SPR Guide v0.3.2

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SPR : A Secure Programmable Router

SPR lets users run security-hardened networks without restrictive drawbacks by providing adaptive microsegmentation with flexibility.

Fundamentally Secure

SPR is a new type of router, designed to be immune to network attacks that enable devices to breach laterally across networks which separates it from other networking technology. SPR addresses WiFi in particular, as it typically has weak security properties that SPR corrects through robust, defense-in-depth features. It also supports `VLAN Tagging` for wired devices and `Wireguard™ VPN` clients.

The Network Design

Default deny

The firewall drops forwarded and input packets by default. Devices are explicitly configured for communicating to the internet, accessing DNS, or intranet communications.

Zero-trust networking

Device identities are established via unique wifi passphrases, VLAN tagging on wired devices, and VPN keys. This creates a high source of confidence about how traffic is routed.

Device isolation

Each device on the network is isolated into its own private network, and devices send traffic through the router to communicate.

▾ How does this perform?

There is a negligible latency tradeoff when devices do not directly communicate on local networks. The router arbitrates communication between devices for better control. The verdict maps, similar to ipsets, provide scalable rules without an exponential number of firewall rules that make traditional firewall rules prohibitively slow.

Best of class WiFi features

Each device is given a unique WiFi passphrase to block traffic interception, injection, and rogue AP attacks that are otherwise possible with WiFi. Devices have unique group encryption keys and each device connects with an individual VLAN and virtual interface. SPR is also the very first project to support multiple passphrases with WPA3 on the same SSID.

<details>
<summary>What about Enterprise WiFi Security?</summary>

Among authentication suites, EAP-TLS is a recommended best practice and creates valid security properties. However, it requires installing certificates on devices which is not possible with many IOT or locked down devices, limiting the ability to harden their access. Rather than create MAC bypass holes, SPR uses the most commonly supported schemes that are universal to all wifi capable systems. Another common authentication mechanism is EAP-PEAP however this suffers from long standing MITM issues as PEAPv2 with channel binding to stop attacks was never formally adopted or fully supported by the industry; the PEAP relay attack applies after secure authentication has happened.
</details>

Multicast Support

Zeroconf and mDNS are both prevalent and a requisite for home networking. However, these require being on the same subnet to work or a router that supports IGMP forwarding or a proxy. SPR has a userland proxy to transparently relay multicast traffic between devices and across network interfaces. The firewall supports configuration for how to use multicast

Design Ethos

Transparent and Modifiable

SPR is built as an open source project. It is built to be developer friendly and allow iterative development without reflashing or reinstalling.

Containerized

Containers make it simple to build the code from scratch or run prebuilt images. The containers split network services up by functionality and are orchestrated with APIs. SPR is built to run as a WiFi router, but it can also be launched as a standalone VPN & DNS Service within a virtualized network namespace.

Sound Software Selection

SPR is built mostly with golang and a react frontend. Where possible, memory-safe languages with good security track records are preferred over native code such as C or code that is difficult to write securely, like PHP.

The Service Listing

The following services are currently included with SPR:

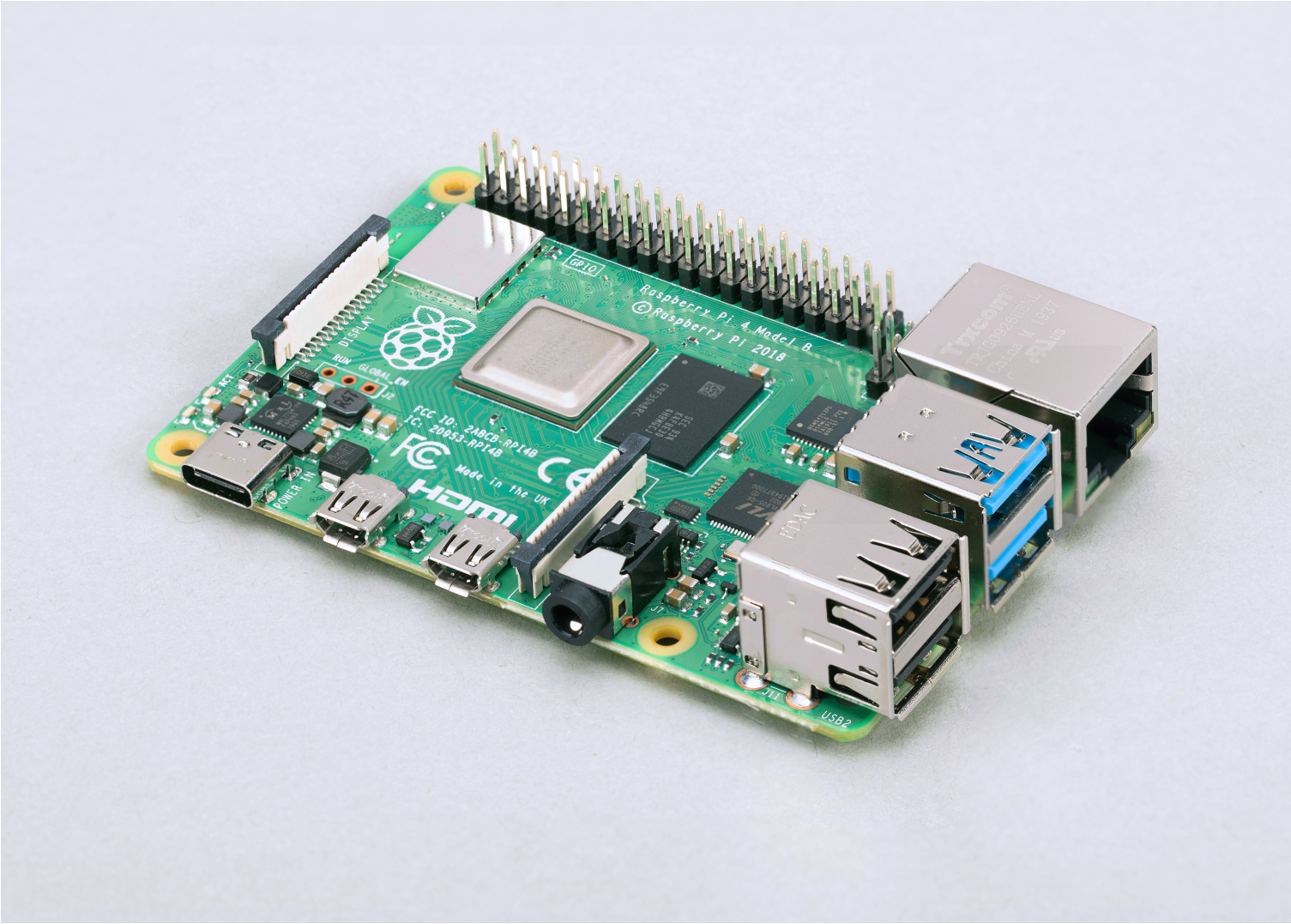
- api ⇨ API for frontends and CLIs to manage connected devices, network groups, and firewall rules
- base ⇨ Networking initialization and configuration at startup
- db ⇨ Database key/value store
- dhcp ⇨ DHCP Server
- dhcp_client ⇨ DHCP Client for requesting IP addresses from uplink
- dns ⇨ DNS Service, running CoreDNS
- multicast_udp_proxy ⇨ A multicast proxy to support multicast networking for usability
- packet_logs ⇨ NFLog packet log emitter
- ppp ⇨ A Point-to-Point protocol service for authenticating and requesting IP addresses from uplink
- superd ⇨ Daemon to manage docker comms and restarting SPR
- wifid ⇨ Wifi Base Station Service, running hostapd

API Extensions

- DNS Block & Log ⇨ Fine grained DNS Rules & Logs
- Wireguard ⇨ Configuration service for running a Wireguard VPN

- Lookup ⇨ OUI & ASN Lookup Service
- Dyndns ⇨ Dyndns Service

Raspberry Pi 4 Model B Hardware Guide



Hardware Requirements

The current setup assumes you'll be using a Raspberry Pi Model 4b with an mt76 based wireless adapter. The built-in ethernet port of the Raspberry Pi is connected to upstream/WAN/internet.

Running SPR

- A WiFi Dongle for better performance and WPA3 support. The following WiFi6 dongles work great: Netgear's A8000 6-E, and the bulkier ALFA AWUS036AXML 6-E. For Wifi5: Netgear's A620 and

Alfa's AWUS036ACM.

> **WIFI DONGLES**
>
> The WiFi 5 dongles have been tested to perform well with a *500-550Mbps* top speed in a low noise environment and the WiFi 6 dongles can reach closer to *700mpbs* in a low noise environment.

- A USB SSD works best. A 16GB SD card can also be used but is not recommended
- Ethernet cable for setup (and if you run uplink over the wire)
- *Optional* For running multiple WiFi adapters, a powered USB 3.0 capable hub is recommended
- *Optional* An Ethernet USB Dongle for additional LAN devices since the built-in ethernet card (eth0) will be used for the WAN. The UE 300 has been tested to run near line speed on the Pi (*950Mbps*). The U3 330 also works and provides additional USB 3.0 ports.

> **TIP**
>
> Grab the Complete Starter Kit for everything you need to get started here

Building from source

- 8 GB of RAM are recommended for building SPR on the Pi. Any amount of RAM can work for building but ramdisks have to be disabled in the docker build. The prebuilt GHCR has prebuilt SPR images available also.

Using a different wireless card

For using a different wireless adapter, the default hostapd configuration may need to be modified in the UI or in `configs/wifi/`. Note that the built-in Raspberry Pi Wireless card can not be used as an AP by default as it does not support AP/VLAN, which is a feature that SPR relies on.

Install the SPR Pi 4 Image

For running SPR on a Raspberry Pi 4, a pre-built image is available on the releases page.

You can download `spr.img.xz` and flash it with a tool such as Balena Etcher, or if you prefer to write the image using the command line:

```
# On a mac, write the image to the external disk (rdiskX).
# Be careful to make sure you identify your removable drive correctly.
$ xzcat spr.img.xz | dd of=/dev/rdiskX bs=$[1024*1024]
```

> **TIP**
>
> If you use Balena Etcher be sure to download the image first and choose *Flash from file*.

Running

1. Plug in SPR to your local network using a ethernet cable
2. Boot the drive on the Pi - setup will complete on device and reboot
3. Visit http://spr.local to setup your device

Default credentials for ssh are: `ubuntu:ubuntu`

> **UPSTREAM SERVICES**
>
> Under `/home/spr/super/config/base/config.sh`, consider disabling `UPSTREAM_SERVICES_ENABLE=1` if you do not want the API and SSH exposed to the WAN ethernet interface. This can also be toggled under the Firewall Services tab in the UI.

Follow the SPR Setup Guide

If you prefer to run on an existing image, or run from a fresh Ubuntu server install, you can Follow the SPR setup guide

Setup Guide

SPR is built to run on systems capable of running Ubuntu and Docker. For also developing on-device, systems should have 32-64GB of writable storage and 8GB of RAM. With less RAM, building from ram disks should be disabled (see the README).

Base System Setup

NOTE This guide shows how to setup and run SPR using Docker. See the Raspberry Pi 4 Setup Guide for running SPR using a prebuilt image.

Download and install Ubuntu Server

Skip this step if you already have a base system setup.

For Running on a Raspberry Pi you can download the 23.04 Ubuntu image here. For other hardware, download an Ubuntu server installer for your architecutre (arm64 or amd64), then boot the device into the installer.

SPR has been tested mainly on ubuntu release however many Linux distributions should work.

