1.25 ms

--- 10.0.0.8 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.257/1.257/1.257/0.000 ms
[root@centos7 ~]#curl  10.0.0.8
centos8 website
```

范例: 删除自定义链

```
#无法直接删除自定义链,删除自定议链和创建的顺序相反
[root@centos8 ~]#iptables -X WEB_CHAIN
iptables v1.8.4 (nf_tables):  CHAIN_USER_DEL failed (Device or resource busy):
chain WEB_CHAIN


[root@centos8 ~]#iptables -D INPUT 3
[root@centos8 ~]#iptables -X WEB_CHAIN
iptables v1.8.4 (nf_tables):  CHAIN_USER_DEL failed (Device or resource busy):
chain WEB_CHAIN

[root@centos8 ~]#iptables -F WEB_CHAIN
[root@centos8 ~]#iptables -L  WEB_CHAIN
Chain WEB_CHAIN (0 references)
target     prot opt source               destination

[root@centos8 ~]#iptables -X WEB_CHAIN
[root@centos8 ~]#iptables -vnL --line-numbers
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
1       10   867 ACCEPT     all  --  lo     *       0.0.0.0/0
 0.0.0.0/0
2     5824  437K ACCEPT     all  --  *      *       10.0.0.1
0.0.0.0/0
3     4279  248K REJECT     all  --  *      *       0.0.0.0/0
 0.0.0.0/0            reject-with icmp-port-unreachable

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

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

查看类:

```
-L：list，列出指定鏈上的所有规则，本选项须置后
-n：numberic，以数字格式显示地址和端口号
-v：verbose，详细信息
-vv  更详细
-x：exactly，显示计数器结果的精确值,而非单位转换后的易读值
--line-numbers：显示规则的序号
-S  selected,以iptables-save 命令格式显示链上规则
```

常用组合：

```
-vnL
-vvnxL --line-numbers
```

规则管理类：

```
-A：append，追加
-I：insert，插入，要指明插入至的规则编号，默认为第一条
-D：delete，删除
        (1) 指明规则序号
        (2) 指明规则本身
-R：replace，替换指定链上的指定规则编号
-F：flush，清空指定的规则链
-Z：zero，置零
        iptables的每条规则都有两个计数器
         (1) 匹配到的报文的个数
         (2) 匹配到的所有报文的大小之和
```

范例：

```
[root@centos8 ~]#iptables -F OUTPUT
```

3、chain：

PREROUTING，INPUT，FORWARD，OUTPUT，POSTROUTING

4、匹配条件

- 基本：通用的，PARAMETERS
- 扩展：需加载模块，MATCH EXTENTIONS

5、处理动作：

```
-j targetname [per-target-options]
```

简单动作：

```
ACCEPT
DROP
```

扩展动作：

```
REJECT：--reject-with:icmp-port-unreachable默认
RETURN：返回调用链
REDIRECT：端口重定向
LOG：记录日志，dmesg
MARK：做防火墙标记
DNAT：目标地址转换
SNAT：源地址转换
MASQUERADE：地址伪装
自定义链
```

3.3 iptables 基本匹配条件

基本匹配条件：无需加载模块，由iptables/netfilter自行提供

```
[!] -s, --source  address[/mask][,...]：源IP地址或者不连续的IP地址
[!] -d, --destination address[/mask][,...]：目标IP地址或者不连续的IP地址
[!] -p, --protocol protocol：指定协议，可使用数字如0（all）
    protocol: tcp, udp, icmp, icmpv6, udplite,esp, ah, sctp, mh or"all"
    参看：/etc/protocols
[!] -i, --in-interface name：报文流入的接口；只能应用于数据报文流入环节，只应用于INPUT、
FORWARD、PREROUTING链
[!] -o, --out-interface name：报文流出的接口；只能应用于数据报文流出的环节，只应用于
FORWARD、OUTPUT、POSTROUTING链
```

范例：

```
[root@centos8 ~]#iptables -A INPUT -s 10.0.0.6,10.0.0.10 -j REJECT
[root@centos8 ~]#iptables -I INPUT -i lo -j ACCEPT
[root@centos8 ~]#curl 127.0.0.1
10.0.0.8
[root@centos8 ~]#curl 10.0.0.8
10.0.0.8

[root@centos8 ~]#iptables -I  INPUT 2 -s 10.0.0.6  ! -p icmp -j ACCEPT
```

3.4 iptables 扩展匹配条件

扩展匹配条件：需要加载扩展模块（/usr/lib64/xtables/*.so），方可生效
扩展模块的查看帮助 ：man iptables-extensions

扩展匹配条件：

- 隐式扩展
- 显式扩展

3.4.1 隐式扩展

iptables 在使用-p选项指明了特定的协议时，无需再用-m选项指明扩展模块的扩展机制，不需要手动加载扩展模块

tcp 协议的扩展选项

```
[!] --source-port, --sport port[:port]：匹配报文源端口,可为端口连续范围
[!] --destination-port,--dport port[:port]：匹配报文目标端口,可为连续范围
[!] --tcp-flags  mask  comp
     mask 需检查的标志位列表，用,分隔 , 例如 SYN,ACK,FIN,RST
     comp 在mask列表中必须为1的标志位列表，无指定则必须为0，用,分隔tcp协议的扩展选项
```

范例：

```
--tcp-flags  SYN,ACK,FIN,RST  SYN     #表示要检查的标志位为SYN,ACK,FIN,RST四个，其中
SYN必须为1，余下的必须为0，第一次握手
--tcp-flags  SYN,ACK,FIN,RST  SYN,ACK  #第二次握手

#错误包
--tcp-flags ALL ALL
--tcp_flags ALL NONE
```

[!] --syn：用于匹配第一次握手, 相当于：--tcp-flags SYN,ACK,FIN,RST SYN

udp 协议的扩展选项

```
[!] --source-port, --sport port[:port]：匹配报文的源端口或端口范围
[!] --destination-port,--dport port[:port]：匹配报文的目标端口或端口范围
```

icmp 协议的扩展选项

```
[!] --icmp-type {type[/code]|typename}
      type/code
        0/0   echo-reply        icmp应答
        8/0   echo-request      icmp请求
```

范例：

```
[root@centos8 ~]#iptables -A INPUT -s 10.0.0.6 -p tcp --dport 21:23 -j REJECT
[root@centos8 ~]#ipn
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
1        1    60 REJECT     tcp  --  *      *       10.0.0.6
0.0.0.0/0            tcp dpts:21:23 reject-with icmp-port-unreachable

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

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

范例：

```
[root@centos8 ~]#iptables -A INPUT  -p tcp --syn  -j REJECT
```

范例：

```
[root@centos8 ~]#iptables -A INPUT -s 10.0.0.6 -p icmp --icmp-type 8 -j REJECT
```

3.4.2 显式扩展及相关模块

显示扩展即必须使用-m选项指明要调用的扩展模块名称，需要手动加载扩展模块

```
 [-m matchname [per-match-options]]
```

扩展模块的使用帮助：

- CentOS 7,8: man iptables-extensions
- CentOS 6: man iptables

3.4.2.1 multiport扩展

以离散方式定义多端口匹配,最多指定15个端口

```
#指定多个源端口
[!] --source-ports,--sports port[,port|,port:port]...

# 指定多个目标端口
[!] --destination-ports,--dports port[,port|,port:port]...

#多个源或目标端
[!] --ports port[,port|,port:port]...
```

范例：

```
[root@centos8 ~]#iptables -A INPUT -s 172.16.0.0/16 -d 172.16.100.10 -p tcp -m
multiport --dports 20:22,80 -j ACCEPT


[root@centos8 ~]#iptables -A INPUT -s 10.0.0.6 -p tcp -m multiport --dports
445,139 -j REJECT
[root@centos8 ~]#ipn
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
1        2   120 REJECT     tcp  --  *      *       10.0.0.6
0.0.0.0/0            multiport dports 445,139 reject-with icmp-port-unreachable

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

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

3.4.2.2 iprange扩展

指明连续的（但一般不是整个网络）ip地址范围

```
[!] --src-range from[-to]   源IP地址范围
[!] --dst-range from[-to]   目标IP地址范围
```

范例：

```
iptables -A INPUT -d 172.16.1.100 -p tcp --dport 80 -m iprange --src-range
172.16.1.5-172.16.1.10 -j DROP
```

3.4.2.3 mac扩展

mac 模块可以指明源MAC地址,，适用于：PREROUTING, FORWARD，INPUT chains

```
[!] --mac-source XX:XX:XX:XX:XX:XX
```

范例：

```
iptables -A INPUT -s 172.16.0.100 -m mac  --mac-source  00:50:56:12:34:56 -j
ACCEPT
iptables -A INPUT -s 172.16.0.100  -j REJECT
```

3.4.2.4 string扩展

对报文中的应用层数据做字符串模式匹配检测

```
--algo {bm|kmp} 字符串匹配检测算法
    bm：Boyer-Moore
    kmp：Knuth-Pratt-Morris
--from offset       开始偏移
--to offset         结束偏移
[!] --string pattern    要检测的字符串模式
[!] --hex-string pattern 要检测字符串模式，16进制格式
```

范例：

```
iptables -A OUTPUT -p tcp --sport 80 -m string --algo kmp --from 62  --string
"google" -j REJECT
iptables -A OUTPUT -p tcp --sport 80 -m string --algo bm --from 62  --string
"google" -j REJECT #此算法有bug
```

3.4.2.5 time扩展

注意：CentOS 8 此模块有问题

根据将报文到达的时间与指定的时间范围进行匹配

```
--datestart YYYY[-MM[-DD[Thh[:mm[:ss]]]]]  日期
--datestop YYYY[-MM[-DD[Thh[:mm[:ss]]]]]
--timestart hh:mm[:ss]        时间
--timestop hh:mm[:ss]
[!] --monthdays day[,day...]   每个月的几号
[!] --weekdays day[,day...]   星期几，1 – 7 分别表示星期一到星期日
--kerneltz：内核时区（当地时间），不建议使用，CentOS 7版本以上系统默认为 UTC
注意： centos6 不支持kerneltz ，--localtz指定本地时区(默认)
```

范例: CentOS 8 的 time模块问题

```
[root@centos8 ~]#rpm -ql iptables  |grep time
/usr/lib64/xtables/libxt_time.so

[root@centos8 ~]#iptables -A INPUT -m time --timestart 12:30 --timestop 13:30 -j ACCEPT
iptables v1.8.4 (nf_tables): Couldn't load match `time':No such file or directory
```

