

Introduction to firewalld

WHAT?

Learn about <u>firewalld</u> an important tool for securing Linux servers and services. It is the default and primary network defense mechanism on many modern distributions. The intuitive zone-based management and dynamic configuration capabilities allow for precise control over network traffic without service interruption.

WHY?

firewalld is essential because it provides a modern, dynamic and user-friendly way to manage network security on Linux systems by abstracting complex firewall rules into intuitive zones and services.

EFFORT

It takes you up to 30 minutes to read through this article.

GOAL

1

To effectively manage and enhance the security of a Linux system.

REQUIREMENTS

- sudo or root privileges, because firewalld commands, especially
- those that make permanent changes to the firewall rules, require elevated privileges.
 - firewalld is the default firewall on many modern Linux
- distributions, if it is not preinstalled on your system, you need to install the firewalld package.

A basic understanding of the Linux terminal is essential.

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1 About firewalld

firewalld is a dynamic firewall management service that provides a flexible and efficient way to control network traffic on Linux systems. It allows modifications without interrupting existing connections. The benefits of using firewalld are:

- Dynamic configuration: Apply changes instantly without breaking existing connections.
- *User-friendly interface*: Zones and services simplify complex firewall rules.
- Abstraction: There is no need to directly manipulate nftables rules for common scenarios.
- *Persistent configuration*: Easy management of rules that survive reboots.
- Persistent configuration: By default, <u>firewalld</u> operates on a <u>deny-all</u> principle by blocking all incoming traffic unless explicitly allowed.

1.1 firewalld zones

A firewall zone is a predefined set of rules that dictate how incoming and outgoing network traffic is handled for a specific network interface or source IP address. Each zone represents a different level of trust for the network it is associated with. You can apply different security policies based on where the network connection originates.

Zones are like security profiles. For example, you would want to apply different firewall rules for a public Wi-Fi connection and your secure home network. <u>firewalld</u> zones allow you to define these distinct sets of rules and apply them accordingly. A network connection is subject to the rules of only one <u>firewalld</u> zone. A <u>firewalld</u> zone can have many network interfaces or source IP addresses.

The /usr/lib/firewalld/zones/ directory stores the predefined zones. For example:

```
> /usr/lib/firewalld/zones ls
block.xml dmz.xml docker.xml drop.xml external.xml home.xml internal.xml nm-
shared.xml public.xml trusted.xml work.xml
```

Some of the default settings of the predefined zones are as follows:

drop

- Trust level: Completely untrusted.
- *Behavior:* All incoming network packets are dropped without any reply. Only outgoing connections initiated from the system are allowed. This provides a "stealth" mode where the system appears nonexistent to external attackers.
- *Use Case*: Used for maximum stealth and security, completely ignoring unwanted traffic. Suitable as a strict default for a server that should never accept incoming connections.

block

- *Trust level:* Very low.
- *Behavior:* All incoming network connections are rejected with an <u>icmp-host-pro-hibited</u> message for IPv4 and <u>cmp6-adm-prohibited</u> for IPv6. This informs the sender that their connection was explicitly rejected. Only outgoing connections initiated from the system are possible.
- *Use Case*: Applied when you want to explicitly signal to senders that their connection attempts are being blocked.

public

- *Trust level:* Untrusted or public.
- Behavior: Represents public, untrusted networks where you do not trust other systems. Only selected incoming connections are accepted by default for example, SSH, DHCPv6 client, etc.
- *Use Case:* Common default zone for interfaces connected directly to the Internet, such as your router's WAN interface. Also includes being connected to a network where you have no control over other devices.

external

- Trust level: External with masquerading.
- Behavior: Intended for external networks when the firewall acts as a gateway or router. Usually, NAT masquerading is enabled by default. Only selected incoming connections are accepted, under the assumption that you do not trust other systems on this network.
- Use Case: Used when your Linux machine acts as a router, connecting an internal
 private network to the public Internet. The external interface is placed in this zone
 to hide internal network topology while allowing internal clients to access external
 resources such as the Internet.

dmz (Demilitarized Zone)

- Trust level: Limited public access.
- Behavior: For systems in a DMZ zone that are publicly accessible but with limited access to the internal network. Only selected incoming connections are accepted. The default usually includes SSH and other services you expose.
- *Use Case:* Suitable for public-facing servers such as Web, mail and DNS servers. These servers are intentionally exposed to the Internet but are isolated from your internal, more trusted networks. Useful when you want to host services that need to be Internet-accessible while minimizing the risk to your core internal infrastructure.