Write image to SD-card or USB

You can flash the image with a tool such as Balena Etcher @ https://www.balena.io/etcher/

If you prefer to write the image using the command line:

```
# On a mac, write the image to the external disk (rdiskX).
# Be careful to make sure you identify your removable drive correctly.
$ xzcat ubuntu-22.0-4-preinstalled-server-arm64+raspi.img.xz | dd
of=/dev/rdiskX bs=$[1024*1024]
```

Setup

Boot the system and login, the default credentials are `ubuntu/ubuntu`

Fetch the SPR repository

```
# On the booted system
git clone https://github.com/spr-networks/super
cd super
```

Prepare the Ubuntu Install for SPR base/setup.sh

```
#if using a flash drive
sudo base/setup.sh
#or if using an sdcard the following script reduces disk usage
# base/setup-sdcard.sh #this setup will reduce writes from log files
reboot
```

Configuration

Inside the super directory, copy `base/template_configs/` to `configs/`

```
cd super
cp -R base/template_configs configs
./configs/scripts/gen_coredhcp_yaml.sh > configs/dhcp/coredhcp.yml
./configs/scripts/gen_watchdog.sh  > configs/watchdog/watchdog.conf
```

Verify the main config `configs/base/config.sh` is correct. Ensure that `WANIF` matches the name of the outbound interface if not using the builtin ethernet port.

Also, consider disabling `UPSTREAM_SERVICES_ENABLE=1` if you do not want the API and SSH exposed to the WAN port.

Run SPR

Start the services (this script runs `docker-compose up -d`):

```
./run_docker_compose.sh
```

Testing containers are built and published to GitHub's Container Registry, and can be run without building on the device. If you would instead like to build everything from source, proceed to the next section.

To see logs:

```
docker-compose logs -f
```

Run SPR dev release

If you want to get the latest features and updates you can switch to the dev release of SPR by setting the `RELEASE_VERSION` and `RELEASE_CHANNEL` environment variables:

```
export RELEASE_VERSION="latest" RELEASE_CHANNEL="-dev"
./run_docker_compose.sh
```

Setting the `RELEASE_VERSION` variable can also be used to run specific versions:

```
export RELEASE_VERSION="v0.1.28"
./run_docker_compose.sh
```

Building the project

SPR can be built on device, however there is a small gotcha.

Because SPR uses `nftables` exclusively, and docker is made to work with `iptables` which the SPR install disables for docker, a fixup script is needed.

The script installs minimal docker forwarding rules. Once SPR is running this is no longer needed. However, is SPR fails to run and you need to build with docker, you may need to run this script again.

```
#fix forwarding rules for Docker
sudo ./base/docker_nftables_setup.sh
```

And build.

```
sudo ./build_docker_compose.sh
```

If something went wrong with with a cached stage, it is possible to specify `--no-cache`. For example: `sudo ./build_docker_compose.sh --no-cache`

A specific service can also be built by passing it as an argument (`./build_docker_compose.sh api`)

To run the local build:

```
./run_docker_compose.sh
```

Additional Notes

Check dns-Corefile to tweak DNS server configuration as well as the hostapd settings in `configs/dns/`

It is possible to use SPR's DNS server for the host system's DNS requests too, by updating the resolv.conf file.

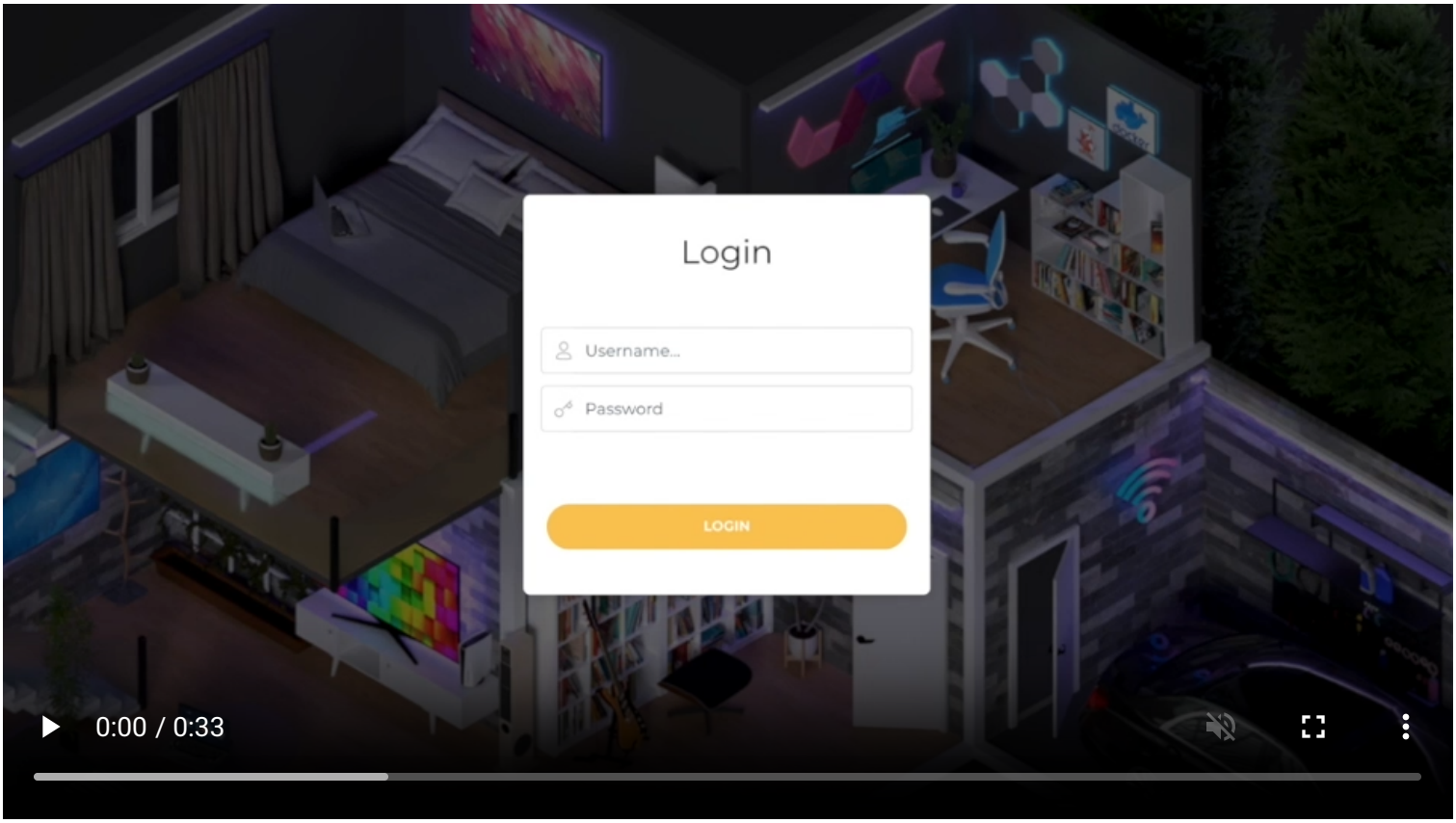
```
sudo echo -e "nameserver 127.0.0.1" > /etc/resolv.conf
```

Sign in to the Web UI

Connect to the IP of the device from the wired WAN interface in a browser, SPR is using mDNS and you should be able to reach it @ http://spr.local.

A setup screen should show up asking you to set up interfaces and assign a username and password.

Add new devices


Login
Username...
Password
LOGIN
0:00 / 0:33

Virtual Setup Guide

SPR can run its services in a network namespace and expose Wireguard or DNS as services. This is helpful for running SPR in the cloud as a personal VPN, for example.

Quick Setup

```
sudo bash -c "$(curl -fsSL https://raw.github.com/spr-networks/super/master/virtual_install.sh)"
```

This will download the SPR repository and run *virtual_install.sh*. The script will install dependencies, start all the containers and add one peer that can connect to the VPN. See the next section for a walkthrough of the script.

If you want to add another device, just run the setup script again:

```
cd super
sudo ./virtual_install.sh
```

Next setup a client to connect to SPR over VPN.

Host network configuration

Your source ip address need to be able to access the host running spr on port 51280/udp. For setup in the cloud, see the blog specific vendor guides for network configuration:

- Google Cloud
- Amazon AWS
- Digital Ocean

Manual configuration

Clone the super repository

```
git clone https://github.com/spr-networks/super.git
```

Install dependencies

```
apt install -y curl git docker-compose docker.io jq qrencode iproute2
wireguard-tools
```

Configuration

1. **Populate the configuration directory**

```
cd super
cp -R base/template_configs/ configs/
```

2. **Enable virtual config in `configs/base/config.sh`**

```
cp configs/base/virtual-config.sh configs/base/config.sh
```

Example configuration:

```
#!/bin/sh
VIRTUAL_SPR=1
UPSTREAM_SERVICES_ENABLE=1
WANIF=eth0
RUN_WAN_DHCP=true
RUN_WAN_DHCP_IPV=4
LANIP=192.168.2.1
DNSIP=$LANIP
TINYNETSTART=192.168.2.4
TINYNETSTOP=192.168.2.255
TINYNETMASK=255.255.255.252
TINYSLASHMASK=30
WIREGUARD_PORT=51280
```

3. **Set an api username and password for the web UI**

```
```

```
echo "{\"admin\" : \"your password goes here\"}" >
configs/auth/auth_users.json
```

Start the SPR Services

```
docker-compose -f docker-compose-virt.yml up -d
```

Note: *On MacOS you may need to modify docker-compose-virt.yml to disable the* `journald` *driver and enable the* `json-file` *driver instead.*

Optional Copy the virtual config for easier control of the docker containers:

```
cp docker-compose-virt.yml docker-compose.yml
```

Now you can run `docker-compose restart` in the super directory to restart all the containers.

Sign in to the Web UI

The API is setup to listen on localhost:8000 on the host. To access the service from your local machine, forward port 8000 using ssh:

```
ssh $HOST -N -L 8000:127.0.0.1:8000
```

Navigate to http://localhost:8000/

Sign in with the username and password assigned in step 3 of the configuration.

Setup and connect to VPN

In the SPR web UI, navigate to VPN and click **Add peer**, enable the *lan* group if you want to be able to connect to the admin interface over VPN.

Click **Save** and download the client config or scan the QR Code on your phone with the official WireGuard (© *Jason A. Donenfeld*) client.

Check this guide on how to setup the VPN client for your device.

Note SPR exposes port 51280 over UDP (see `$WIREGUARD_PORT` in config.sh) on the host. If a firewall is present you will need to allow access to this port. Check the documentation for your hosting provider on how to do this.