范例: 关于 -- kerneltz 选项

```
[root@centos8 ~]#man iptables-extensions
The caveat with the kernel timezone is that Linux distributions may ignore to
set the kernel timezone,and instead only set the system time. Even if a
particular distribution does set the timezone at boot,it  is  usually  does not
keep the kernel timezone offset - which is what changes on DST - up to date.
ntpd will not touch the kernel timezone, so running it will not resolve the
issue. As such,one  may   encounter a timezone that is always +0000, or one that
is wrong half of the time of the year. As such,using --kerneltz is highly
discouraged.
```

范例:

```
[root@centos7 ~]#iptables -A INPUT -s 172.16.0.0/16 -d 172.16.100.10 -p tcp --dport 80 -m time --timestart 14:30 --timestop 18:30 --weekdays Sat,Sun --kerneltz -j DROP
```

3.4.2.6 connlimit扩展

根据每客户端IP做并发连接数数量匹配

可防止Dos(Denial of Service，拒绝服务)攻击

```
--connlimit-upto  N     #连接的数量小于等于N时匹配
--connlimit-above N     #连接的数量大于N时匹配
```

范例:

```
iptables -A INPUT  -p tcp --dport 80 -m connlimit --connlimit-above 2 -j REJECT
iptables -A INPUT -d 172.16.100.10 -p tcp --dport 22 -m connlimit --connlimit-above 2 -j REJECT
```

3.4.2.7 limit扩展

基于收发报文的速率做匹配，令牌桶过滤器

```
--limit-burst number     #前多少个包不限制
--limit #[/second|/minute|/hour|/day]
```

范例：

```
iptables -I INPUT -d 172.16.100.10 -p icmp --icmp-type 8 -m limit --limit
10/minute --limit-burst 5 -j ACCEPT
iptables -I INPUT 2 -p icmp -j REJECT
```

范例：

```
[root@centos8 ~]#iptables -A INPUT -p icmp -m limit --limit-burst 10 --limit
20/minute -j ACCEPT
[root@centos8 ~]#iptables -A INPUT -p icmp  -j REJECT

[root@centos6 ~]#ping 10.0.0.8
PING 192.168.39.8 (192.168.39.8) 56(84) bytes of data.
64 bytes from 192.168.39.8: icmp_seq=1 ttl=64 time=0.779 ms
64 bytes from 192.168.39.8: icmp_seq=2 ttl=64 time=0.436 ms
64 bytes from 192.168.39.8: icmp_seq=3 ttl=64 time=0.774 ms
64 bytes from 192.168.39.8: icmp_seq=4 ttl=64 time=0.391 ms
64 bytes from 192.168.39.8: icmp_seq=5 ttl=64 time=0.441 ms
64 bytes from 192.168.39.8: icmp_seq=6 ttl=64 time=0.356 ms
64 bytes from 192.168.39.8: icmp_seq=7 ttl=64 time=0.553 ms
64 bytes from 192.168.39.8: icmp_seq=8 ttl=64 time=0.458 ms
64 bytes from 192.168.39.8: icmp_seq=9 ttl=64 time=0.459 ms
64 bytes from 192.168.39.8: icmp_seq=10 ttl=64 time=0.479 ms
64 bytes from 192.168.39.8: icmp_seq=11 ttl=64 time=0.450 ms
64 bytes from 192.168.39.8: icmp_seq=12 ttl=64 time=0.471 ms
64 bytes from 192.168.39.8: icmp_seq=13 ttl=64 time=0.531 ms
64 bytes from 192.168.39.8: icmp_seq=14 ttl=64 time=0.444 ms
From 192.168.39.8 icmp_seq=15 Destination Port Unreachable
64 bytes from 192.168.39.8: icmp_seq=16 ttl=64 time=0.668 ms
From 192.168.39.8 icmp_seq=17 Destination Port Unreachable
From 192.168.39.8 icmp_seq=18 Destination Port Unreachable
64 bytes from 192.168.39.8: icmp_seq=19 ttl=64 time=0.692 ms
From 192.168.39.8 icmp_seq=20 Destination Port Unreachable
From 192.168.39.8 icmp_seq=21 Destination Port Unreachable
64 bytes from 192.168.39.8: icmp_seq=22 ttl=64 time=0.651 ms
```

3.4.2.8 state扩展

state 扩展模块，可以根据"连接追踪机制"去检查连接的状态，较耗资源

conntrack机制：追踪本机上的请求和响应之间的关系

状态类型：

- NEW：新发出请求；连接追踪信息库中不存在此连接的相关信息条目，因此，将其识别为第一次发出的请求
- ESTABLISHED：NEW状态之后，连接追踪信息库中为其建立的条目失效之前期间内所进行的通信状态

- RELATED：新发起的但与已有连接相关联的连接，如：ftp协议中的数据连接与命令连接之间的关系
- INVALID：无效的连接，如flag标记不正确
- UNTRACKED：未进行追踪的连接，如：raw表中关闭追踪

已经追踪到的并记录下来的连接信息库

```
[root@centos8 ~]#cat /proc/net/nf_conntrack
ipv4     2 tcp      6 431325 ESTABLISHED src=10.0.0.7 dst=10.0.0.8 sport=49900 dport=80 src=10.0.0.8 dst=10.0.0.7 sport=80 dport=49900 [ASSURED] mark=0 zone=0 use=2
ipv4     2 tcp      6 431325 ESTABLISHED src=10.0.0.7 dst=10.0.0.8 sport=49886 dport=80 src=10.0.0.8 dst=10.0.0.7 sport=80 dport=49886 [ASSURED] mark=0 zone=0 use=2
ipv4     2 tcp      6 431325 ESTABLISHED src=10.0.0.7 dst=10.0.0.8 sport=49892 dport=80 src=10.0.0.8 dst=10.0.0.7 sport=80 dport=49892 [ASSURED] mark=0 zone=0 use=2
ipv4     2 tcp      6 431325 ESTABLISHED src=10.0.0.7 dst=10.0.0.8 sport=49904 dport=80 src=10.0.0.8 dst=10.0.0.7 sport=80 dport=49904 [ASSURED] mark=0 zone=0 use=2
ipv4     2 tcp      6 431325 ESTABLISHED src=10.0.0.7 dst=10.0.0.8 sport=49890 dport=80 src=10.0.0.8 dst=10.0.0.7 sport=80 dport=49890 [ASSURED] mark=0 zone=0 use=2
ipv4     2 tcp      6 431325 ESTABLISHED src=10.0.0.7 dst=10.0.0.8 sport=49888 dport=80 src=10.0.0.8 dst=10.0.0.7 sport=80 dport=49888 [ASSURED] mark=0 zone=0 use=2
ipv4     2 tcp      6 431325 ESTABLISHED src=10.0.0.7 dst=10.0.0.8 sport=49896 dport=80 src=10.0.0.8 dst=10.0.0.7 sport=80 dport=49896 [ASSURED] mark=0 zone=0 use=2
ipv4     2 tcp      6 431325 ESTABLISHED src=10.0.0.7 dst=10.0.0.8 sport=49898 dport=80 src=10.0.0.8 dst=10.0.0.7 sport=80 dport=49898 [ASSURED] mark=0 zone=0 use=2
ipv4     2 tcp      6 431325 ESTABLISHED src=10.0.0.7 dst=10.0.0.8 sport=49894 dport=80 src=10.0.0.8 dst=10.0.0.7 sport=80 dport=49894 [ASSURED] mark=0 zone=0 use=2
ipv4     2 tcp      6 431325 ESTABLISHED src=10.0.0.7 dst=10.0.0.8 sport=49902 dport=80 src=10.0.0.8 dst=10.0.0.7 sport=80 dport=49902 [ASSURED] mark=0 zone=0 use=2
```

调整连接追踪功能所能够容纳的最大连接数量

```
[root@centos8 ~]#cat /proc/sys/net/netfilter/nf_conntrack_max
26624
[root@centos8 ~]#cat /proc/sys/net/nf_conntrack_max
26624
```

查看连接跟踪有多少条目

```
[root@centos8 ~]#cat /proc/sys/net/netfilter/nf_conntrack_count
10
```

不同的协议的连接追踪时长

```
[root@centos8 ~]#ll /proc/sys/net/netfilter/
total 0
```

```
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_acct
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_buckets
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_checksum
-r--r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_count
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_dccp_loose
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_dccp_timeout_closereq
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_dccp_timeout_closing
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_dccp_timeout_open
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_dccp_timeout_partopen
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_dccp_timeout_request
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_dccp_timeout_respond
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_dccp_timeout_timewait
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_events
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_expect_max
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_generic_timeout
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_helper
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_icmp_timeout
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_log_invalid
-rw-r--r-- 1 root root 0 Mar 19 18:13 nf_conntrack_max
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_sctp_timeout_closed
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_sctp_timeout_cookie_echoed
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_sctp_timeout_cookie_wait
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_sctp_timeout_established
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_sctp_timeout_heartbeat_acked
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_sctp_timeout_heartbeat_sent
-rw-r--r-- 1 root root 0 Mar 19 18:14
nf_conntrack_sctp_timeout_shutdown_ack_sent
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_sctp_timeout_shutdown_recd
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_sctp_timeout_shutdown_sent
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_be_liberal
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_loose
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_max_retrans
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_timeout_close
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_timeout_close_wait
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_timeout_established
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_timeout_fin_wait
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_timeout_last_ack
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_timeout_max_retrans
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_timeout_syn_recv
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_timeout_syn_sent
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_timeout_time_wait
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_tcp_timeout_unacknowledged
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_timestamp
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_udp_timeout
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_conntrack_udp_timeout_stream
dr-xr-xr-x 1 root root 0 Mar 19 18:14 nf_log
-rw-r--r-- 1 root root 0 Mar 19 18:14 nf_log_all_netns
```

说明:

- 连接跟踪，需要加载模块： modprobe nf_conntrack_ipv4
- 当服务器连接多于最大连接数时dmesg 可以观察到 ： kernel: ip_conntrack: table full, dropping packet错误,并且导致建立TCP连接很慢。
- 各种状态的超时后，链接会从表中删除

范例: 面试题

```
[root@centos8 ~]#echo 1 > /proc/sys/net/netfilter/nf_conntrack_max
[root@centos8 ~]#tail /var/log/messages
Jul  8 10:03:53 centos8 kernel: nf_conntrack: nf_conntrack: table full, dropping packet

[root@centos6 ~]#tail /var/log/messages
Jul  8 09:51:16 centos6 kernel: nf_conntrack: table full, dropping packet.
```

连接过多的解决方法两个：

(1) 加大nf_conntrack_max 值

```
vi /etc/sysctl.conf
net.nf_conntrack_max = 393216
net.netfilter.nf_conntrack_max = 393216
```