work

- Trust level: Mostly trusted (work environment).
- Behavior: In a work environment, you usually trust other computers on the network.
 Allows selected incoming connections that are common in a work environment, such as SSH and DHCPv6 client.
- *Use Case*: Suitable for office networks and systems on a corporate LAN.

home

- *Trust level:* Mostly trusted (home environment).
- Behavior: In a home environment, you mostly trust the other systems on the network.
 Allows more services than public or external zones, often including common home network services like file sharing, media servers, and printers, along with SSH and DHCPv6 client.
- *Use case*: Best for home networks and small home office setups.

trusted

- Trust level: Highest.
- Behavior: All network connections are accepted without any filtering. Firewalling is not implemented for connections assigned to this zone.
- Use Case: Reserved for highly trusted connections.

1.2 firewalld policies and rules

<u>firewalld</u> policies provide a more advanced and flexible way to manage network traffic compared to traditional zones. They allow you to define rich rules that specify the source and destination of traffic, services, ports and actions such as accept, reject and drop. These policies are useful for setting up complex routing, port forwarding or creating isolated network segments within a single host.

<u>firewalld</u> policies leverage zones to define rule sets. They apply rules statefully and in one direction, which means you define traffic flow in one direction, and <u>firewalld</u> implicitly permits the return path. These policies link an ingress zone (where traffic enters) with an egress zone (where traffic exits). This defines the specific path and direction a policy's rules apply to. You can view the policies, for example:

```
> /usr/lib/firewalld/policies ls
allow-host-ipv6.xml
```

Firewall rules let you precisely control network traffic, allowing or blocking it to protect your system from security threats. Firewall rules define certain criteria based on various attributes such as, source and destination IP addresses, ports and network interfaces. firewalld segregates firewall rules into zones and policies. Each zone in firewalld has a unique set of rules that dictates the traffic permissions for its associated network interfaces.

1.3 Services and ports

Services are recommended when a predefined service is available. For example, instead of remembering that HTTP uses TCP port 80, you can simply add the http service. This is less error-prone and easier to manage. Use ports when a service is not predefined or when you are using a custom port for a service. You can view the active services and ports for the default zones with the following:

```
> sudo firewall-cmd --list-services
> sudo firewall-cmd --list-ports
```

2 Managing firewall rules and zones

You can configure <u>firewalld</u> zones and their rules with the graphical Web interface Cockpit or the **firewall-cmd**utility for command-line control.

2.1 Managing firewall rules and zones using the **firewalld-cmd** utility

You can use the CLI interface to manage firewalld zones.

2.1.1 Adding firewalld zones

To add a new firewalld zone:

1. Create a new zone, for example:

```
> sudo firewall-cmd --permanent --new-zone=test
```

2. Set the trust level of the zone that defines the default behavior:

```
> sudo firewall-cmd --permanent --zone=example --set-target=trusted
```

3. Reload the firewalld service to apply the new configuration:

```
> sudo firewall-cmd --reload
```

2.1.2 Adding a service to a zone

To add a service to a zone:

1. List all services to check if your service is already predefined:

```
> sudo firewall-cmd --get-services

0-AD RH-Satellite-6 RH-Satellite-6-capsule afp alvr amanda-client amanda-k5-
client amqp amqps anno-1602

anno-1800 apcupsd audit ausweisapp2 bacula bacula-client bareos-director
bareos-filedaemon bareos-storage bb bgp bitcoin bitcoin-rpc bitcoin-testnet
bitcoin-testnet-rpc bittorrent-lsd ceph ceph-exporter ceph-mon cfengine checkmk-
agent civilization-iv civilization-v cockpit collectd condor-collector cratedb ctdb
dds dds-multicast dds-unicast dhcp dhcpv6 dhcpv6-client distcc dns dns-over-quic
dns-over-tls docker-registry docker-swarm dropbox-lansync elasticsearch etcd-client
etcd-server factorio finger foreman foreman-proxy freeipa-4 freeipa-ldap freeipa-
ldaps freeipa-replication freeipa-trust ftp galera
ganglia-client ganglia-master git gpsd grafana gre http http3 https ident imap
imaps ipfs ipp ipp-client ipsec irc ircs
[...]
```

2. You can add a service either temporarily for the runtime session or permanently, for example:

```
> sudo firewall-cmd --zone=public --add-service=http
> sudo firewall-cmd --zone=public --permanent --add-service=http
```

The --permanent flag ensures the change persists across all reboots.