Overview

Need a guide thats missing? File a ticket

Updating SPR

- How to update

Manage Devices

- Add a Device
- Edit Devices
- Copy a device

Mange DNS Rules

- DNS Block Lists Block Ads, Tracking & More
- DNS & Tags Make block lists select devices by Tag
- DNS Overrides Make custom DNS Rules
- DNS Settings Set DNS Privacy settings, DNS Provider
- DNS Logs Inspect DNS Queries

Link Setup

Uplink Configuration

- Set DHCP settings or assign a Static IP
- Enable a Wireless Uplink

Downlink Configuration (LAN)

- Enable Wired LAN Interface

- Enable VLAN Trunk Port

Firewall

Common rules

- Port Forwarding is if you want to open a port *from WAN* and forward the traffic to a local device
- Inbound Traffic Block block access from a specific address and/or destination
- Forwarding Traffic Block allow/block devices from your local network

Advanced firewall configuration

- Custom Interface Access - Join a docker bridge or custom interface to SPR networking
- Multicast Proxy -- Configure mDNS, SSDP, and other UDP broadcast services
- Endpoints - Define one-way connectivity rules

Logging and Events

- Events view
- Enable notifications
- Using the cli tools

WiFi Settings

- wifi-spr-compability
- Updating SSID Name
- Channel configuration

Docker Tips & Tricks

SPR runs inside of containers. It can run a network inside of a network namespace, or with the host network namespace. Here are some useful things to know

Virtual mode

Super ships with 3 docker compose files

- `docker-compose.yml` the default for running SPR on the host network
- `docker-compose-virt.yml` for running SPR in virtual bridge, for example for a cloud VPN
- `docker-compose-test.yml` for running the end to end tests

If using SPR in virtual mode, make sure to use the virtual compose file.

```
docker compose -f docker-compose-virt.yml up -d
```

Updating from the command line

```
sudo -s
cd /home/spr/super/
docker compose pull
docker compose up -d
```

Listing running containers

```
docker ps
```

```
root@haxlab0:/home/spr/super# docker ps
CONTAINER ID   IMAGE                                                COMMAND
CREATED          STATUS                  PORTS     NAMES
ad9f3a4aa353   ghcr.io/spr-networks/super_wifid:latest
"/bin/sh -c /scripts…"   17 seconds ago   Up Less than a second
superwifid
e509fed11404   ghcr.io/spr-networks/super_wireguard:latest
"/scripts/startup.sh"    28 seconds ago   Up 1 second
```

```
superwireguard
5b0cec25f671   ghcr.io/spr-networks/super_multicast_udp_proxy:latest
"/scripts/startup.sh"    28 seconds ago   Up 2 seconds
super_multicast_udp_proxy
746c2599eb42   ghcr.io/spr-networks/super_db:latest
"/scripts/startup.sh"    28 seconds ago   Up 2 seconds
superdb
63c30c8dbc83   ghcr.io/spr-networks/super_plugin-lookup:latest
"/scripts/startup.sh"    28 seconds ago   Up 2 seconds
superplugin-lookup
8c54ec9f1769   ghcr.io/spr-networks/super_api:latest
"/scripts/startup.sh"    39 seconds ago   Up 4 seconds
superapi
a1679ce36ca4   ghcr.io/spr-networks/super_dhcp:latest
"/scripts/startup.sh"    39 seconds ago   Up 4 seconds
superdhcp
a69a08569bd8   ghcr.io/spr-networks/super_dhcp_client:latest
"/scripts/client.sh"     39 seconds ago   Up 4 seconds
superdhcp_client
4ca730f9cf84   ghcr.io/spr-networks/super_dns:latest
"/bin/sh -c /scripts…"   39 seconds ago   Up 4 seconds
superdns
d5ff0bd8d40d   ghcr.io/spr-networks/super_base:latest
"/bin/sh -c /scripts…"   50 seconds ago   Up 5 seconds
superbase
fc8006db1370   ghcr.io/spr-networks/super_superd:latest
"/scripts/startup.sh"    50 seconds ago   Up 5 seconds
superd
e58a351190b1   ghcr.io/spr-networks/super_packet_logs:latest
"/scripts/startup.sh"    50 seconds ago   Up 5 seconds
superpacket_logs
8a94e9476931   spr-nexmon-nexmon
"/scripts/startup.sh"    4 weeks ago      Up 3 days
supernexmon
```

Viewing logs

```
docker compose logs -f wifid
```

```
root@haxlab0:/home/spr/super# docker compose logs -f wifid
superwifid  |   % Total    % Received % Xferd  Average Speed   Time    Time
```

```
Time  Current
superwifid  |                                 Dload  Upload   Total   Spent
Left  Speed
100     6  100     6    0     0     65      0 --:--:-- --:--:-- --:--:--    65
superwifid  | wlan1: interface state UNINITIALIZED->COUNTRY_UPDATE
superwifid  | wlan1: interface state COUNTRY_UPDATE->HT_SCAN
```

Entering a container

```
docker exec -it superapi bash
```

```
root@haxlab0:/# ip -br addr
lo               UNKNOWN        127.0.0.1/8 ::1/128
eth0             UP             192.168.2.218/30 fe80::e65f:1ff:fefd:a175/64
wlan1            UP             fe80::9618:65ff:fe55:54ae/64
tailscale0       UNKNOWN        fe80::31cf:a08b:d7e0:47e4/64
docker0          DOWN           172.17.0.1/16 fe80::42:1ff:fea3:7057/64
tailscale        DOWN           172.18.0.1/16
mon0             DOWN
wlan0            UNKNOWN
sprloop          UNKNOWN        192.168.200.1/32 fe80::6416:d1ff:fe70:bf2a/64
wg0              UNKNOWN
root@haxlab0:/#
```

Release Channels

Want to test the dev branch? Don't want to build it? You can use the `-dev` RELEASE_CHANNEL

```
export RELEASE_CHANNEL=-dev
docker compose pull
```

Starting plugins without the `api/superd`

The `SUPDERDIR` path is required to let docker compose know where the state and config directories are.

```
```

```
export SUPERDIR=/home/spr/super/
docker compose -f plugins/plugin/docker-compose.yml up -d
```

Building super

For convenience, we provide a script, `build_docker_compose.sh` that will build the containers.

Building with low system memory

To speed up the build a ramdisk is used from docker's buildkit. If that's not possible, consider disabling that capability

```
./build_docker_compose.sh --set "*.args.USE_TMPFS=false"
```

Making an API Extension

Get the sample code

Get the sample code

Read the api docs for information about how plugins work

Buiding & Running

Typically, plugins are placed into the `plugins` directory. These will be included in backups.

Copy the API sample

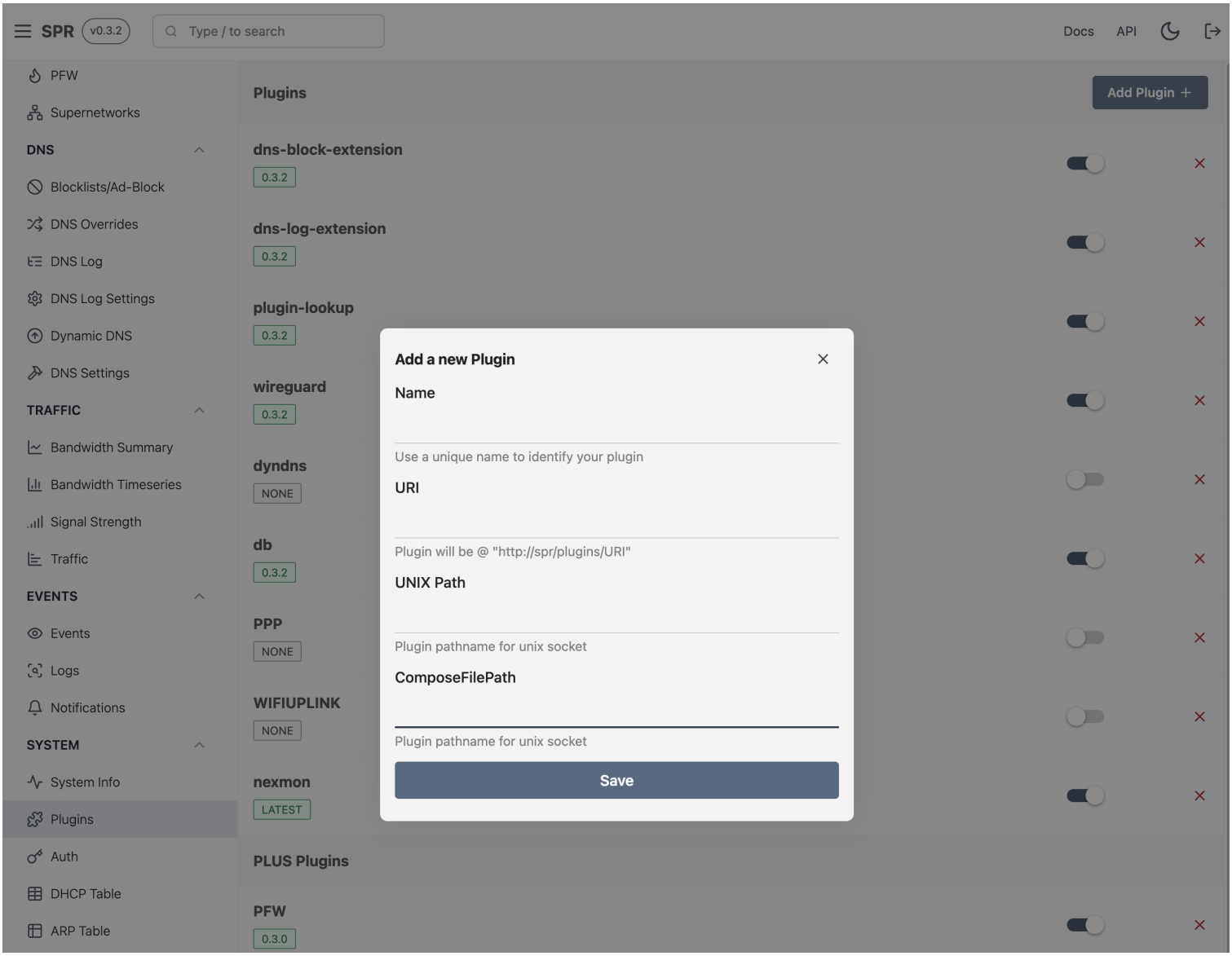
```
cp -R ../api_sample_plugin my_plugin
cd my_plugin
docker compose build
export SUPERDIR=/home/spr/super/ #path where super is
docker compose up
```

API Calls

The plugin can export API extensions over a unix socket to the API. Configuration can be set by updating `configs/base/api.json` and adding a new entry to the `Plugins` list

```
{
 "Name": "my_plugin",
 "URI": "my_plugin"",
 "UnixPath": "/state/plugins/my_plugin/socket",
 "Enabled": true,
 "Plus": false,
 "GitURL": "",
 "ComposeFilePath": ""
},
```

or by updating the UI



Configuring the plugin to auto-start

In an upcoming release, this mechanism will be streamlined for advanced users.

For now, SPR does not allow arbitrary containers to be configured for auto-start from the UI alone. Update the `configs/base/custom_compose_paths.json` to add the plugin. It is expected to be relative from the `super/` directory, for example `plugins/my_plugin/docker-compose.yml`

SPRBus notes

SPRBus is our event bus where the API can send events. The sample includes commented code for how to use it.

Testing

Linux end to end tests

SPR has end to end tests which can be executed on a linux machine with system privilege. The tests will spin up mac80211_hwsim based wireless networks and exercise the API.

See `tests/README.md`

Setup

```
apt install -y linux-image-extra-virtual net-tools iw

cd tests/runner/
./build.sh
cd ../../
```

Run the tests

```
./tests/tests_start.sh
./tests/run-tests.sh
./tests/tests_stop.sh
```

Expected output

```
~ running tests @ http://localhost:8000
~ ID= 8c60362f977d
~ waiting for runner to be done ...
+ test run passed
```

UI Dev

In the super directory, go to the `frontend` directory.

Running the UI with the Mock API

```
super/frontend $ REACT_APP_API=mock yarn start
```

The UI will start on port `localhost:3000`. React scripts will auto open a browser. The UI will update in real time as code changes are made.