(2) 降低 nf_conntrack timeout时间

```
vi /etc/sysctl.conf
net.netfilter.nf_conntrack_tcp_timeout_established = 300
net.netfilter.nf_conntrack_tcp_timeout_time_wait = 120
net.netfilter.nf_conntrack_tcp_timeout_close_wait = 60
net.netfilter.nf_conntrack_tcp_timeout_fin_wait = 120
iptables -t nat -L -n
```

格式：

```
[!] --state state
```

范例: 不允许远程主机 10.0.0.7 访问本机,但本机可以访问10.0.0.7

```
[root@centos8 ~]#iptables -S
-P INPUT ACCEPT
-P FORWARD ACCEPT
-P OUTPUT ACCEPT
-A INPUT -s 10.0.0.1/32 -j ACCEPT
-A INPUT -m state --state ESTABLISHED -j ACCEPT
-A INPUT ! -s 10.0.0.7/32 -m state --state NEW -j ACCEPT
-A INPUT -j REJECT --reject-with icmp-port-unreachable
```

范例：

```
iptables -A INPUT -d 172.16.1.10 -p tcp -m multiport --dports 22,80 -m state --state NEW,ESTABLISHED -j ACCEPT
iptables -A OUTPUT -s 172.16.1.10 -p tcp -m multiport --sports 22,80 -m state --state ESTABLISHED -j ACCEPT


[root@centos8 ~]#iptables -A INPUT  -m state --state ESTABLISHED -j ACCEPT #此条规则必须在NEW规则前面
[root@centos8 ~]#iptables -A INPUT  -m state --state NEW -j REJECT
```

案例：开放被动模式的ftp服务

CentOS 8 此模块有bug

(1) 装载ftp连接追踪的专用模块：
  跟踪模块路径：`/lib/modules/kernelversion/kernel/net/netfilter`

```
vim /etc/sysconfig/iptables-config
IPTABLES_MODULES=“nf_conntrack_ftp"
modprobe  nf_conntrack_ftp
```

(2) 放行请求报文：
  命令连接：NEW, ESTABLISHED
  数据连接：RELATED, ESTABLISHED

```
iptables -I INPUT -d LocalIP -p tcp -m state --state ESTABLISHED,RELATED -j
ACCEPT
iptables -A INPUT -d LocalIP -p tcp --dport 21 -m state --state NEW -j ACCEPT
```

(3) 放行响应报文：

```
iptables -I OUTPUT -s LocalIP -p tcp -m state --state ESTABLISHED -j ACCEPT
```

范例：开放被动模式的ftp服务示例

```
yum install vsftpd
systemctl start vsftpd
modprobe nf_conntrack_ftp
iptables -F
iptables -A INPUT   -m state --state ESTABLISHED,RELATED -j ACCEPT
iptables -A INPUT -p tcp --dport 21 -m state --state NEW -j ACCEPT
iptables -A OUTPUT  -m state --state ESTABLISHED -j ACCEPT
iptables -P INPUT DROP
iptables -P OUTPUT DROP
iptables -vnL
```

3.5 Target

target 包括以下类型：

```
自定义链, ACCEPT,  DROP,  REJECT，RETURN,LOG，SNAT，DNAT，REDIRECT，MASQUERADE

LOG：非中断target,本身不拒绝和允许,放在拒绝和允许规则前，并将日志记录在/var/log/messages系
统日志中
--log-level level     级别： debug，info，notice，warning，error，crit，alert,emerg
--log-prefix prefix 日志前缀，用于区别不同的日志，最多29个字符
```

范例：

```
[root@centos8 ~]#iptables -I INPUT  -s 10.0.0.0/24 -p tcp -m multiport --dports
80,21,22,23 -m state --state NEW -j LOG --log-prefix "new connections: "

[root@centos8 ~]#tail -f /var/log/messages
Mar 19 18:41:07 centos8 kernel: iptables tcp connection: IN=eth0 OUT=
MAC=00:0c:29:f8:5d:b7:00:50:56:c0:00:08:08:00 SRC=10.0.0.1 DST=10.0.0.8 LEN=40
TOS=0x00 PREC=0x00 TTL=128 ID=43974 DF PROTO=TCP SPT=9844 DPT=22 WINDOW=4102
RES=0x00 ACK URGP=0
Mar 19 18:41:07 centos8 kernel: new connections: IN=eth0 OUT=
MAC=00:0c:29:f8:5d:b7:00:50:56:c0:00:08:08:00 SRC=10.0.0.1 DST=10.0.0.8 LEN=40
TOS=0x00 PREC=0x00 TTL=128 ID=43975 DF PROTO=TCP SPT=9844 DPT=22 WINDOW=4102
RES=0x00 ACK URGP=0
Mar 19 18:41:08 centos8 kernel: new connections: IN=eth0 OUT=
```

范例：

```
[root@centos8 ~]#iptables -R INPUT 2 -p tcp --dport 21 -m state --state NEW -j
LOG --log-prefix "ftp new link: "

[root@centos8 ~]#tail -f /var/log/messages
Dec 21 10:02:31 centos8 kernel: ftp new link: IN=eth0 OUT=
MAC=00:0c:29:f9:8d:90:00:0c:29:10:8a:b1:08:00 SRC=192.168.39.6 DST=192.168.39.8
LEN=60 TOS=0x00 PREC=0x00 TTL=64 ID=15556 DF PROTO=TCP SPT=53706 DPT=21
WINDOW=14600 RES=0x00 SYN URGP=0
```

3.6 规则优化最佳实践

1. 安全放行所有入站和出站的状态为ESTABLISHED状态连接,建议放在第一条，效率更高
2. 谨慎放行入站的新请求
3. 有特殊目的限制访问功能，要在放行规则之前加以拒绝
4. 同类规则（访问同一应用，比如：http ），匹配范围小的放在前面，用于特殊处理
5. 不同类的规则（访问不同应用，一个是http，另一个是mysql ），匹配范围大的放在前面，效率更高

   ```
   -s 10.0.0.6 -p tcp --dport 3306  -j REJECT
   -s 172.16.0.0/16 -p tcp --dport 80  -j REJECT
   ```

6. 应该将那些可由一条规则能够描述的多个规则合并为一条,减少规则数量,提高检查效率
7. 设置默认策略，建议白名单（只放行特定连接）
   - iptables -P，不建议，容易出现“自杀现象”
   - 规则的最后定义规则做为默认策略，推荐使用，放在最后一条

3.7 iptables规则保存

使用iptables命令定义的规则，手动删除之前，其生效期限为kernel存活期限

持久保存规则：

CentOS 7,8

```
iptables-save  >  /PATH/TO/SOME_RULES_FILE
```

CentOS 6

```
#将规则覆盖保存至/etc/sysconfig/iptables文件中
service  iptables  save
```

加载规则

CentOS 7,8 重新载入预存规则文件中规则：

```
iptables-restore <  /PATH/FROM/SOME_RULES_FILE
```

iptables-restore选项

```
-n, --noflush：不清除原有规则
-t, --test：仅分析生成规则集，但不提交
```

CentOS 6：

```
#会自动从/etc/sysconfig/iptables 重新载入规则
service  iptables  restart
```

开机自动重载规则

- 用脚本保存各个iptables命令；让此脚本开机后自动运行

  /etc/rc.d/rc.local文件中添加脚本路径 /PATH/TO/SOME_SCRIPT_FILE
- 用规则文件保存各个规则，开机时自动载入此规则文件中的规则

  在/etc/rc.d/rc.local文件添加

  ```
  iptables-restore < /PATH/FROM/IPTABLES_RULES_FILE
  ```
- 定义Unit File, CentOS 7，8 可以安装 iptables-services 实现iptables.service

  范例：CentOS 7，8 使用 iptables-services

  ```
  [root@centos8 ~]#yum  -y install iptables-services
  [root@centos8 ~]#cp /etc/sysconfig/iptables{,.bak}

  #保存现在的规则到文件中方法1
  [root@centos8 ~]#/usr/libexec/iptables/iptables.init save

  #保存现在的规则到文件中方法2
  [root@centos8 ~]#iptables-save > /etc/sysconfig/iptables

  #开机启动
  [root@centos8 ~]#systemctl enable iptables.service
  [root@centos8 ~]#systemctl mask firewalld.service nftables.service
  ```