3. Reload the firewalld service to apply the new configuration:

```
> sudo firewall-cmd --reload
```

4. Verify the results:

```
> sudo firewall-cmd --zone=public --list-services
```

2.1.3 Adding a port to a zone

If your application does not have a predefined service, you can open a specific port or a range of ports.

1. You can either add a port temporarily for the runtime session or permanently, for example:

```
> sudo firewall-cmd --zone=public --add-port=8080/tcp
> sudo firewall-cmd --zone=public --permanent --add-port=8080/tcp
```

The --permanentflag ensures the change persists across all reboots.

2. Reload the firewalld service to apply the new configuration:

```
> sudo firewall-cmd --reload
```

3. Verify the results:

```
> sudo firewall-cmd --zone=public --list-ports
```

2.1.4 Deleting firewalld zones

To delete a zone:

1. Verify the zone is not the default or in use:

```
> sudo firewall-cmd --get-default-zone
```

If the zone is in use or default, set a different zone, for example:

```
> sudo firewall-cmd --set-default-zone=NEW_DEFAULT_ZONE
```

2. Check if any network interfaces are bound to the zone:

```
> sudo firewall-cmd --zone=ZONE_TO_BE_DELETED --list-all
```

3. The <u>interfaces</u> field in the output lists all the interfaces. Theses interfaces need to be reassigned to another zone. For example:

```
> sudo firewall-cmd --zone=public --permanent --change-interface=ITERFACE_NAME
```

4. Delete the zone:

```
> sudo firewall-cmd --permanent --delete-zone=ZONE_TO_BE_DELETED
```

5. Reload the firewalld service to apply the new configuration:

```
> sudo firewall-cmd --reload
```

2.2 Managing firewall rules and zones with Cockpit

Cockpit enables you to create new zones or update the existing ones. In the firewall settings, you can add services to a zone or allow access to ports.



Note: Cockpit service is mandatory

Do not remove the Cockpit service from the default firewall zone as the Cockpit service may get blocked, and you may get disconnected from the server.

2.2.1 Adding firewall zones

The *public zone* is the default firewall zone. To add a new zone, proceed as follows:

PROCEDURE 1: ADDING NEW FIREWALL ZONES

- 1. Navigate to the *Networking* page.
- 2. Click Edit rules and zones.
- 3. Click Add new zone.
- 4. Select *Trust level*. Each trust level of network connections has a predefined set of included services (the Cockpit service is included in all trust levels). The description for each trust level appears in the *Description* section.
- 5. Define allowed addresses within the zone. Select one of the values:
 - Entire subnet to allow all addresses in the subnet.
 - Range—a comma-separated list of IP addresses with the routing prefix, for example, 192.0.2.0/24, 2001:db8::/32.
- 6. Click Add zone.

2.2.2 Adding allowed services and ports to a zone

You can add services to an existing firewall zone as described below:

PROCEDURE 2: ADDING SERVICES TO A FIREWALL ZONE

1. Navigate to the Networking page.

- 2. Click Edit rules and zones.
- 3. Click Add services.
- 4. To add a service, select *Services* and choose the services from the list.
- 5. To allow custom ports, select *Custom ports* and specify the port value for UDP and/or TCP. You can assign an identifier to this port.
- 6. To confirm the changes, click *Add services* or *Add ports*, respectively.

3 Common firewalld commands

The **firewall-cmd** command-line tool is used to configure and manage the <u>fire-walld</u> daemon. It is a powerful, dynamic utility that allows for the creation, modification, and deletion of firewall rules without requiring a full service restart, which prevents interruption of active network connections.

Some common firewall-cmd command examples include:

• Checking if firewalld is running. The outputs are running, not running or RUN-NING BUT FAILED. For example:

```
> sudo firewall-cmd --state
running
```

• Listing all available zones, for example:

```
> sudo firewall-cmd --get-zones
block dmz docker drop external home internal nm-shared public trusted work
```

• Viewing the default zone, for example:

```
> sudo firewall-cmd --get-default-zone
public
```

• Viewing the active zones and the assigned, for example:

```
> sudo firewall-cmd --get-active-zones
docker
interfaces: docker0
public (default)
interfaces: lo enp1s0
```