Point the UI to your API

```
super/frontend $ REACT_APP_API=http://192.168.2.1 yarn start
```

Run the tests

```
super/frontend $ yarn test
```

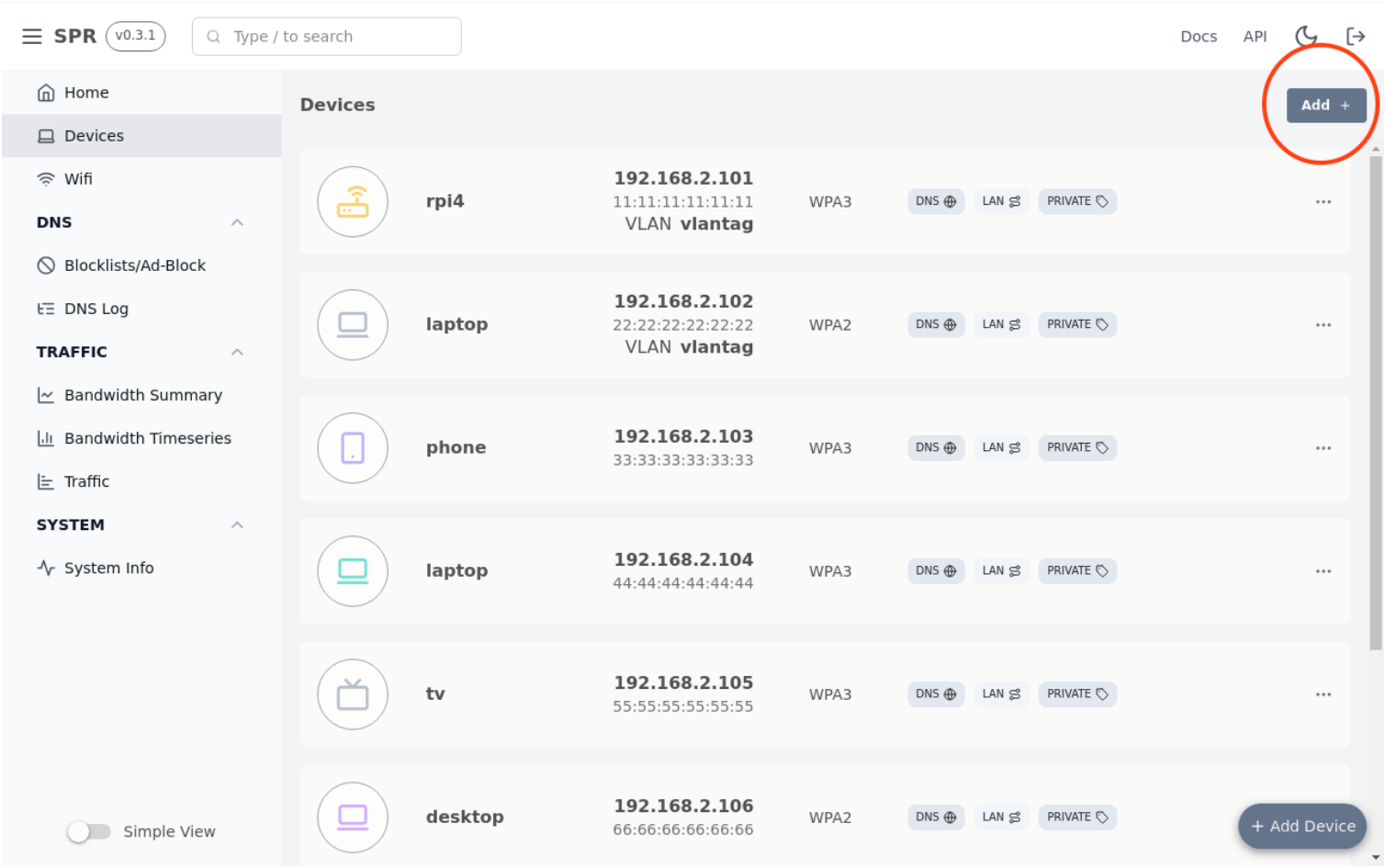
Manage Devices

Add a Device Learn how to add new devices to your network. Since there is no global wifi password, a new entry is made for each new device.

Edit Devices Set tags, edit styles & update device info

Copy a device Lets you share wireless password between devices

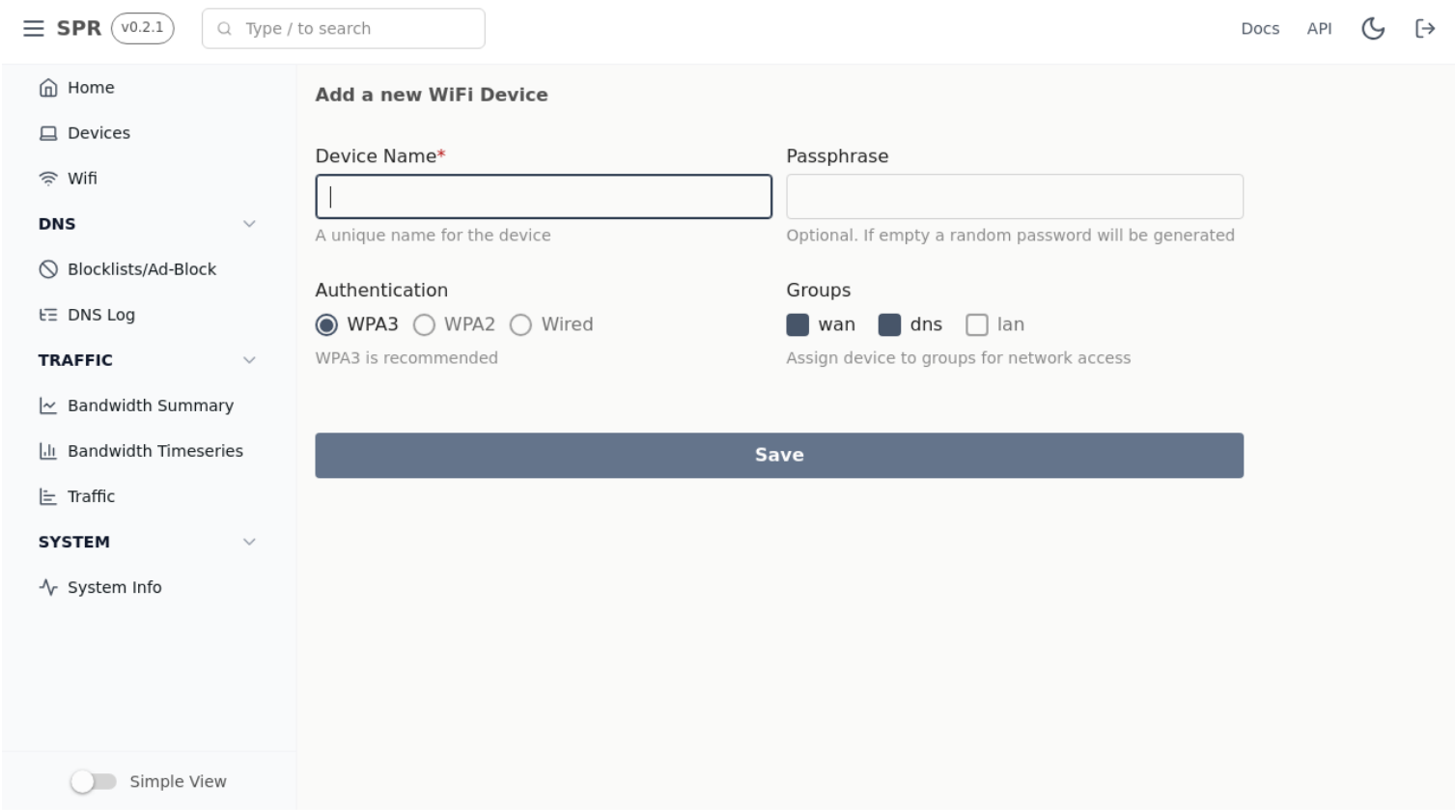
Add a Device



Navigate to *Devices* in the menu & click *Add Device*.

▼ ⚠ iCloud Keychain Sync and WiFi Passwords

You need to set the same password on each of the iOS devices that are in the same keychain. Without this, they would sync the wrong password to each other and lock each other out of the network. You can copy an existing iOS device instead of adding a new one, to keep the same password.



You are required to enter a *Device Name*. Pick a name for your device & enter a password (or leave empty for random), click **Save**.

<details>
<summary>Authentication and Groups</summary>

Authentication

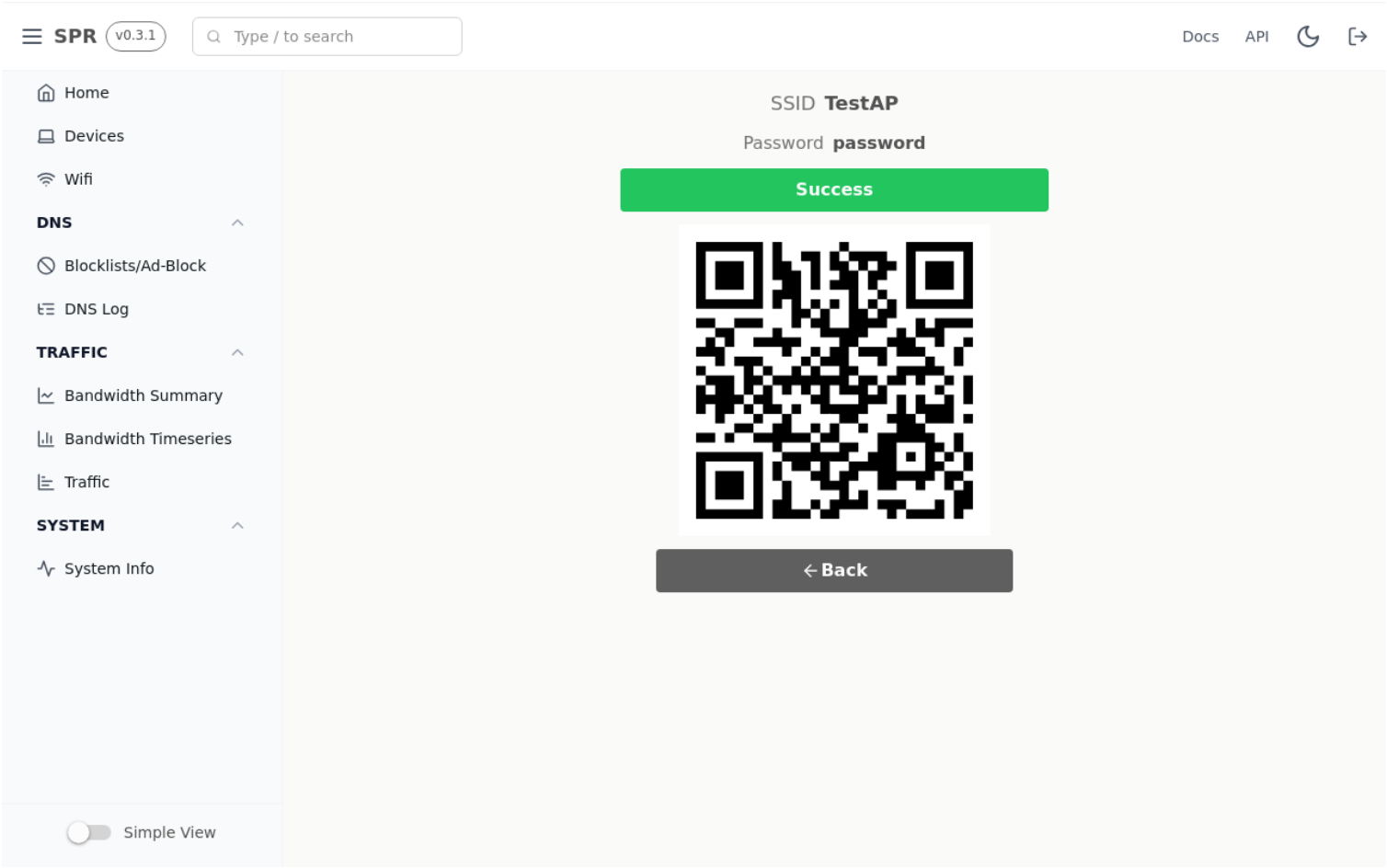
WPA3 works for newer devices and is recommended. Choose *WPA2* if *WPA3* does not work or *Wired* if you are connecting the device over ethernet.