3.8 网络防火墙

iptables/netfilter 利用filter表的FORWARD链,可以充当网络防火墙：

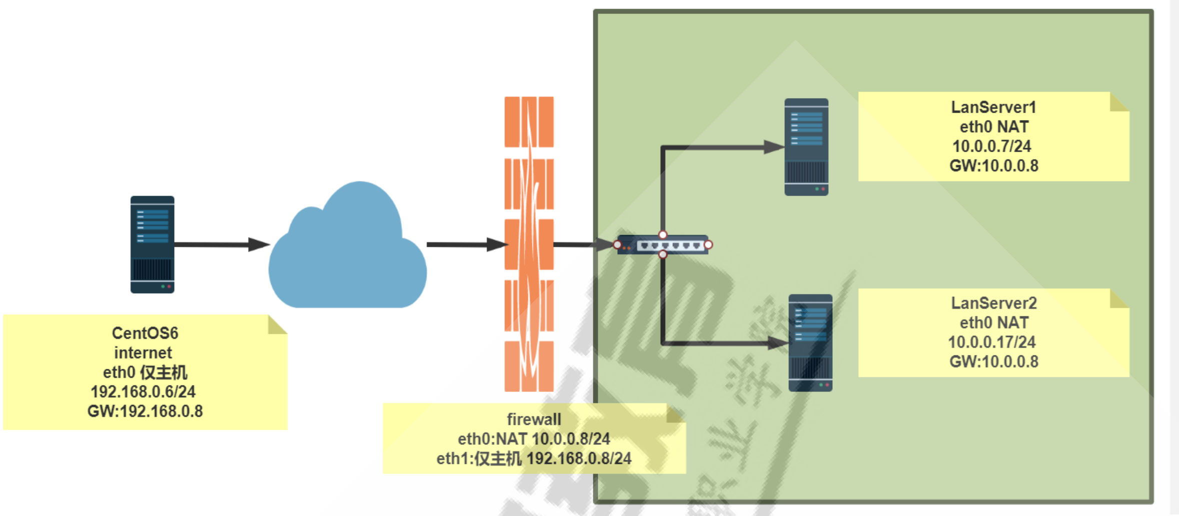
注意的问题：

(1) 请求-响应报文均会经由FORWARD链，要注意规则的方向性

(2) 如果要启用conntrack机制，建议将双方向的状态为ESTABLISHED的报文直接放行

3.8.1 FORWARD 链实现内外网络的流量控制

范例: 实现内网访问可以访问外网,反之禁止



```
#环境准备
[root@internet ~]#hostname  -I
192.168.0.6
[root@internet ~]#route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.0.0     0.0.0.0         255.255.255.0   U     0      0        0 eth0
169.254.0.0     0.0.0.0         255.255.0.0     U     1002   0        0 eth0
0.0.0.0         192.168.0.8     0.0.0.0         UG    0      0        0 eth0


[root@firewall ~]#hostname -I
10.0.0.8 192.168.0.8
[root@firewall ~]#vim /etc/sysctl.conf
net.ipv4.ip_forward=1
[root@firewall ~]#sysctl -p


[root@lanserver1 ~]#hostname -I
10.0.0.7
[root@lanserver1 ~]#route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         10.0.0.8        0.0.0.0         UG    100    0        0 eth0
10.0.0.0        0.0.0.0         255.255.255.0   U     100    0        0 eth0


[root@lanserver2 ~]#hostname -I
10.0.0.17
[root@lanserver2 ~]#route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
```

```
0.0.0.0         10.0.0.8        0.0.0.0         UG    100    0        0 eth0
10.0.0.0        0.0.0.0         255.255.255.0   U     100    0        0 eth0


#方法1 通过标准模块实现内网访问外网特定服务http和icmp,反之禁止
[root@firewall ~]#iptables -AFORWARD -j REJECT
[root@firewall ~]#iptables -IFORWARD -s 10.0.0.0/24  -p tcp --dport 80  -j
ACCEPT
[root@firewall ~]#iptables -IFORWARD -d 10.0.0.0/24  -p tcp --sport 80  -j
ACCEPT
[root@firewall ~]#iptables -I FORWARD   -s 10.0.0.0/24 -p icmp --icmp-type 8 -j
ACCEPT
[root@firewall ~]#iptables -I FORWARD   -d 10.0.0.0/24 -p icmp --icmp-type 0 -j
ACCEPT

[root@firewall ~]#iptables -vnL --line-numbers
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
1      174 14616 ACCEPT     icmp --  *      *       0.0.0.0/0
 10.0.0.0/24          icmptype 0
2      218 18312 ACCEPT     icmp --  *      *       10.0.0.0/24
 0.0.0.0/0            icmptype 8
3       10  1084 ACCEPT     tcp  --  *      *       0.0.0.0/0
 10.0.0.0/24          tcp spt:80
4       31  1938 ACCEPT     tcp  --  *      *       10.0.0.0/24
 0.0.0.0/0            tcp dpt:80
5      312 25632 REJECT     all  --  *      *       0.0.0.0/0
 0.0.0.0/0            reject-with icmp-port-unreachable

Chain OUTPUT (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
#方法2 利用state模块实现内网访问可以访问外网,反之禁止
[root@firewall ~]#iptables -DFORWARD 1
[root@firewall ~]#iptables -DFORWARD 2
[root@firewall ~]#iptables -vnL --line-numbers
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
1      342 28728 ACCEPT     icmp --  *      *       10.0.0.0/24
 0.0.0.0/0            icmptype 8
2       47  2898 ACCEPT     tcp  --  *      *       10.0.0.0/24
 0.0.0.0/0            tcp dpt:80
3      462 37608 REJECT     all  --  *      *       0.0.0.0/0
 0.0.0.0/0            reject-with icmp-port-unreachable

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

```
[root@firewall ~]#iptables -IFORWARD -m state --state RELATED,ESTABLISHED -j
ACCEPT
[root@firewall ~]#iptables -vnL --line-numbers
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
1       40  3429 ACCEPT     all  --  *      *       0.0.0.0/0
 0.0.0.0/0            state RELATED,ESTABLISHED
2      443 37212 ACCEPT     icmp --  *      *       10.0.0.0/24
 0.0.0.0/0            icmptype 8
3       49  3018 ACCEPT     tcp  --  *      *       10.0.0.0/24
 0.0.0.0/0            tcp dpt:80
4      563 46068 REJECT     all  --  *      *       0.0.0.0/0
 0.0.0.0/0            reject-with icmp-port-unreachable

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


[root@lanserver1 ~]#ping 192.168.0.6 -c1
PING 192.168.0.6 (192.168.0.6) 56(84) bytes of data.
64 bytes from 192.168.0.6: icmp_seq=1 ttl=63 time=2.20 ms

[root@lanserver2 ~]#curl 192.168.0.6
internet

[root@internet ~]#ping 10.0.0.7 -c1
PING 10.0.0.7 (10.0.0.7) 56(84) bytes of data.
From 192.168.0.8 icmp_seq=1 Destination Port Unreachable

[root@internet ~]#curl 10.0.0.7
curl: (7) couldn't connect to host


#利用state模块实现允许内网可以访问外网所有资源
[root@firewall ~]#iptables -DFORWARD 2
[root@firewall ~]#iptables -DFORWARD 2
[root@firewall ~]#iptables -IFORWARD 2 -s 10.0.0.0/24 -m state --state NEW  -j
ACCEPT
[root@firewall ~]#iptables -vnL --line-numbers
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
1      134 15209 ACCEPT     all  --  *      *       0.0.0.0/0
 0.0.0.0/0            state RELATED,ESTABLISHED
2        3   204 ACCEPT     all  --  *      *       10.0.0.0/24
 0.0.0.0/0            state NEW
```

```
3      572 46680 REJECT     all  --  *      *       0.0.0.0/0
 0.0.0.0/0            reject-with icmp-port-unreachable

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


[root@lanserver1 ~]#ping 192.168.0.6 -c1
PING 192.168.0.6 (192.168.0.6) 56(84) bytes of data.
64 bytes from 192.168.0.6: icmp_seq=1 ttl=63 time=2.26 ms

[root@lanserver2 ~]#curl 192.168.0.6
internet
[root@lanserver2 ~]#ssh 192.168.0.6
The authenticity of host '192.168.0.6 (192.168.0.6)' can't be established.
RSA key fingerprint is SHA256:ldHMw3UFehPuE3bgtMHIX5IxRRTM7fwC4iZOQqglcys.
RSA key fingerprint is MD5:8c:44:d9:3d:22:54:62:d8:27:77:d5:06:09:58:76:92.
Are you sure you want to continue connecting (yes/no)?


[root@internet ~]#curl 10.0.0.7
curl: (7) couldn't connect to host
[root@internet ~]#ping 10.0.0.7 -c1
PING 10.0.0.7 (10.0.0.7) 56(84) bytes of data.
From 192.168.0.8 icmp_seq=1 Destination Port Unreachable

[root@internet ~]#ssh 10.0.0.7
ssh: connect to host 10.0.0.7 port 22: Connection refused

#允许内网指定主机被外网访问
[root@firewall ~]#iptables -IFORWARD  3 -d 10.0.0.7 -p tcp --dport 80 -j ACCEPT
[root@firewall ~]#iptables -vnL --line-numbers
Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
1       63 12862 ACCEPT     all  --  *      *       0.0.0.0/0
 0.0.0.0/0            state RELATED,ESTABLISHED
2        9   612 ACCEPT     all  --  *      *       10.0.0.0/24
 0.0.0.0/0            state NEW
3        1    60 ACCEPT     tcp  --  *      *       0.0.0.0/0
 10.0.0.7             tcp dpt:80
4      586 47464 REJECT     all  --  *      *       0.0.0.0/0
 0.0.0.0/0            reject-with icmp-port-unreachable

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

[root@internet ~]#curl 10.0.0.7
lanserver1
[root@internet ~]#ping 10.0.0.7 -c1
PING 10.0.0.7 (10.0.0.7) 56(84) bytes of data.
From 192.168.0.8 icmp_seq=1 Destination Port Unreachable
```

```
[root@internet ~]#curl 10.0.0.17
curl: (7) couldn't connect to host
```

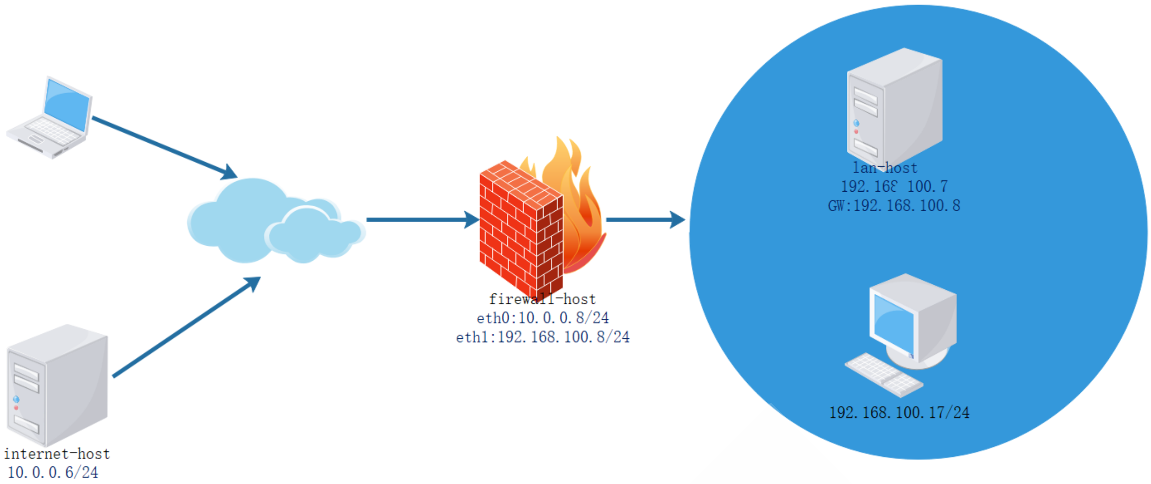
范例：内部可以访问外部，外部禁止访问内部

```
[root@internet-host ~]#hostname -I
10.0.0.6
[root@internet-host ~]#route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.0.0.0        0.0.0.0         255.255.255.0   U     1      0        0 eth0
0.0.0.0         10.0.0.8        0.0.0.0         UG    0      0        0 eth0

[root@firewall-host ~]#hostname -I
10.0.0.8 192.168.100.8

[root@lan-host ~]#hostname -I
192.168.100.7
[root@lan-host ~]#route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         192.168.100.8   0.0.0.0         UG    100    0        0 eth0
192.168.100.0   0.0.0.0         255.255.255.0   U     100    0        0 eth0


[root@firewall-host ~]#vim /etc/sysctl.conf
net.ipv4.ip_forward=1
[root@firewall-host ~]#sysctl -p
[root@firewall-host ~]#iptables -A FORWARD -d 192.168.100.0/24  -m state --state NEW  -j REJECT
```

范例：针对内部的特定服务可以允许外部访问，其它服务禁止访问