• Viewing all rules for the default zone, for example:

```
> sudo firewall-cmd --list-all
public (default, active)
target: default
ingress-priority: 0
egress-priority: 0
icmp-block-inversion: no
interfaces: enpls0 lo
sources:
services: cockpit dhcpv6-client ssh
ports:
protocols:
forward: yes
masquerade: no
forward-ports:
source-ports:
icmp-blocks:
rich rules:
rule family="ipv4" source address="192.168.1.100" service name="ssh" accept
```

• Viewing all rules for a specific zone, for example:

```
> sudo firewall-cmd --zone=public --list-all
public (default, active)
target: default
ingress-priority: 0
egress-priority: 0
icmp-block-inversion: no
interfaces: enp1s0 lo
sources:
services: cockpit dhcpv6-client ssh
ports:
protocols:
forward: yes
masquerade: no
forward-ports:
source-ports:
icmp-blocks:
rich rules:
rule family="ipv4" source address="192.168.1.100" service name="ssh" accept
```

• Listing all available predefined services, for example:

```
> sudo firewall-cmd --get-services
   0-AD RH-Satellite-6 RH-Satellite-6-capsule afp alvr amanda-client amanda-k5-client
amap amaps anno-1602 anno-1800
```

```
apcupsd audit ausweisapp2 bacula bacula-client bareos-director bareos-filedaemon
bareos-storage bb bgp bitcoin bitcoin-rpc
 bitcoin-testnet bitcoin-testnet-rpc bittorrent-lsd ceph ceph-exporter ceph-mon
cfengine checkmk-agent civilization-iv civilization-v
 cockpit collectd condor-collector cratedb ctdb dds dds-multicast dds-unicast dhcp
dhcpv6 dhcpv6-client distcc dns dns-over-quic dns-over-tls
 docker-registry docker-swarm dropbox-lansync elasticsearch etcd-client etcd-server
factorio finger foreman foreman-proxy freeipa-4 freeipa-ldap
 freeipa-ldaps freeipa-replication freeipa-trust ftp galera ganglia-client ganglia-
master git gpsd grafana gre http http3 https ident imap imaps
 ipfs ipp ipp-client ipsec irc ircs iscsi-target isns jenkins kadmin kdeconnect
kerberos kibana klogin kpasswd kprop kshell kube-api kube-apiserver
 kube-control-plane kube-control-plane-secure kube-controller-manager kube-
controller-manager-secure kube-nodeport-services kube-scheduler kube-scheduler-
secure
  [...]
```

• Listing the services currently allowed in the default zone, for example:

```
> sudo firewall-cmd --list-services
cockpit dhcpv6-client ssh
```

• Adding a service to the default zone permanently, for example:

```
> sudo firewall-cmd --permanent --add-service=http
success
```

• Removing a service permanently, for example:

```
> sudo firewall-cmd --permanent --remove-service=http
success
```

• Listing the ports currently open in the default zone, for example:

```
> sudo firewall-cmd --list-ports
22/tcp
```

• Opening a specific TCP port temporarily, for example:

```
> sudo firewall-cmd --add-port=8080/tcp
success
```

• Removing an open port permanently, for example:

```
> sudo firewall-cmd --permanent --remove-port=8080/tcp
```

```
success
```

• Adding an interface to a specific zone temporarily, for example:

```
> sudo firewall-cmd --zone=trusted --add-interface=eth1 f
success
```

4 firewalld troubleshooting

Troubleshooting <u>firewalld</u> involves checking its status, verifying rules, and restarting or reloading the service. If you encounter issues, you can enable debugging, examine logs and adjust firewall rules as needed.

4.1 Check firewalld status

• Use the **systemctl status** command, for example:

• The **firewall-cmd --state** command gives a quick status check with <u>running</u>, <u>not running</u> or RUNNING BUT FAILED outputs. For example:

```
> sudo firewall-cmd --state
running
```

• If firewalld is not running, use the **systemctl start firewalld** command.

```
> sudo systemctl start firewalld
```

• If the firewalld service is masked, unmask it first, then enable and start it, for example:

```
> sudo systemctl unmask --now firewalld
> sudo systemctl enable firewalld
> sudo systemctl start firewalld
```