Groups

- **wan** internet access
- **dns** for domain lookups, block/filter dns
- **lan** access to all other local devices
</details>

wan and **dns** is enabled by default. Add the device to **lan** sparingly, as this grants it access to all other devices. You can create groups and rules later for defining more specific access.

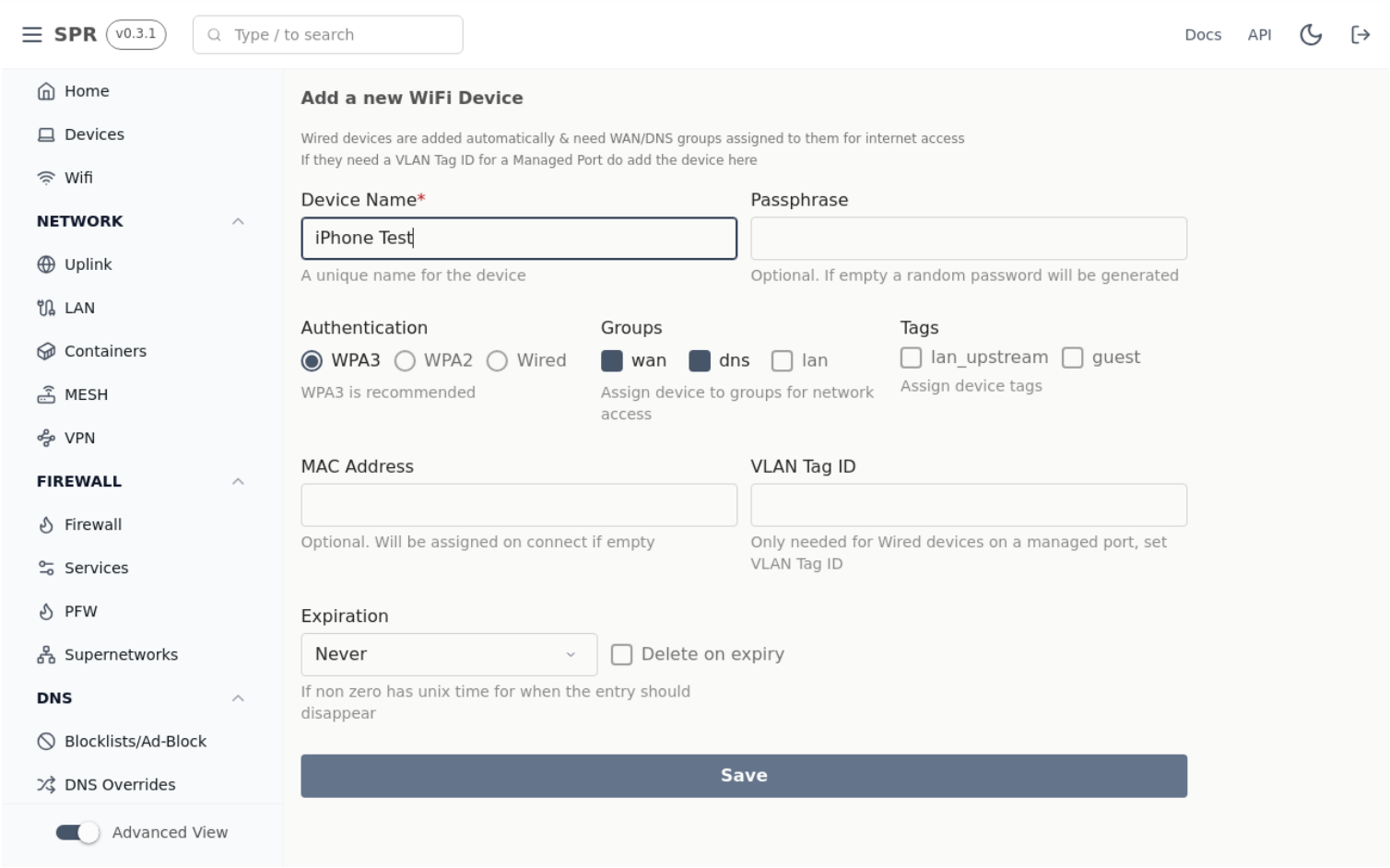
Connect to the Wifi with your device, either by scanning the QR code or with the password.



A notification will popup when the device is connected & the device is available in the device view.

Advanced Settings

Toggle *"Advanced View"* in the menu if you want to add Device expiry & other features.



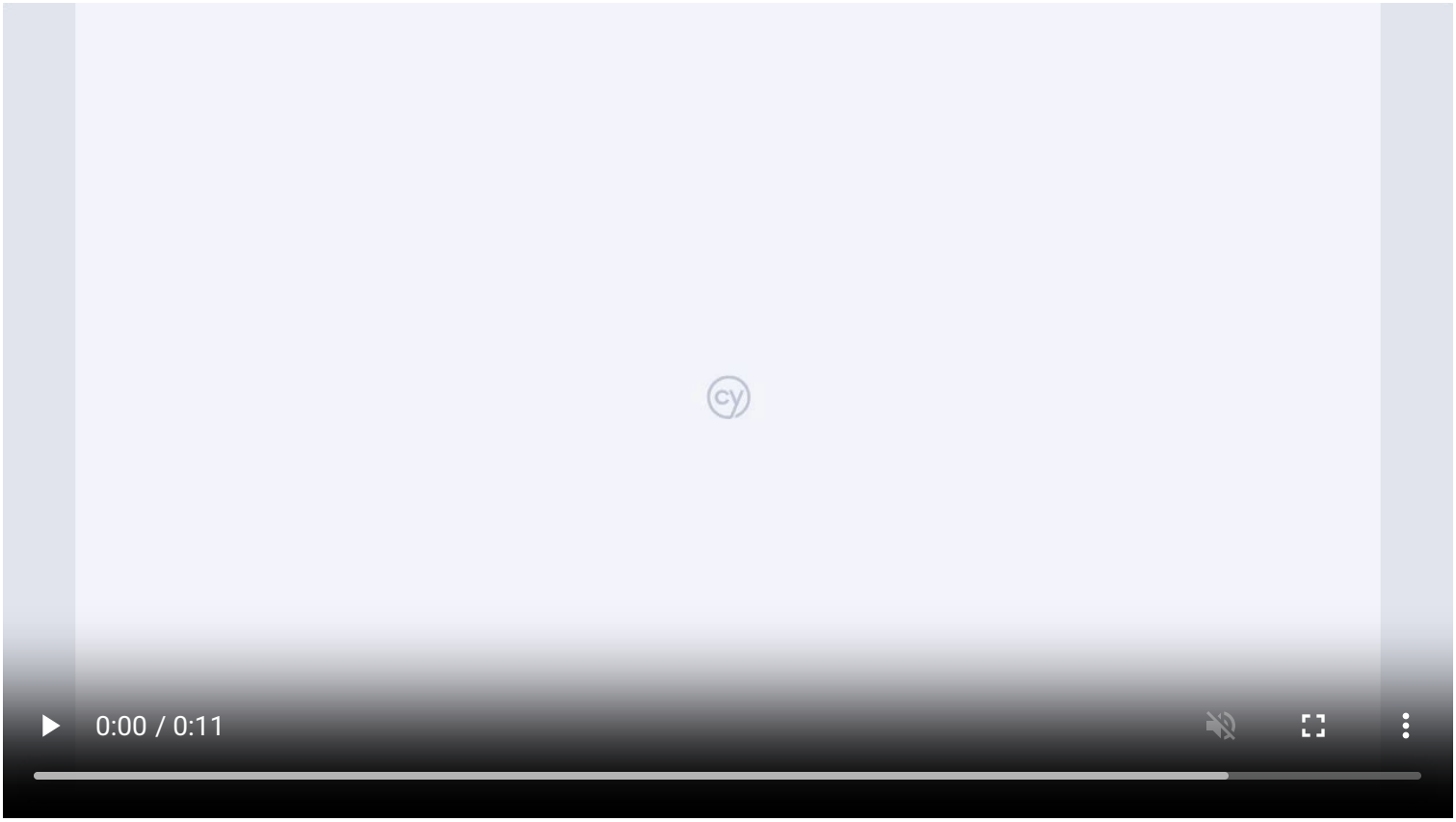
The advanced settings allow you to set MAC address, VLAN Tag ID and other settings for the device.

Tags

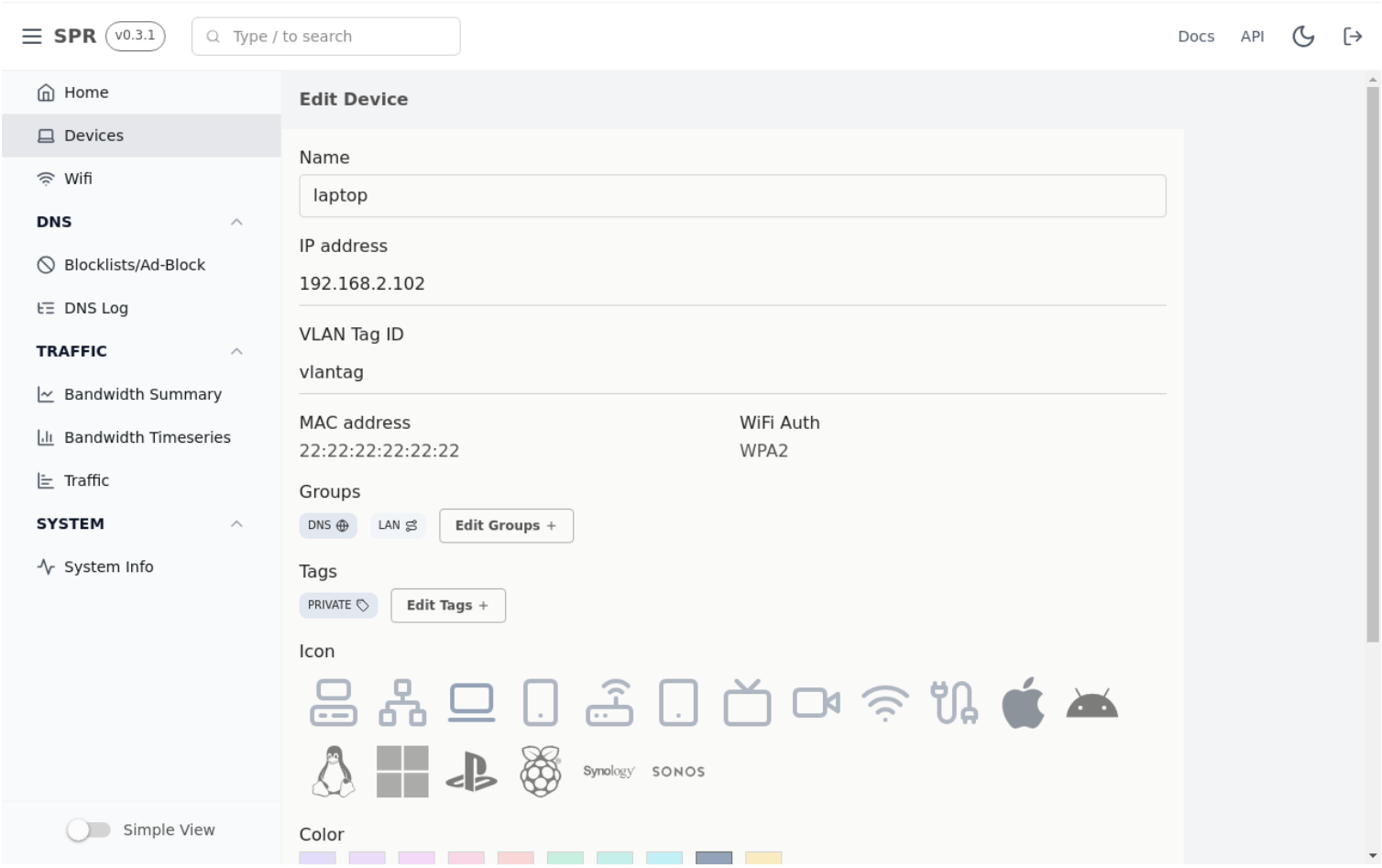
- **lan_upstream** allows the device to query LAN addresses from rfc1918 upstream of SPR
- **guest** if this is a guest device

Set Expiration (example 1 day) if the device only needs temporary access, also if you want to automatically delete the device on expiry.