```
[root@firewall-host ~]#iptables -I FORWARD -d 192.168.100.0/24 -p tcp --dport 80 -j ACCEPT
[root@firewall-host ~]#iptables -vnL  FORWARD --line-numbers
Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
num   pkts bytes target     prot opt in     out     source
destination
1        6   486 ACCEPT     tcp  --  *      *       0.0.0.0/0
 192.168.100.0/24     tcp dpt:80
2        3   228 REJECT     all  --  *      *       0.0.0.0/0
 192.168.100.0/24     state NEW reject-with icmp-port-unreachable
```

3.8.2 NAT 表



NAT: network address translation，支持PREROUTING，INPUT，OUTPUT，POSTROUTING四个链

请求报文：修改源/目标IP，由定义如何修改

响应报文：修改源/目标IP，根据跟踪机制自动实现

NAT的实现分为下面类型：

- SNAT：source NAT ，支持POSTROUTING, INPUT，让本地网络中的主机通过某一特定地址访问外部网络，实现地址伪装,请求报文：修改源IP
- DNAT：destination NAT 支持PREROUTING , OUTPUT，把本地网络中的主机上的某服务开放给外部网络访问(发布服务和端口映射)，但隐藏真实IP,请求报文：修改目标IP
- PNAT：port nat，端口和IP都进行修改

思考题:

```
在单位内部使用未经申请的公网地址,如:6.0.0.0/8网段,进行内部网络通讯,并利用SNAT连接Internet,是否可以?
```

3.8.3 SNAT

SNAT：基于nat表的target，适用于固定的公网IP

SNAT选项：

- --to-source [ipaddr[-ipaddr]][:port[-port]]
- --random

```
iptables -t nat -A POSTROUTING -s LocalNET ! -d LocalNet -j SNAT --to[-source] ExtIP
```

注意: 需要开启 ip_forward

范例：

```
iptables -t nat -A POSTROUTING -s 10.0.0.0/24 ! -d 10.0.0.0/24 -j SNAT --to-source 172.18.1.6-172.18.1.9
```

MASQUERADE：基于nat表的target，适用于动态的公网IP，如：拨号网络

MASQUERADE选项：

- --to-ports port[-port]

- --random

```
iptables -t nat -A POSTROUTING -s LocalNET ! -d LocalNet -j MASQUERADE
```

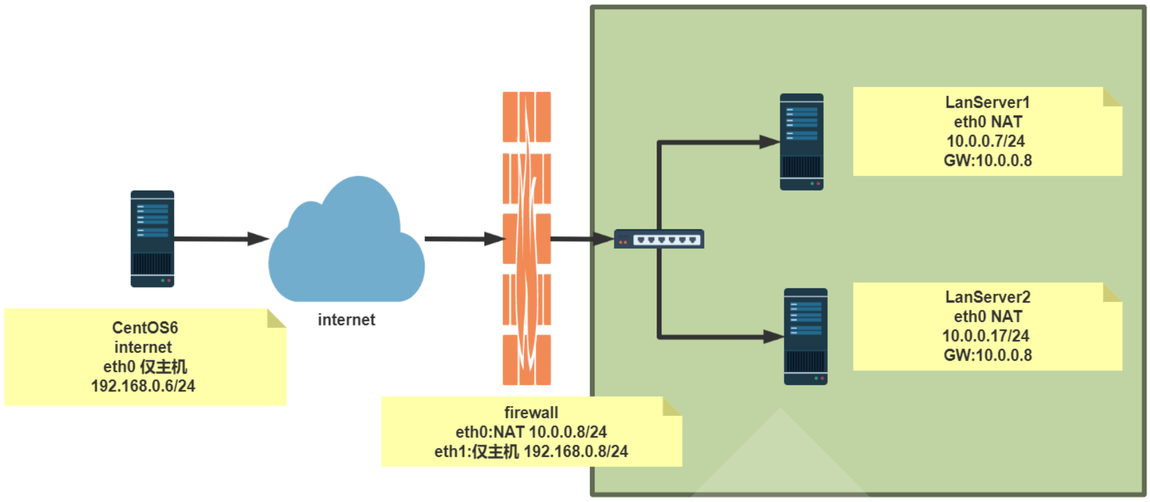
范例：

```
iptables -t nat -A POSTROUTING -s 10.0.0.0/24  ! -d 10.0.0.0/24 -j MASQUERADE
```

范例：查看本地主机访问公网时使用的IP

```
[root@centos8 ~]#curl http://ip.sb
111.199.191.204

#Windows10 支持curl
C:\Users\Wang>curl ip.sb
111.199.184.218

[root@centos8 ~]#curl http://ipinfo.io/ip/
111.199.191.204
[root@centos8 ~]#curl  http://ifconfig.me
111.199.191.204
[root@centos8 ~]#curl -L http://tool.lu/ip
当前IP: 111.199.191.204
归属地: 中国 北京 北京
[root@centos8 ~]#curl -sS --connect-timeout 10 -m 60
https://www.bt.cn/Api/getIpAddress
111.199.189.164
[root@centos8 ~]#curl "https://api.ipify.org?format=string"
111.199.184.218

[root@firewall ~]#curl cip.cc
IP   : 39.164.140.134
地址  : 中国  河南  鹤壁
运营商 : 移动

数据二 : 河南省郑州市 | 移动

数据三 :

URL : http://www.cip.cc/39.164.140.134
```

范例: SNAT



```
#启用路由转发
[root@firewall ~]#vim /etc/sysctl.conf
net.ipv4.ip_forward=1
[root@firewall ~]#sysctl -p

#针对专线静态公共IP
[root@firewall ~]#iptables -t nat -A POSTROUTING -s 10.0.0.0/24 -j SNAT --to-source 192.168.0.8

#针对拨号网络和专线静态公共IP
[root@firewall ~]#iptables -t nat -A POSTROUTING -s 10.0.0.0/24 -j MASQUERADE

#查看监听端口
[root@firewall ~]#ss -ntl
State         Recv-Q         Send-Q                 Local Address:Port
      Peer Address:Port
LISTEN        0              128                          0.0.0.0:22
           0.0.0.0:*
LISTEN        0              100                        127.0.0.1:25
           0.0.0.0:*
LISTEN        0              128                             [::]:22
              [::]:*
LISTEN        0              100                            [::1]:25
              [::]:*

#内网可以访问外网
[root@lanserver1 ~]#curl 192.168.0.6
internet

#外网不可以访问内网
[root@internet ~]#curl 10.0.0.7
curl: (7) Failed to connect to 10.0.0.7: Network is unreachable

#在外网服务器查看到是firewalld的地址在访问
[root@internet ~]#tail -f /var/log/httpd/access_log
192.168.0.8 - - [08/Jul/2020:17:36:54 +0800] "GET / HTTP/1.1" 200 9 "-" "curl/7.29.0"

#查看转换状态信息
[root@firewall ~]#cat /proc/net/nf_conntrack
```

```
ipv4     2 tcp      6 112 TIME_WAIT src=10.0.0.7 dst=192.168.0.6 sport=58384
dport=80 src=192.168.0.6 dst=192.168.0.8 sport=80 dport=58384 [ASSURED] mark=0
zone=0 use=2
```

范例：实现SNAT

```
[root@internet-host ~]#hostname -I
10.0.0.6
[root@internet-host ~]#route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.0.0.0        0.0.0.0         255.255.255.0   U     1      0        0 eth0

#启用路由转发
[root@firewall ~]#vim /etc/sysctl.conf
net.ipv4.ip_forward=1
[root@firewall ~]#sysctl -p

[root@firewall-host ~]#hostname -I
10.0.0.8 192.168.100.8
[root@firewall-host ~]#sysctl -a |grep net.ipv4.ip_forward
net.ipv4.ip_forward = 1

[root@lan-host ~]#hostname -I
192.168.100.7
[root@lan-host ~]#route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         192.168.100.8   0.0.0.0         UG    100    0        0 eth0
192.168.100.0   0.0.0.0         255.255.255.0   U     100    0        0 eth0


[root@firewall-host ~]#iptables -t nat -A POSTROUTING -s 192.168.100.0/24 -j SNAT
--to-source 10.0.0.8
[root@firewall-host ~]#iptables -vnL -t nat
Chain PREROUTING (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination


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


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

    0     0 SNAT       all  --  *      *       192.168.100.0/24     0.0.0.0/0
         to:10.0.0.8

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

```
[root@lan-host ~]#curl 10.0.0.6
internet Server
[root@internet-host ~]#curl 192.168.100.7
curl: (7) Failed to connect to 192.168.100.7: Network is unreachable

[root@internet-host ~]#tail  /var/log/httpd/access_log
10.0.0.8 - - [21/Mar/2020:16:31:35 +0800] "GET / HTTP/1.1" 200 16 "-"
"curl/7.29.0"

[root@lan-host ~]#ping 10.0.0.6
PING 10.0.0.6 (10.0.0.6) 56(84) bytes of data.
64 bytes from 10.0.0.6: icmp_seq=1 ttl=63 time=0.989 ms
64 bytes from 10.0.0.6: icmp_seq=2 ttl=63 time=0.544 ms


[root@internet-host ~]#tcpdump -i eth0 -nn icmp
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 65535 bytes
16:34:30.171222 IP 10.0.0.8 > 10.0.0.6: ICMP echo request, id 24718, seq 120,
length 64
16:34:30.171255 IP 10.0.0.6 > 10.0.0.8: ICMP echo reply, id 24718, seq 120,
length 64


[root@firewall-host ~]#iptables -t nat -R POSTROUTING 1  -s 192.168.100.0/24 -j
MASQUERADE
[root@firewall-host ~]#iptables -t nat -nvL
Chain PREROUTING (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination


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


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

    0     0 MASQUERADE  all  --  *      *       192.168.100.0/24     0.0.0.0/0


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

[root@firewall-host ~]#cat /proc/net/nf_conntrack
ipv4     2 tcp      6 32 TIME_WAIT src=192.168.100.7 dst=10.0.0.6 sport=39430
dport=80 src=10.0.0.6 dst=10.0.0.8 sport=80 dport=39430 [ASSURED] mark=0 zone=0
use=2
```

3.8.4 DNAT

DNAT：nat表的target，适用于端口映射，即可重定向到本机，也可以支持重定向至不同主机的不同端口，但不支持多目标，即不支持负载均衡功能

DNAT选项：

- --to-destination [ipaddr[-ipaddr]][:port[-port]]