4.2 Check firewalld rules

• The **firewall-cmd --list-all-zones** command displays all zones and their rules, for example:

```
> sudo firewall-cmd --list-all-zones
        block
          target: %%REJECT%%
          ingress-priority: 0
          egress-priority: 0
          icmp-block-inversion: no
          interfaces:
          sources:
          services:
          ports:
          protocols:
          forward: yes
          masquerade: no
          forward-ports:
          source-ports:
          icmp-blocks:
          rich rules:
        dmz
          target: default
          ingress-priority: 0
          egress-priority: 0
          icmp-block-inversion: no
          interfaces:
          sources:
          services: ssh
          ports:
          protocols:
```

```
forward: yes
  masquerade: no
  forward-ports:
  source-ports:
  icmp-blocks:
    rich rules:

docker (active)
    target: ACCEPT
  ingress-priority: 0
  egress-priority: 0
  icmp-block-inversion: no
[...]
```

• The **firewall-cmd --list-ports** command shows open ports, for example:

```
> sudo firewall-cmd --list-ports
22/tcp
```

• The <u>firewall-cmd --zone=YOUR_ZONE --list-all.</u> command lists ports for specific zones, for example:

```
> sudo firewall-cmd --zone=dmz --list-all
                  target: default
                  ingress-priority: 0
                  egress-priority: 0
                  icmp-block-inversion: no
                  interfaces:
                  sources:
                  services: ssh
                  ports:
                  protocols:
                  forward: yes
                  masquerade: no
                  forward-ports:
                  source-ports:
                  icmp-blocks:
                  rich rules:
```

4.3 Debugging firewalld

• Enable debugging in /etc/sysconfig/firewalld by adding --debug=[level] to FIRE-WALLD_ARGS, for example:

```
> sudo vi /etc/sysconfig/firewalld
# firewalld command line args
# possible values: --debug
FIREWALLD_ARGS=--debug=[level]
```

• Start firewalld with the --debugoption, for example:

```
> sudo firewalld --nofork --debug
2025-07-23 11:10:05 DEBUG1: start()
2025-07-23 11:10:05 DEBUG1: Loading firewalld config file '/etc/firewalld/
firewalld.conf'
2025-07-23 11:10:05 DEBUG1: CleanupOnExit is set to 'True'
2025-07-23 11:10:05 DEBUG1: CleanupModulesOnExit is set to 'False'
2025-07-23 11:10:05 DEBUG1: IPv6 rpfilter is enabled
2025-07-23 11:10:05 DEBUG1: LogDenied is set to 'off'
2025-07-23 11:10:05 DEBUG1: FirewallBackend is set to 'nftables'
2025-07-23 11:10:05 DEBUG1: FlushAllOnReload is set to 'False'
2025-07-23 11:10:05 DEBUG1: RFC3964 IPv4 is set to 'True'
2025-07-23 11:10:05 DEBUG1: NftablesFlowtable is set to 'off'
2025-07-23 11:10:05 DEBUG1: NftablesCounters is set to 'False'
2025-07-23 11:10:05 DEBUG1: Loading lockdown whitelist
2025-07-23 11:10:05 ipset not usable, disabling ipset usage in firewall. Other set
backends (nftables) remain usable.
2025-07-23 11:10:05 iptables-restore and iptables are missing, IPv4 direct rules
won't be usable.
2025-07-23 11:10:05 ip6tables-restore and ip6tables are missing, IPv6 direct rules
won't be usable.
2025-07-23 11:10:05 ebtables-restore and ebtables are missing, eb direct rules won't
2025-07-23 11:10:05 DEBUG1: Loading icmptype file '/usr/lib/firewalld/icmptypes/
address-unreachable.xml'
2025-07-23 11:10:05 DEBUG1: Loading icmptype file '/usr/lib/firewalld/icmptypes/bad-
header.xml'
2025-07-23 11:10:05 DEBUG1: Loading icmptype file '/usr/lib/firewalld/icmptypes/
beyond-scope.xml'
2025-07-23 11:10:05 DEBUG1: Loading icmptype file '/usr/lib/firewalld/icmptypes/
communication-prohibited.xml'
2025-07-23 11:10:05 DEBUG1: Loading icmptype file '/usr/lib/firewalld/icmptypes/
destination-unreachable.xml'
[...]
```

5 More information

To learn more about firewalld, refer to the following resources:

- The official source for concepts, architecture, how-to and links to all man pages. (https://fire-walld.org/documentation/)

 ✓
- Man page essential for understanding command-line interaction with <u>firewalld</u> (https://fire-walld.org/documentation/man-pages/firewall-cmd.html)
- A comprehensive resource with excellent explanations and practical examples that also cover nftables. (https://wiki.archlinux.org/title/Firewalld)

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