Edit Device



See video on how to add a new tag for a device & use it to block ads for specific devices.



Set groups, tags, icon, color and other settings for your devices in the edit view.

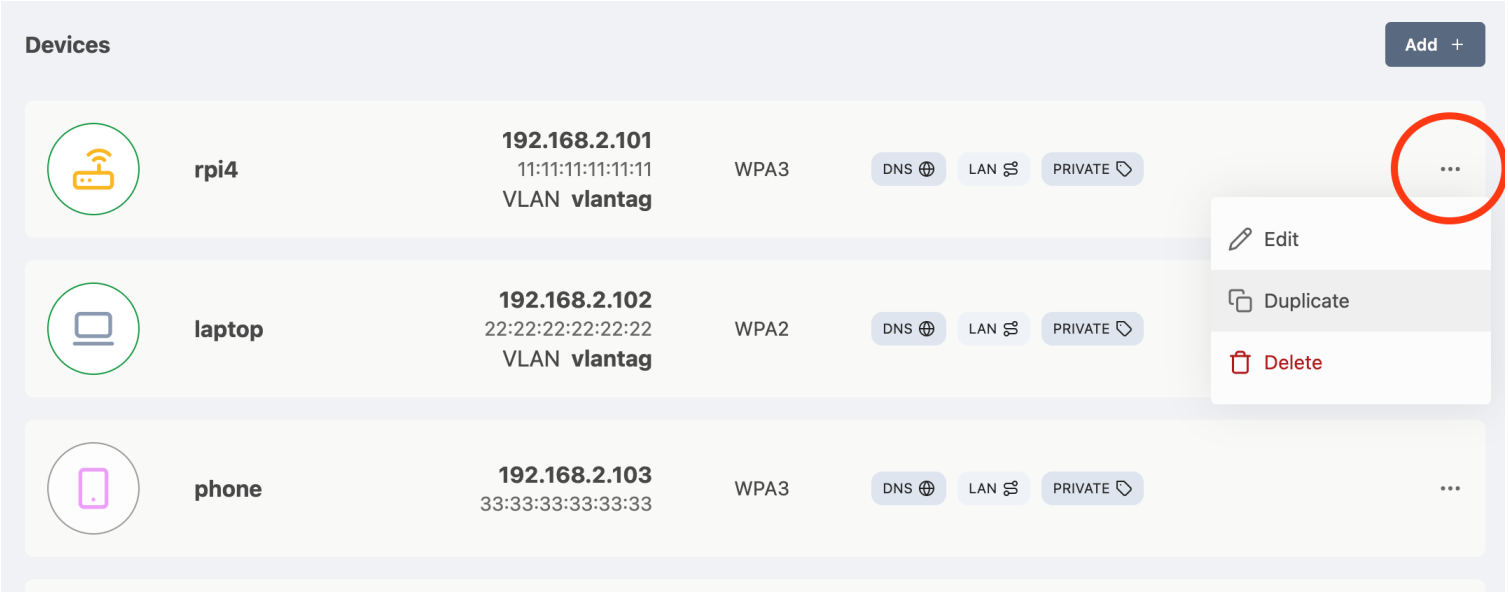
Copy or Duplicate A Device Entry

Click the ellipse on the end of the device listing, and select duplicate, then rename the device. This will copy the device to a new entry, and wait for a connection for a MAC address to be assigned.

The new entry will have the same WiFi password. This is especially useful for devices using iCloud Keychain Sync, which assumes the same WiFi password for all devices.

<details>
<summary>⚠ iCloud Keychain Sync and WiFi Passwords</summary>

You need to set the same password on each of the iOS devices that are in the same keychain. Without this, they would sync the wrong password to each other and lock each other out of the network.
</details>



DNS Block Lists & Settings

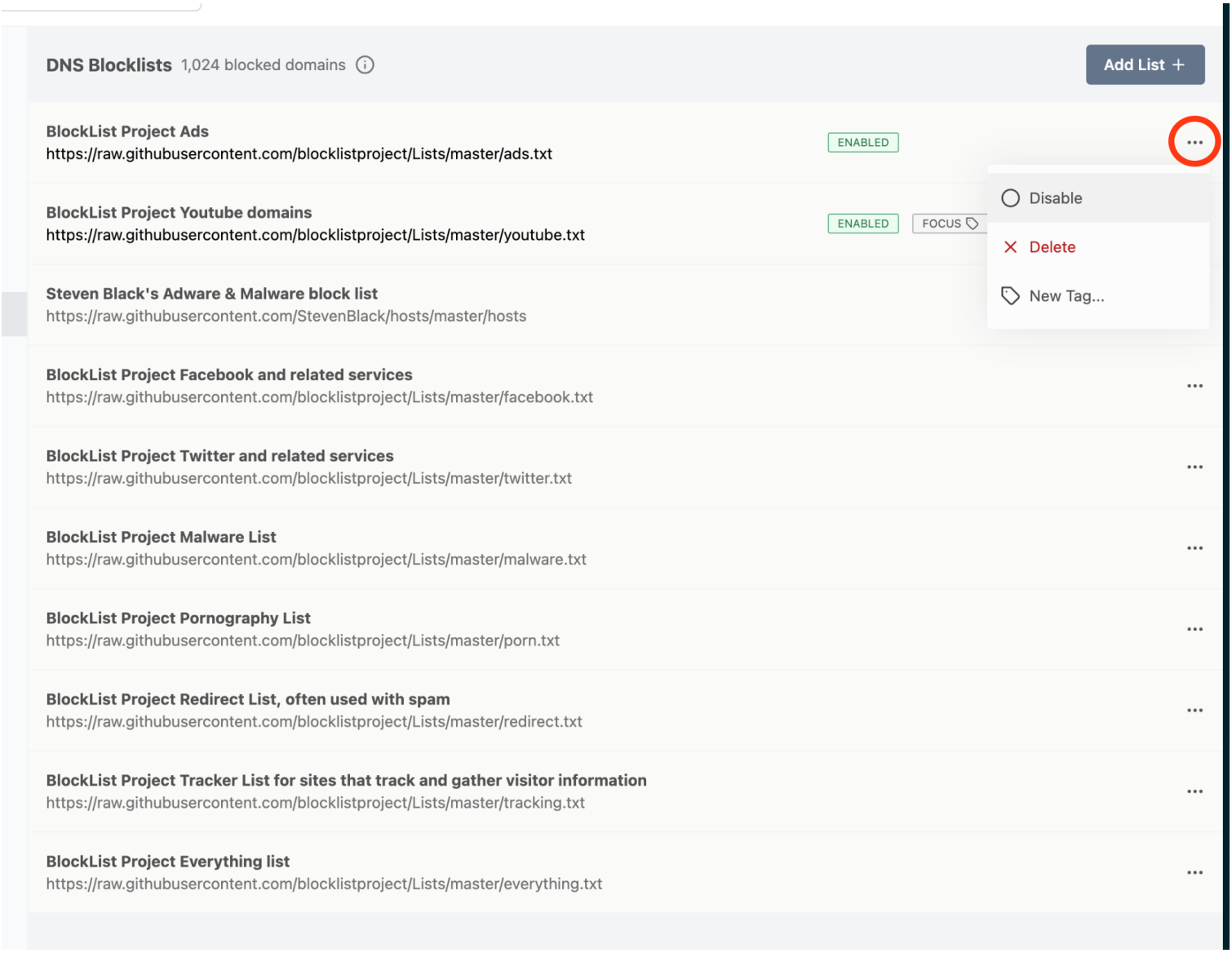
- DNS Block Lists Block Ads, Tracking & More
- DNS & Tags Make block lists select devices by Tag
- DNS Overrides Make custom DNS Rules
- DNS Settings Set DNS Privacy settings, DNS Provider
- DNS Logs Inspect DNS Queries

Block lists

Manage Existing Blocklists:

Next to each blocklist, click the three dots open a menu for additional actions you can take, such as:

- Enable: Turn on a blocklist
- Disable: To turn off the blocklist without deleting it.
- Delete: To remove the blocklist entirely.



Block Lists Tags

It is also possible to apply a Tag to a blocklist. With tags set, the block list will only apply to devices that also have one of the tags assigned. Other devices are not affected by the block list