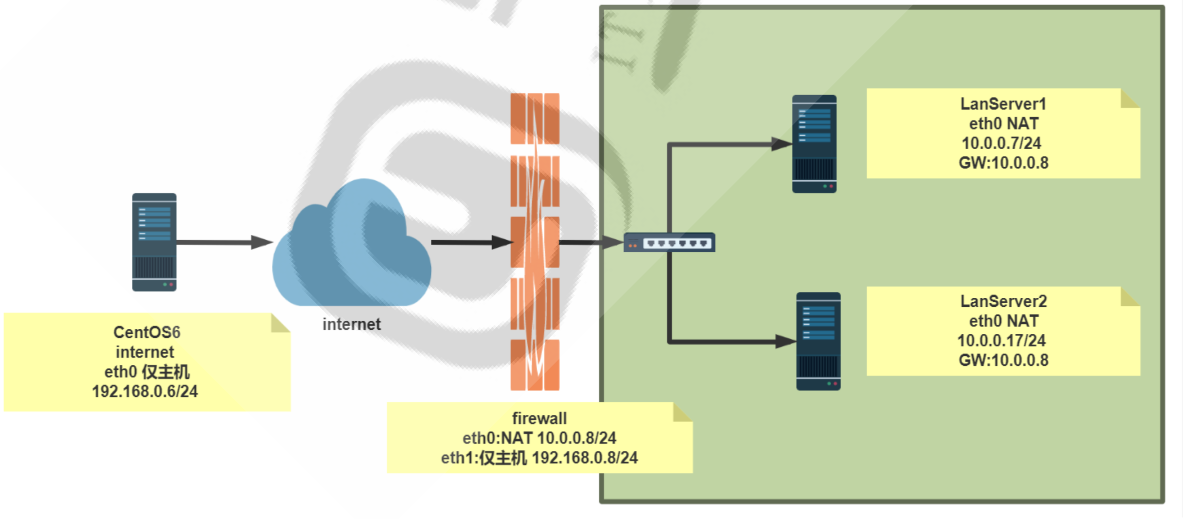
```
[root@firewall-host ~]#man iptables-extensions
--to-destination [ipaddr[-ipaddr]][:port[-port]]
    which  can  specify  a single new destination IP address, an inclusive range
of IP addresses. Optionally a port range, if the rule also specifies one of the
following protocols: tcp, udp, dccp  or  sctp.  If no port range is specified,
then the destination port will never be modi-fied. If no IP address is specified
then only the destination port will be modified.  In Ker-nels  up  to  2.6.10
you can add several --to-destination options. For those kernels, if you specify
more than one destination address, either via an address range or multiple  --to-
des-tination  options,  a  simple  round-robin  (one after another in cycle) load
balancing takes place between these addresses.  Later Kernels (>= 2.6.11-rc1)
don't have the ability  to  NAT to multiple ranges anymore.
```

DNAT 格式:

```
iptables -t nat -A PREROUTING -d ExtIP -p tcp|udp --dport PORT -j DNAT --to-
destination InterSeverIP[:PORT]
```

注意: 需要开启 ip_forward

范例：DNAT



```
#启用路由转发
[root@firewall ~]#vim /etc/sysctl.conf
net.ipv4.ip_forward=1
[root@firewall ~]#sysctl -p

[root@firewall ~]#iptables -t nat -A PREROUTING -d 192.168.0.8 -p tcp --dport 80
-j DNAT --to-destination 10.0.0.7:8080
[root@firewall ~]#ss -ntl
State           Recv-Q          Send-Q                      Local Address:Port
        Peer Address:Port
```

```
LISTEN        0              128                            0.0.0.0:22
           0.0.0.0:*
LISTEN        0              100                          127.0.0.1:25
           0.0.0.0:*
LISTEN        0              128                               [::]:22
              [::]:*
LISTEN        0              100                              [::1]:25
              [::]:*
[root@internet ~]#curl 192.168.0.8
lanserver1
[root@lanserver1 ~]#tail /var/log/httpd/access_log
192.168.0.6 - - [08/Jul/2020:18:10:37 +0800] "GET / HTTP/1.1" 200 11 "-"
"curl/7.19.7 (x86_64-redhat-linux-gnu) libcurl/7.19.7 NSS/3.27.1 zlib/1.2.3
libidn/1.18 libssh2/1.4.2"

[root@firewall ~]#cat /proc/net/nf_conntrack
ipv4     2 tcp      6 117 TIME_WAIT src=192.168.0.6 dst=192.168.0.8 sport=58170
dport=80 src=10.0.0.7 dst=192.168.0.6 sport=8080 dport=58170 [ASSURED] mark=0
zone=0 use=2
```

范例:

```
iptables -t nat -A PREROUTING -s 0/0 -d 172.18.100.6 -p tcp --dport 22 -j DNAT -
-to-destination 10.0.1.22

iptables -t nat -A PREROUTING -s 0/0 -d 172.18.100.6 -p tcp --dport 80 -j DNAT -
-to-destination 10.0.1.22:8080
```

范例:

```
[root@firewall-host ~]#iptables -t nat -A PREROUTING -d 10.0.0.8 -p tcp --dport
80 -j DNAT --to-destination 192.168.100.7
[root@firewall-host ~]#iptables -t nat -vnL PREROUTING
Chain PREROUTING (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination

    0     0 DNAT       tcp  --  *      *       0.0.0.0/0            10.0.0.8
        tcp dpt:80 to:192.168.100.7
[root@firewall-host ~]#ss -ntl
State          Recv-Q        Send-Q                  Local Address:Port
    Peer Address:Port
LISTEN        0             128                            0.0.0.0:22
         0.0.0.0:*
LISTEN        0             128                               [::]:22
            [::]:*

[root@internet-host ~]#curl 10.0.0.8
lan server
[root@internet-host ~]#telnet 10.0.0.8
Trying 10.0.0.8...
telnet: connect to address 10.0.0.8: Connection refused

[root@lan-host ~]#tail -f /var/log/httpd/access_log
10.0.0.6 - - [21/Mar/2020:17:32:37 +0800] "GET / HTTP/1.1" 200 11 "-"
"curl/7.19.7 (x86_64-redhat-linux-gnu) libcurl/7.19.7 NSS/3.27.1 zlib/1.2.3
libidn/1.18 libssh2/1.4.2"
```

```
[root@firewall-host ~]#tail -f /proc/net/nf_conntrack
ipv4     2 tcp      6 81 TIME_WAIT src=10.0.0.6 dst=10.0.0.8 sport=59426
dport=80 src=192.168.100.7 dst=10.0.0.6 sport=80 dport=59426 [ASSURED] mark=0
zone=0 use=2

[root@lan-host ~]#vim /etc/httpd/conf/httpd.conf
listen 8000

[root@lan-host ~]#systemctl restart httpd
[root@lan-host ~]#ss -ntl
State      Recv-Q Send-Q          Local Address:Port                         Peer
Address:Port
LISTEN     0      100                 127.0.0.1:25
       *:*
LISTEN     0      128                         *:22
       *:*
LISTEN     0      128                      [::]:23
    [::]:*
LISTEN     0      100                     [::1]:25
    [::]:*
LISTEN     0      128                      [::]:8000
    [::]:*
LISTEN     0      128                      [::]:22
    [::]:*

[root@firewall-host ~]#iptables -t nat -R PREROUTING 1 -d 10.0.0.8 -p tcp --dport
80 -j DNAT --to-destination 192.168.100.7:8000
[root@firewall-host ~]#iptables -t nat -vnL
Chain PREROUTING (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination

    0     0 DNAT       tcp  --  *      *       0.0.0.0/0            10.0.0.8
        tcp dpt:80 to:192.168.100.7:8000

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


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

   11   816 MASQUERADE  all  --  *      *       192.168.100.0/24     0.0.0.0/0


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

3.8.5 REDIRECT 转发

REDIRECT，是NAT表的 target，通过改变目标IP和端口，将接受的包转发至同一个主机的不同端口，可用于PREROUTING OUTPUT链

REDIRECT选项：

- --to-ports port[-port]

注意: 无需开启 ip_forward

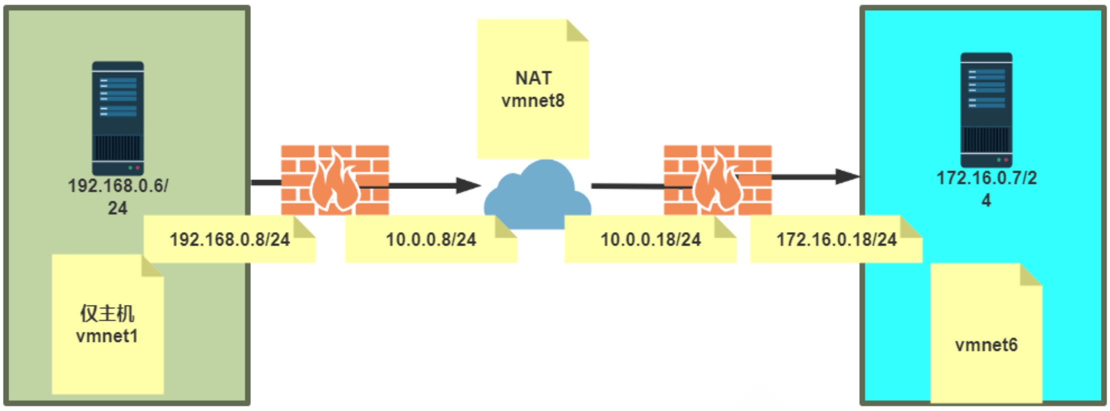
范例:

```
iptables -t nat -A PREROUTING -d 172.16.100.10 -p tcp --dport 80 -j REDIRECT --to-ports 8080
```

范例:

```
[root@lan-host ~]#ss -ntl
State      Recv-Q Send-Q          Local Address:Port                         Peer
Address:Port
LISTEN     0      100                 127.0.0.1:25
       *:*
LISTEN     0      128                        *:22
       *:*
LISTEN     0      128                     [::]:23
    [::]:*
LISTEN     0      100                    [::1]:25
    [::]:*
LISTEN     0      128                     [::]:80
    [::]:*
LISTEN     0      128                     [::]:22
    [::]:*
[root@lan-host ~]#iptables -t nat -A PREROUTING  -p tcp --dport 8000 -j REDIRECT --to-ports 80

[root@lan-host ~]#iptables -vnL  -t nat
Chain PREROUTING (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination

    1    60 REDIRECT   tcp  --  *      *       0.0.0.0/0            0.0.0.0/0
         tcp dpt:8000 redir ports 80