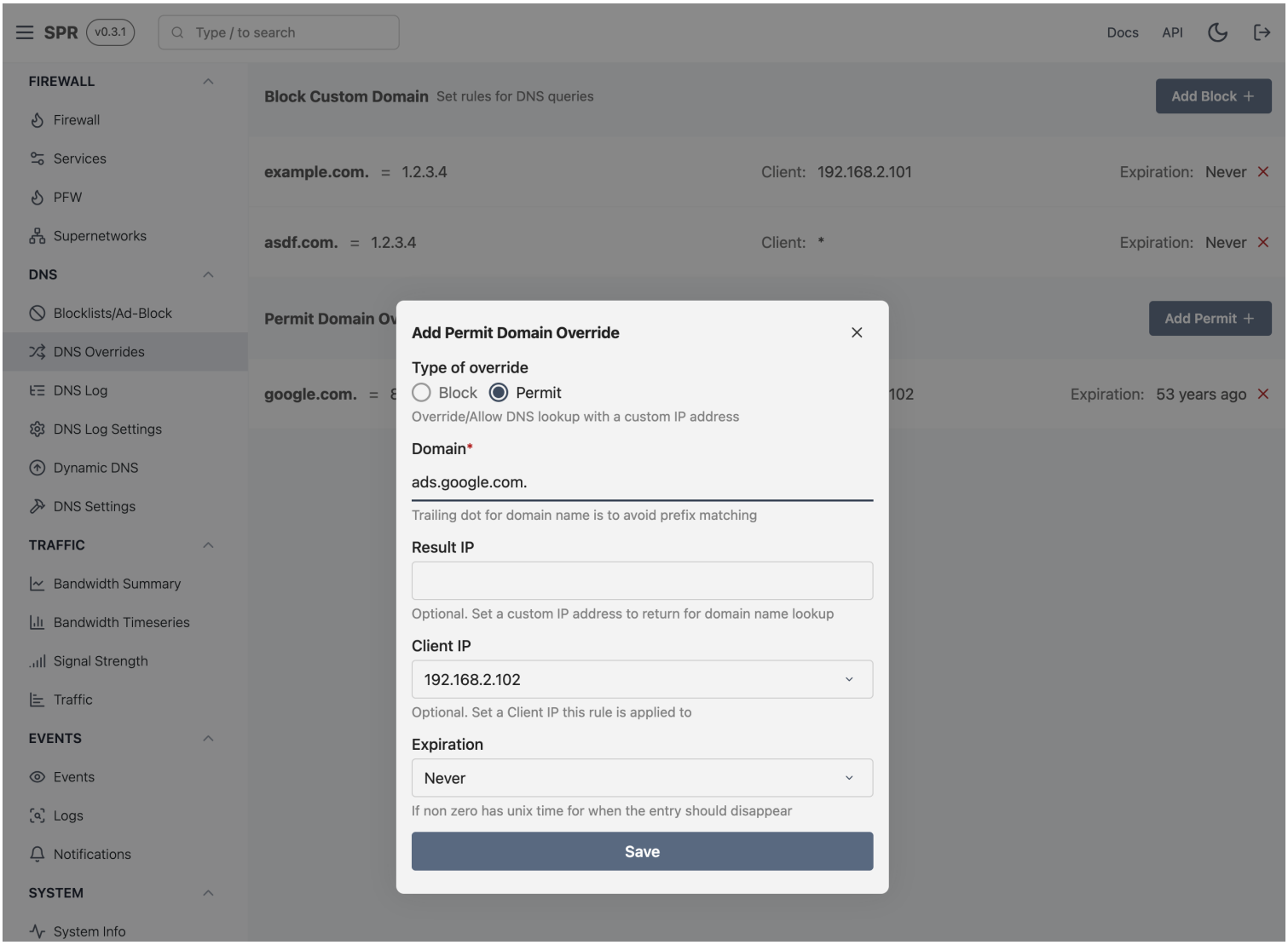
DNS Overrides

Permit Override

Permit overrides can be used to allow domains that are otherwise in a blocklist. The rule can be device specific, by assigning a Client IP, or it can be global.

The rule can also have an expiration assigned for the rule to expire.

Lastly, the permit rule can have an IP address to override a DNS response with an IP address

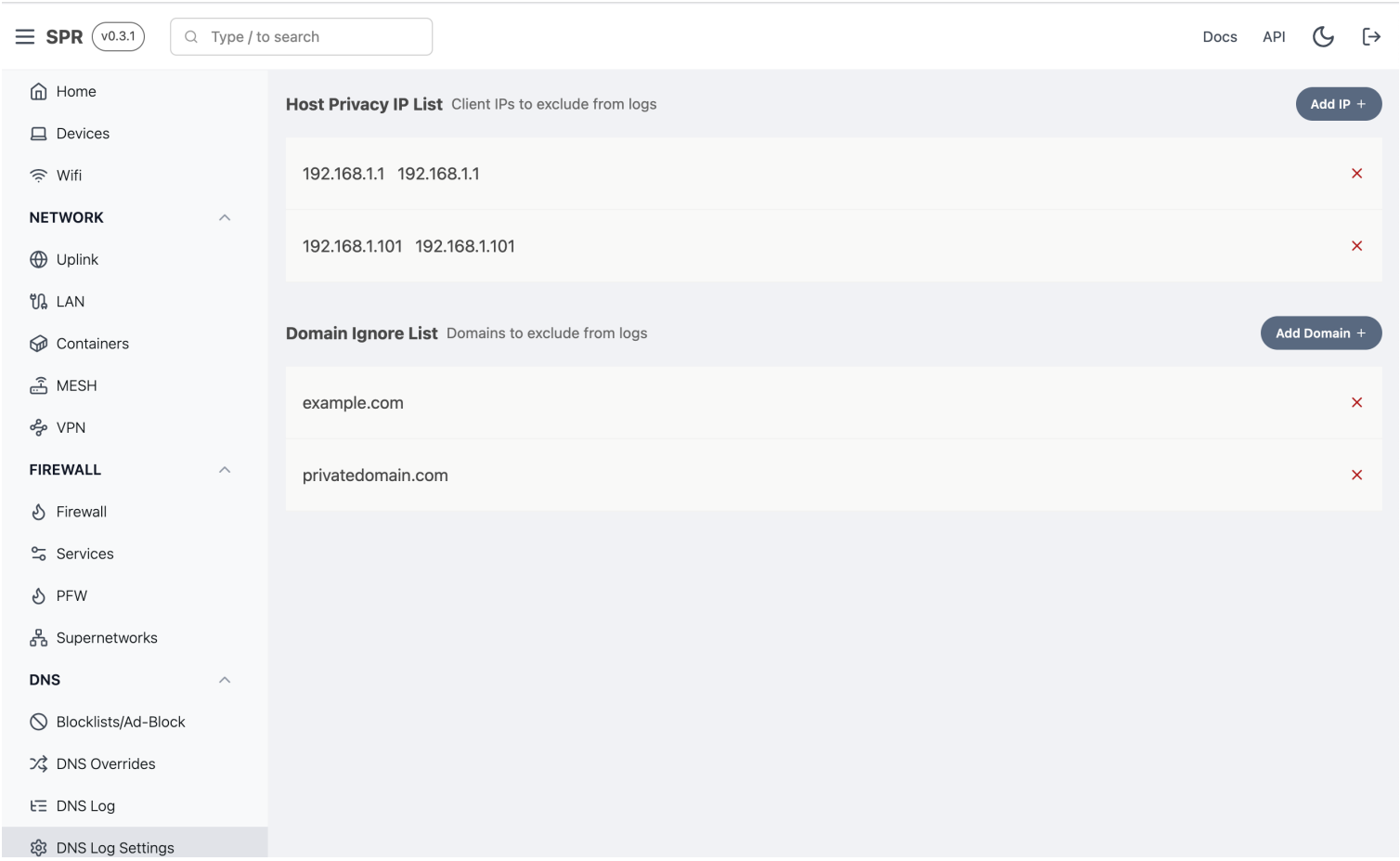


Block Override

A block override can also be used to create a rule to block a domain. The Result IP is ignored for a block rule.

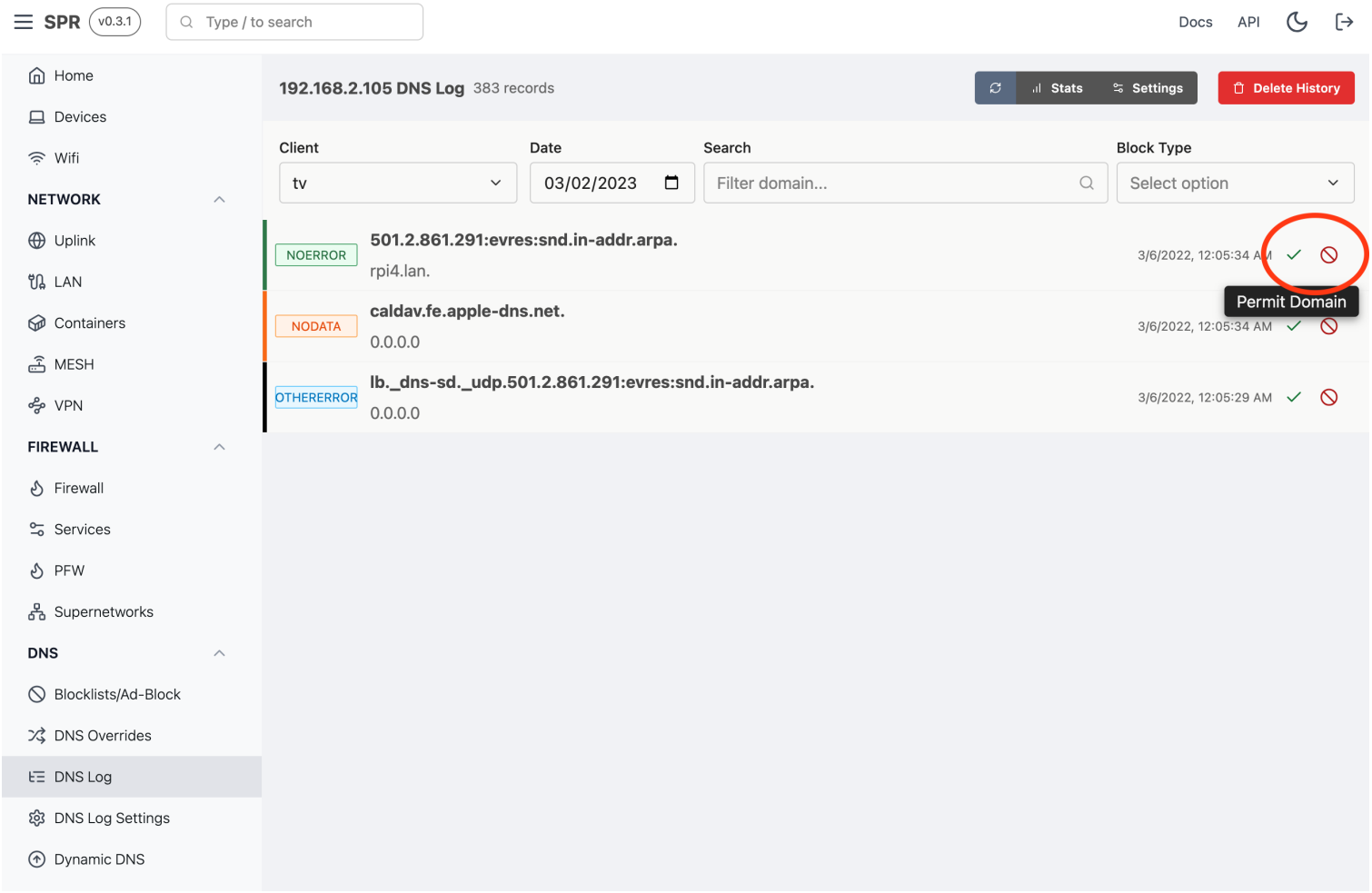
Settings

The DNS Settings can be used to set Client IPs or Domains to keep out of the DNS Logs