Chain INPUT (policy ACCEPT 1 packets, 60 bytes)
 pkts bytes target     prot opt in     out     source               destination


Chain OUTPUT (policy ACCEPT 1 packets, 120 bytes)
 pkts bytes target     prot opt in     out     source               destination


Chain POSTROUTING (policy ACCEPT 1 packets, 120 bytes)
 pkts bytes target     prot opt in     out     source               destination
```

3.8.6 综合案例: 两个私有网络的互相通迅



3.9 实战案例：马哥教育原校区的防火墙配置设置

```
# Generated by iptables-save v1.4.7 on Wed May 18 09:22:34 2016
*filter
:INPUT ACCEPT [85890:4530430]
:FORWARD ACCEPT [76814:55698470]
:OUTPUT ACCEPT [166620:238017546]
-A FORWARD -s 172.16.0.100/32 -j ACCEPT
-A FORWARD -s 172.16.0.200/32 -j ACCEPT
-A FORWARD -s 172.16.0.67/32 -j ACCEPT
#WANG   ADD NEXT LINE IN  20170627
#-A FORWARD -s 172.16.0.0/16 -j ACCEPT
#WANG   ADD NEXT LINE IN 20170704
#-A FORWARD -s 172.18.0.0/16 -j ACCEPT
#-A FORWARD -s 172.18.0.0/16 -j REJECT
#-A FORWARD -s 172.16.0.68/32 -j ACCEPT
#-A FORWARD -s 172.16.0.69/32 -j ACCEPT
#-A FORWARD -s 172.16.0.6/32 -j ACCEPT
-A FORWARD -s 172.17.200.200/32 -j ACCEPT
-A FORWARD -s 172.17.136.136/32 -j ACCEPT
-A FORWARD -s 172.17.0.100/32 -j ACCEPT
-A FORWARD -s 172.18.100.1/32 -j ACCEPT
-A FORWARD -s 172.18.0.100/32 -j ACCEPT
-A FORWARD -s 172.18.200.2/32 -j ACCEPT
-A FORWARD -s 172.18.200.3/32 -j ACCEPT
-A FORWARD -s 172.18.211.211/32 -j ACCEPT
-A FORWARD -s 172.18.212.212/32 -j ACCEPT
-A FORWARD -m iprange --src-range 172.16.0.100-172.16.0.110 -j ACCEPT
-A FORWARD -m iprange --src-range 172.17.0.100-172.17.0.110 -j ACCEPT
-A FORWARD -m iprange --src-range 172.18.0.100-172.18.0.110 -j ACCEPT
-A FORWARD -m iprange --src-range 172.17.100.6-172.17.100.16 -j ACCEPT
-A FORWARD -m iprange --src-range 172.18.100.61-172.18.100.70 -j ACCEPT
-A FORWARD -s 172.16.0.0/16 -m string --string "verycd.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.16.0.0/16 -m string --string "tudou.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.16.0.0/16 -m string --string "youku.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.16.0.0/16 -m string --string "iqiyi.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
```

```
-A FORWARD -s 172.16.0.0/16 -m string --string "pptv.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.16.0.0/16 -m string --string "letv.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.16.0.0/16 -m string --string "xunlei.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable


-A FORWARD -s 172.18.0.0/16 -m string --string "verycd.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.18.0.0/16 -m string --string "tudou.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.18.0.0/16 -m string --string "youku.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.18.0.0/16 -m string --string "iqiyi.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.18.0.0/16 -m string --string "pptv.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.18.0.0/16 -m string --string "letv.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.18.0.0/16 -m string --string "xunlei.com" --algo kmp --to 65535 -j REJECT --reject-with icmp-port-unreachable

#-A FORWARD -s 172.18.0.0/16 -j REJECT
#-A FORWARD -s 172.16.0.0/16 -j REJECT
#-A FORWARD  -i ppp0 -m string --string ".exe" --algo bm --to 65535 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.18.0.0/16 -m time --timestart 08:50:00 --timestop 18:00:00 --weekdays Mon,Wed,Fri  --datestop 2038-01-19T11:14:07 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.17.0.0/16 -m time --timestart 08:50:00 --timestop 18:00:00 --weekdays Mon,Wed,Fri  --datestop 2038-01-19T11:14:07 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.16.0.0/16 -m time --timestart 08:50:00 --timestop 12:30:00 --weekdays Tue,Thu,Sat  --datestop 2038-01-19T11:14:07 -j REJECT --reject-with icmp-port-unreachable
-A FORWARD -s 172.16.0.0/16 -m time --timestart 13:50:00 --timestop 18:00:00 --weekdays Tue,Thu,Sat  --datestop 2038-01-19T11:14:07 -j REJECT --reject-with icmp-port-unreachable
#wang next 2 lines changed in  20170619
#-A FORWARD -s 172.17.0.0/16 -m time --timestart 08:50:00 --timestop 12:30:00 --weekdays Mon,Wed,Fri  --datestop 2038-01-19T11:14:07 -j REJECT --reject-with icmp-port-unreachable
#-A FORWARD -s 172.17.0.0/16 -m time --timestart 13:30:00 --timestop 18:10:00 --weekdays Mon,Wed,Fri  --datestop 2038-01-19T11:14:07 -j REJECT --reject-with icmp-port-unreachable
#-A FORWARD -s 172.18.0.0/16 -m time --timestart 08:50:00 --timestop 18:10:00 --weekdays Mon,Wed,Fri  --datestop 2038-01-19T11:14:07 -j REJECT --reject-with icmp-port-unreachable
#-A FORWARD -s 172.18.0.0/16 -m time --timestart 08:50:00 --timestop 18:10:00 --weekdays Tue,Thu --datestop 2038-01-19T11:14:07 -j REJECT --reject-with icmp-port-unreachable
COMMIT
# Completed on Wed May 18 09:22:34 2016
# Generated by iptables-save v1.4.7 on Wed May 18 09:22:34 2016
*nat
:PREROUTING ACCEPT [1429833:65427211]
:POSTROUTING ACCEPT [850518:35452195]
```

```
:OUTPUT ACCEPT [120198:9146655]
-A POSTROUTING -s 172.16.0.100/32 -j MASQUERADE
-A POSTROUTING -s 172.18.0.100/32 -j MASQUERADE
#-A POSTROUTING -s 172.16.0.200/32 -j MASQUERADE
#wang  add next 1 line in 20170619
#wang  add next 1 line in 20170704
-A POSTROUTING -s 172.16.0.69/32 -j MASQUERADE
-A POSTROUTING -s 172.17.200.200/32 -j MASQUERADE
-A POSTROUTING -s 172.17.136.136/32 -j MASQUERADE
-A POSTROUTING -s 172.17.0.100/32 -j MASQUERADE
#-A POSTROUTING -s 172.18.0.0/16 -j MASQUERADE
#-A POSTROUTING -s 172.16.0.6/32 -j MASQUERADE
-A POSTROUTING -m iprange --src-range 172.16.0.100-172.16.0.110 -j MASQUERADE
-A POSTROUTING -m iprange --src-range 172.17.0.100-172.17.0.110 -j MASQUERADE
-A POSTROUTING -m iprange --src-range 172.18.0.100-172.18.0.110 -j MASQUERADE
-A POSTROUTING -s 172.16.0.0/16 -p tcp -m multiport --dports 80,443,53,22,6666 -j MASQUERADE
-A POSTROUTING -s 172.16.0.0/16 -p udp -m multiport --dports 22 -j MASQUERADE
-A POSTROUTING -s 172.17.0.0/16 -p tcp -m multiport --dports 80,443,53,22,6666 -j MASQUERADE
-A POSTROUTING -s 172.17.0.0/16 -p udp -m multiport --dports 22 -j MASQUERADE
-A POSTROUTING -s 172.18.0.0/16 -p tcp -m multiport --dports 80,443,53,22,6666,1206,5938,1949 -j MASQUERADE
-A POSTROUTING -s 172.18.0.0/16 -p udp -m multiport --dports 22,1206,5938,1949 -j MASQUERADE
COMMIT
# Completed on Wed May 18 09:22:34 2016
```

4 firewalld

4.1 firewalld 介绍

firewalld是CentOS 7.0新推出的管理netfilter的用户空间软件工具,也被ubuntu18.04版以上所支持(apt install firewalld安装即可)

firewalld是配置和监控防火墙规则的系统守护进程。可以实iptables,ip6tables,ebtables的功能

firewalld服务由firewalld包提供

firewalld支持划分区域zone,每个zone可以设置独立的防火墙规则

归入zone顺序：

- 先根据数据包中源地址，将其纳为某个zone
- 纳为网络接口所属zone
- 纳入默认zone，默认为public zone,管理员可以改为其它zone
- 网卡默认属于public zone,lo网络接口属于trusted zone

firewalld zone 分类

zone名称	默认配置
trusted	允许所有流量
home	拒绝除和传出流量相关的，以及ssh,mdsn,ipp-client,samba-client,dhcpv6-client预定义服务之外其它所有传入流量
internal	和home相同
work	拒绝除和传出流量相关的，以及ssh,ipp-client,dhcpv6-client预定义服务之外的其它所有传入流量
public	拒绝除和传出流量相关的，以及ssh,dhcpv6-client预定义服务之外的其它所有传入流量，新加的网卡默认属于public zone
external	拒绝除和传出流量相关的，以及ssh预定义服务之外的其它所有传入流量，属于external zone的传出ipv4流量的源地址将被伪装为传出网卡的地址。
dmz	拒绝除和传出流量相关的，以及ssh预定义服务之外的其它所有传入流量
block	拒绝除和传出流量相关的所有传入流量
drop	拒绝除和传出流量相关的所有传入流量（甚至不以ICMP错误进行回应）

预定义服务

服务名称	配置
ssh	Local SSH server. Traffic to 22/tcp
dhcpv6-client	Local DHCPv6 client. Traffic to 546/udp on the fe80::/64 IPv6 network
ipp-client	Local IPP printing. Traffic to 631/udp.
samba-client	Local Windows file and print sharing client. Traffic to 137/udp and 138/udp.
mdns	Multicast DNS (mDNS) local-link name resolution. Traffic to 5353/udp to the 224.0.0.251 (IPv4) or ff02::fb (IPv6) multicast addresses.

firewalld预定义服务配置

- firewall-cmd --get-services 查看预定义服务列表
- /usr/lib/firewalld/services/*.xml预定义服务的配置

firewalld 三种配置方法

- firewall-config 图形工具: 需安装 firewall-config包
- firewall-cmd 命令行工具: firewalld包,默认安装
- /etc/firewalld/ 配置文件，一般不建议,如:/etc/firewalld/zones/public.xml

4.2 firewall-cmd 命令

firewall-cmd 格式

```
Usage: firewall-cmd [OPTIONS...]
```

常见选项

```
--get-zones       列出所有可用区域
--get-default-zone   查询默认区域
--set-default-zone=<ZONE>    设置默认区域
--get-active-zones   列出当前正使用的区域
--add-source=<CIDR>[--zone=<ZONE>]   添加源地址的流量到指定区域，如果无--zone= 选项，使用默认区域
--remove-source=<CIDR> [--zone=<ZONE>]   从指定区域删除源地址的流量，如无--zone= 选项，使用默认区域
--add-interface=<INTERFACE>[--zone=<ZONE>]   添加来自于指定接口的流量到特定区域，如果无--zone= 选项，使用默认区域
--change-interface=<INTERFACE>[--zone=<ZONE>]    改变指定接口至新的区域，如果无--zone= 选项，使用默认区域
--add-service=<SERVICE> [--zone=<ZONE>] 允许服务的流量通过，如果无--zone= 选项，使用默认区域
--add-port=<PORT/PROTOCOL>[--zone=<ZONE>] 允许指定端口和协议的流量，如果无--zone= 选项，使用默认区域
--remove-service=<SERVICE> [--zone=<ZONE>]   从区域中删除指定服务，禁止该服务流量，如果无--zone= 选项，使用默认区域
--remove-port=<PORT/PROTOCOL>[--zone=<ZONE>]     从区域中删除指定端口和协议，禁止该端口的流量，如果无--zone= 选项，使用默认区域
--reload     删除当前运行时配置，应用加载永久配置
--list-services   查看开放的服务
--list-ports    查看开放的端口
--list-all [--zone=<ZONE>]    列出指定区域的所有配置信息，包括接口，源地址，端口，服务等，如果无--zone= 选项，使用默认区域
```

范例：

```
#查看默认zone
firewall-cmd --get-default-zone
#默认zone设为dmz
firewall-cmd --set-default-zone=dmz
#在internal zone中增加源地址192.168.0.0/24的永久规则
firewall-cmd --permanent --zone=internal  --add-source=192.168.0.0/24
#在internal zone中增加协议mysql的永久规则
firewall-cmd --permanent --zone=internal  --add-service=mysql
#加载新规则以生效
firewall-cmd  --reload
```

范例:

```
[root@centos8 ~]#firewall-cmd --get-zones
block dmz drop external home internal public trusted work


[root@centos7 ~]#firewall-cmd --get-service
RH-Satellite-6 amanda-client amanda-k5-client amqp amqps apcupsd audit bacula
bacula-client bgp bitcoin bitcoin-rpc bitcoin-testnet bitcoin-testnet-rpc ceph
ceph-mon cfengine condor-collector ctdb dhcp dhcpv6 dhcpv6-client distcc dns
docker-registry docker-swarm dropbox-lansync elasticsearch etcd-client etcd-
server finger freeipa-ldap freeipa-ldaps freeipa-replication freeipa-trust ftp
ganglia-client ganglia-master git gre high-availability http https imap imaps ipp
ipp-client ipsec irc ircs iscsi-target isns jenkins kadmin kerberos kibana klogin
kpasswd kprop kshell ldap ldaps libvirt libvirt-tls lightning-network llmnr
managesieve matrix mdns minidlna mongodb mosh mountd mqtt mqtt-tls ms-wbt mssql
murmur mysql nfs nfs3 nmea-0183 nrpe ntp nut openvpn ovirt-imageio ovirt-
storageconsole ovirt-vmconsole plex pmcd pmproxy pmwebapi pmwebapis pop3 pop3s
postgresql privoxy proxy-dhcp ptp pulseaudio puppetmaster quassel radius redis
rpc-bind rsh rsyncd rtsp salt-master samba samba-client samba-dc sane sip sips
slp smtp smtp-submission smtps snmp snmptrap spideroak-lansync squid ssh steam-
streaming svdrp svn syncthing syncthing-gui synergy syslog syslog-tls telnet tftp
tftp-client tinc tor-socks transmission-client upnp-client vdsm vnc-server wbem-
http wbem-https wsman wsmans xdmcp xmpp-bosh xmpp-client xmpp-local xmpp-server
zabbix-agent zabbix-server
```

范例：配置firewalld

```
systemctl mask iptables
systemctl mask ip6tables
systemctl status firewalld
systemctl enable firewalld
systemctl start firewalld
firewall-cmd  --get-default-zone
firewall-cmd  --set-default-zone=public
firewall-cmd  --permanent  --zone=public  --list-all
firewall-cmd  --permanent  --zone=public  --add-port  8080/tcp
firewall-cmd   ---reload
```

4.3 其它规则

当基本firewalld语法规则不能满足要求时，可以使用以下更复杂的规则

- rich-rules 富规则，功能强,表达性语言
- Direct configuration rules 直接规则，灵活性差, 帮助：man 5 firewalld.direct

4.3.1 管理rich规则

rich规则比基本的firewalld语法实现更强的功能，不仅实现允许/拒绝，还可以实现日志syslog和auditd，也可以实现端口转发，伪装和限制速率

规则实施顺序：

- 该区域的端口转发，伪装规则
- 该区域的日志规则
- 该区域的允许规则
- 该区域的拒绝规则

每个匹配的规则生效，所有规则都不匹配，该区域默认规则生效

rich语法：

```
rule
  [source]
  [destination]
  service|port|protocol|icmp-block|masquerade|forward-port
  [log]
  [audit]
  [accept|reject|drop]
```

man 5 firewalld.richlanguage

rich规则选项

选项	描述
--add-rich-rule=''	Add to the specified zone, or the default zone if no zone is specified.
--remove-rich-rule=''	Remove to the specified zone, or the default zone if no zone is specified.
--query-rich-rule=''	Query if has been added to the specified zone, or the default zone if no zone is specified. Returns 0 if the rule is present, otherwise 1.
--list-rich-rules	Outputs all rich rules for the specified zone, or the default zone if no zone is specified.

4.3.2 rich规则实现

拒绝从192.168.0.100的所有流量，当address 选项使用source 或 destination时，必须用family= ipv4 |ipv6

```
firewall-cmd --permanent --zone=public --add-rich-rule='rule   family=ipv4
source address=192.168.0.100/32 reject'
```

限制每分钟只有两个连接到ftp服务

```
firewall-cmd --add-rich-rule=‘rule service name=ftp limit value=2/m accept’
```

抛弃esp（IPsec 体系中的一种主要协议）协议的所有数据包

```
firewall-cmd --permanent --add-rich-rule='rule protocol value=esp drop'
```

接受所有192.168.1.0/24子网端口5900-5905范围的TCP流量

```
firewall-cmd --permanent --zone=vnc --add-rich-rule='rule family=ipv4 source
address=192.168.1.0/24 port port=5900-5905 protocol=tcp accept'
```

rich日志规则

```
log [prefix="<PREFIX TEXT>" [level=<LOGLEVEL>] [limit value="<RATE/DURATION>"]

<LOGLEVEL> 可以是emerg,alert， crit， error， warning， notice， info， debug.
<DURATION> s：秒， m：分钟， h：小时， d：天
audit [limit value="<RATE/DURATION>"]
```

范例

```
#接受ssh新连接，记录日志到syslog的notice级别，每分钟最多三条信息
firewall-cmd --permanent --zone=work --add-rich-rule='rule service name="ssh"
log prefix="ssh " level="notice" limit value="3/m" accept

#从2001:db8::/64子网的DNS连接在5分钟内被拒绝，并记录到日志到audit,每小时最大记录一条信息
firewall-cmd --add-rich-rule='rule family=ipv6 source address="2001:db8::/64"
service name="dns" audit limit value="1/h" reject' --timeout=300

firewall-cmd --permanent --add-rich-rule='rule family=ipv4 source
address=172.25.X.10/32 service name="http" log level=notice prefix="NEW HTTP "
limit value="3/s" accept'
firewall-cmd --reload
tail -f /var/log/messages
curl http://serverX.example.com
```

4.3.3 伪装和端口转发

NAT网络地址转换，firewalld支持伪装和端口转发两种NAT方式

伪装NAT

```
firewall-cmd --permanent --zone=<ZONE> --add-masquerade
firewall-cmd --query-masquerade  #检查是否允许伪装
firewall-cmd --add-masquerade    #允许防火墙伪装IP
firewall-cmd --remove-masquerade #禁止防火墙伪装IP
```

范例：

```
firewall-cmd --add-rich-rule='rule family=ipv4 source address=192.168.0.0/24
masquerade'
```

端口转发

端口转发：将发往本机的特定端口的流量转发到本机或不同机器的另一个端口。通常要配合地址伪装才能实现

```
firewall-cmd --permanent --zone=<ZONE> --add-forward-port=port=
<PORTNUMBER>:proto=<PROTOCOL>[:toport=<PORTNUMBER>][:toaddr=]
```

说明：toport= 和toaddr= 至少要指定一个

范例：

```
#转发传入的连接9527/TCP，到防火墙的80/TCP到public zone 的192.168.0.254
firewall-cmd --add-masquerade  启用伪装
firewall-cmd --zone=public --add-forward-port=port=9527:proto=tcp:toport=80:toaddr=192.168.0.254
```

rich规则的port转发语法：

```
forward-port port=<PORTNUM> protocol=tcp|udp [to-port=<PORTNUM>] [to-addr=<ADDRESS>]
```

范例：

```
#转发从192.168.0.0/24来的，发往80/TCP的流量到防火墙的端口8080/TCP
firewall-cmd --zone=work --add-rich-rule='rule family=ipv4 source address=192.168.0.0/24 forward-port port=80 protocol=tcp to-port=8080'

firewall-cmd --permanent --add-rich-rule 'rule family=ipv4 source address=172.25.X.10/32 forward-port port=443 protocol=tcp to-port=22'
firewall-cmd --reload
ssh -p 443 serverX.example.com
```

范例：限制ssh服务非标准端口访问

```
cp /usr/lib/firewalld/services/ssh.xml /etc/firewalld/services/ssh.xml
vim /etc/firewalld/services/ssh.xml
<port protocol="tcp" port="999"/>
systemctl restart sshd.service
systemctl status -l sshd.service
sealert -a /var/log/audit/audit.log
semanage port -a -t ssh_port_t -p tcp 999
systemctl restart sshd.service
ss -tulpn | grep sshd
firewall-cmd --permanent --zone=work --add-source=172.25.X.0/24
firewall-cmd --permanent --zone=work --add-port=999/tcp
firewall-cmd --reload
```