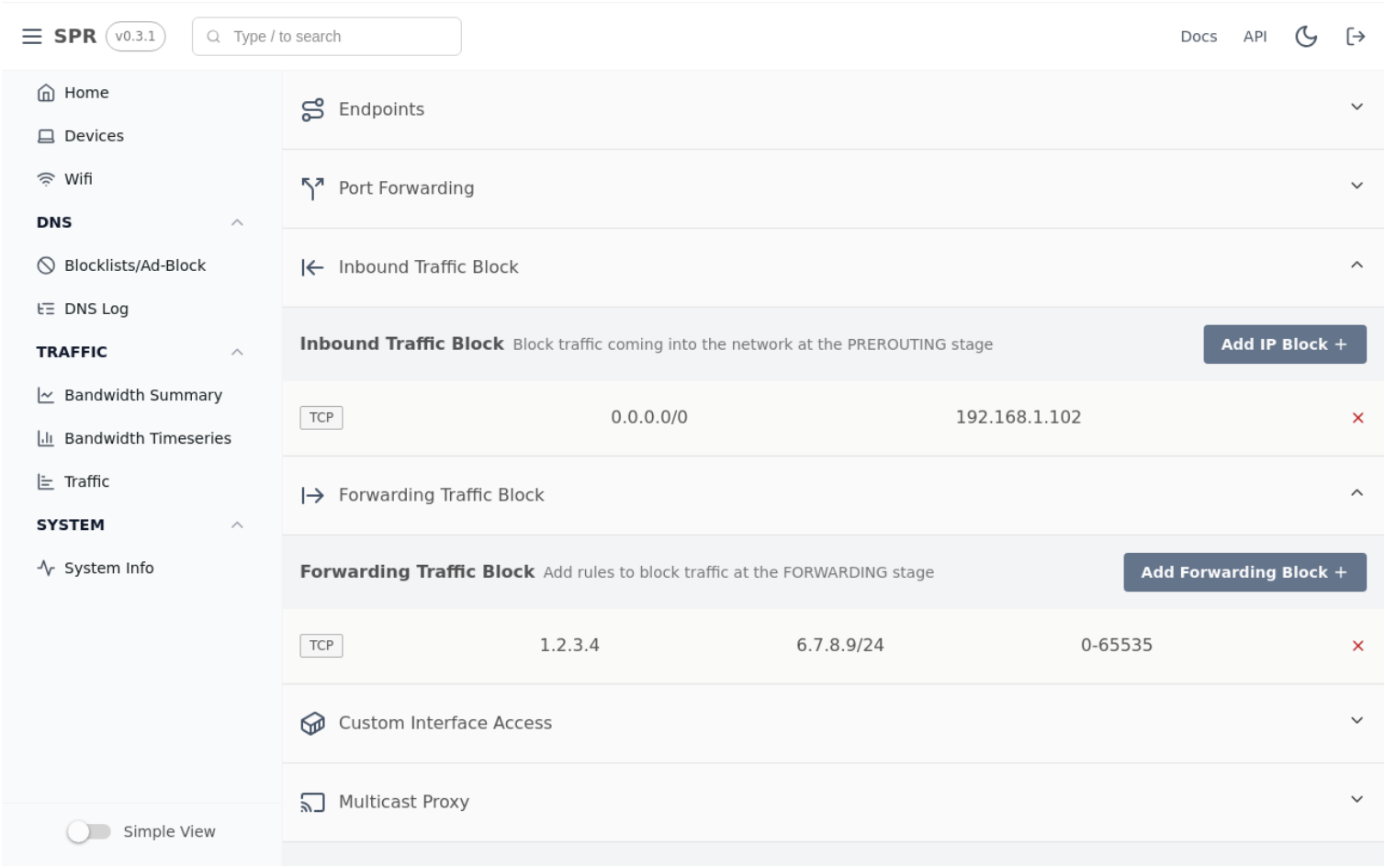


Logs

The DNS Log View can be used to inspect dns requests. Use the buttons on the right to quickly add a permit or deny override rule.


SPR
v0.3.1
Type / to search
Docs
API
Home
Devices
Wifi
NETWORK
Uplink
LAN
Containers
MESH
VPN
FIREWALL
Firewall
Services
PFW
Supernetworks
DNS
Blocklists/Ad-Block
DNS Overrides
DNS Log
DNS Log Settings
Dynamic DNS
192.168.2.105 DNS Log 383 records
Stats
Settings
Delete History
Client
tv
Date
03/02/2023
Search
Filter domain...
Block Type
Select option
NOERROR
501.2.861.291:evres:snd.in-addr.arpa.
rpi4.lan.
3/6/2022, 12:05:34 AM
Permit Domain
NODATA
caldav.fe.apple-dns.net.
0.0.0.0
3/6/2022, 12:05:34 AM
OTHERERROR
lb._dns-sd._udp.501.2.861.291:evres:snd.in-addr.arpa.
0.0.0.0
3/6/2022, 12:05:29 AM

Firewall



Firewall Use Cases

Most common to use is *Port Forwarding* and *Inbound Traffic Block*.

- Port Forwarding is if you want to open a port *from WAN* and forward the traffic to a local device
- Inbound Traffic Block block access from a specific address and/or destination
- Forwarding Traffic Block allow/block devices from your local network

Advanced firewall configuration

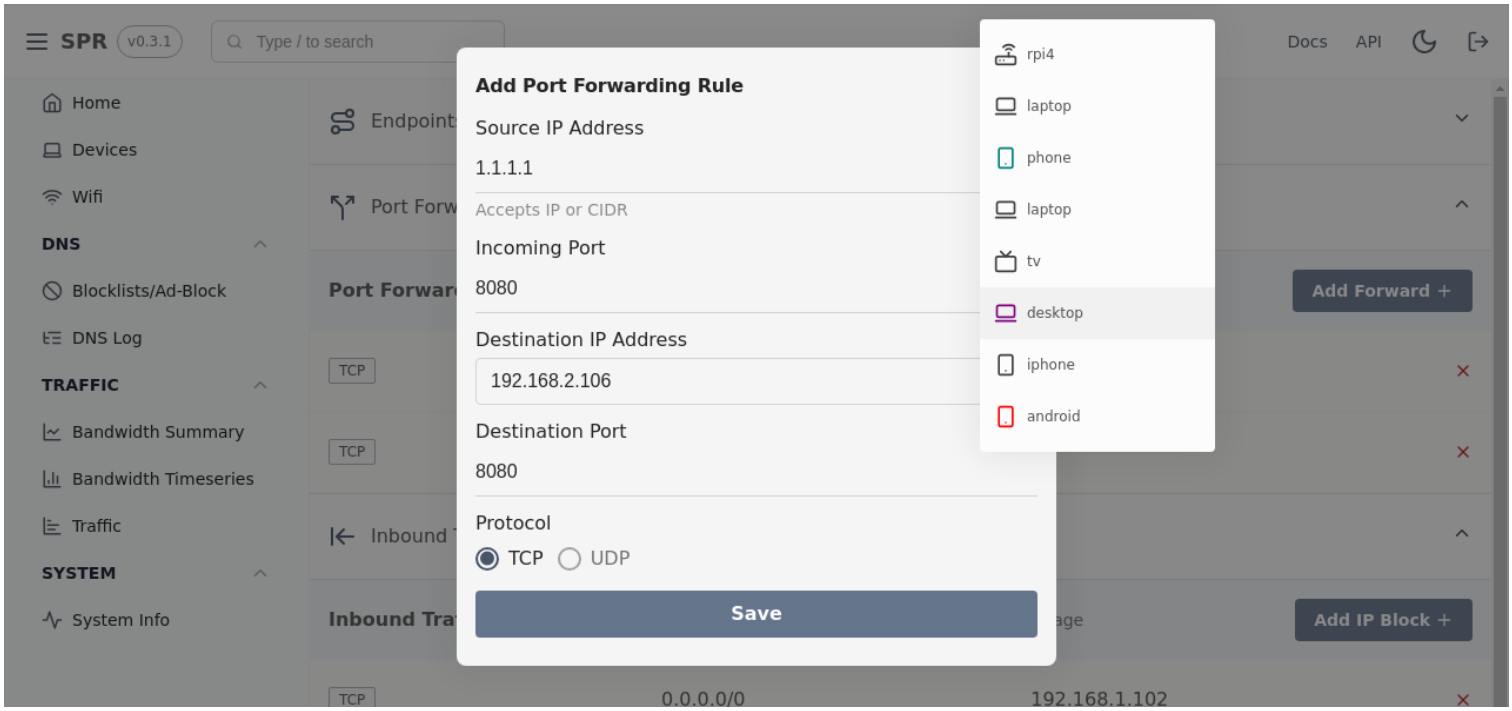
- Custom Interface Access - Join a docker bridge or custom interface to SPR networking
- Multicast Proxy -- Configure mDNS, SSDP, and other UDP broadcast services
- Endpoints - Define one-way connectivity rules

Port Forwarding

Set rules to forward incoming traffic (DNAT forwarding).

Add a Port Forward

On the *Firewall* page expand *Port Forwarding* and click *Add Forward*.



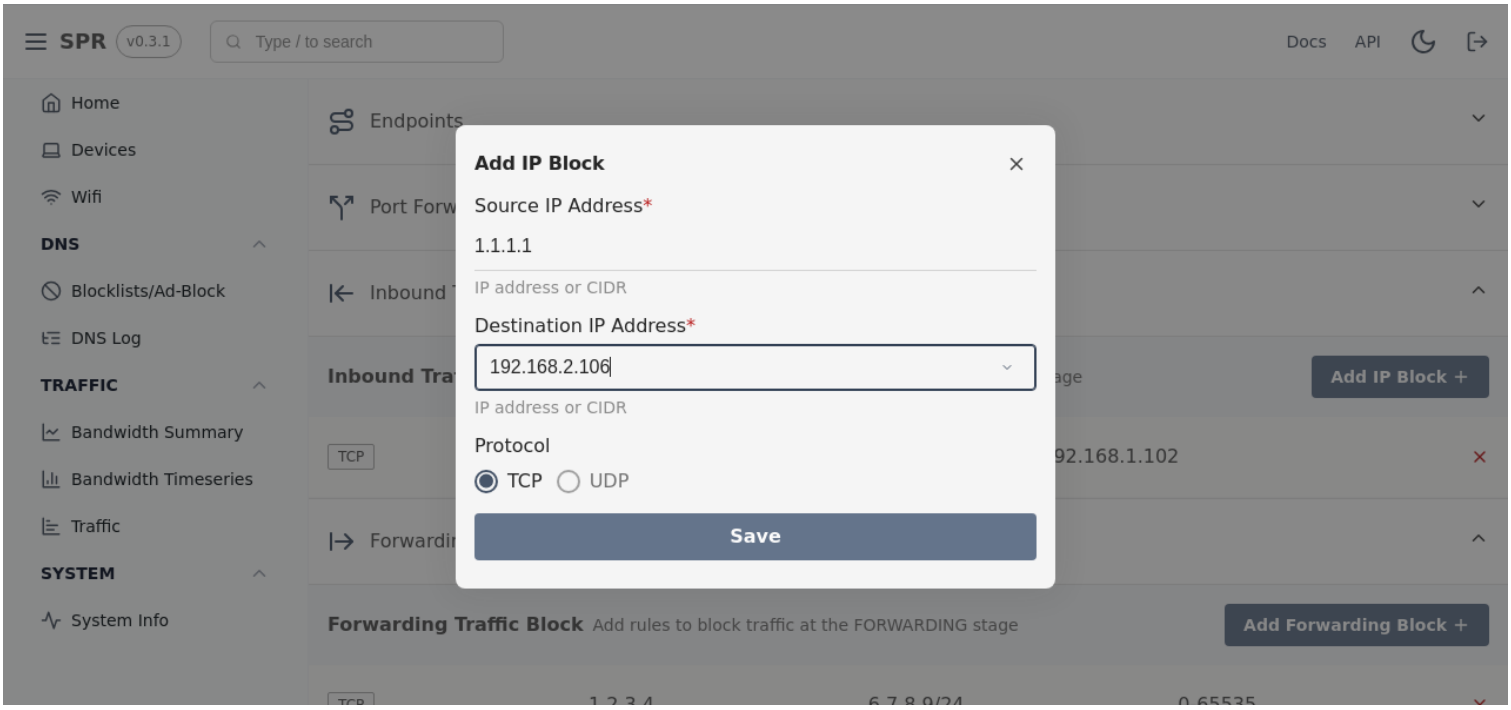
In the screenshot all traffic from source address 1.1.1.1 with destination port 8080 is redirected to 192.168.2.106 on port 8080.

Inbound Traffic Block

Block traffic coming into the network at the PREROUTING stage.

Add a Inbound Block

On the *Firewall* page expand *Inbound Traffic Block* and click *Add IP Block*.



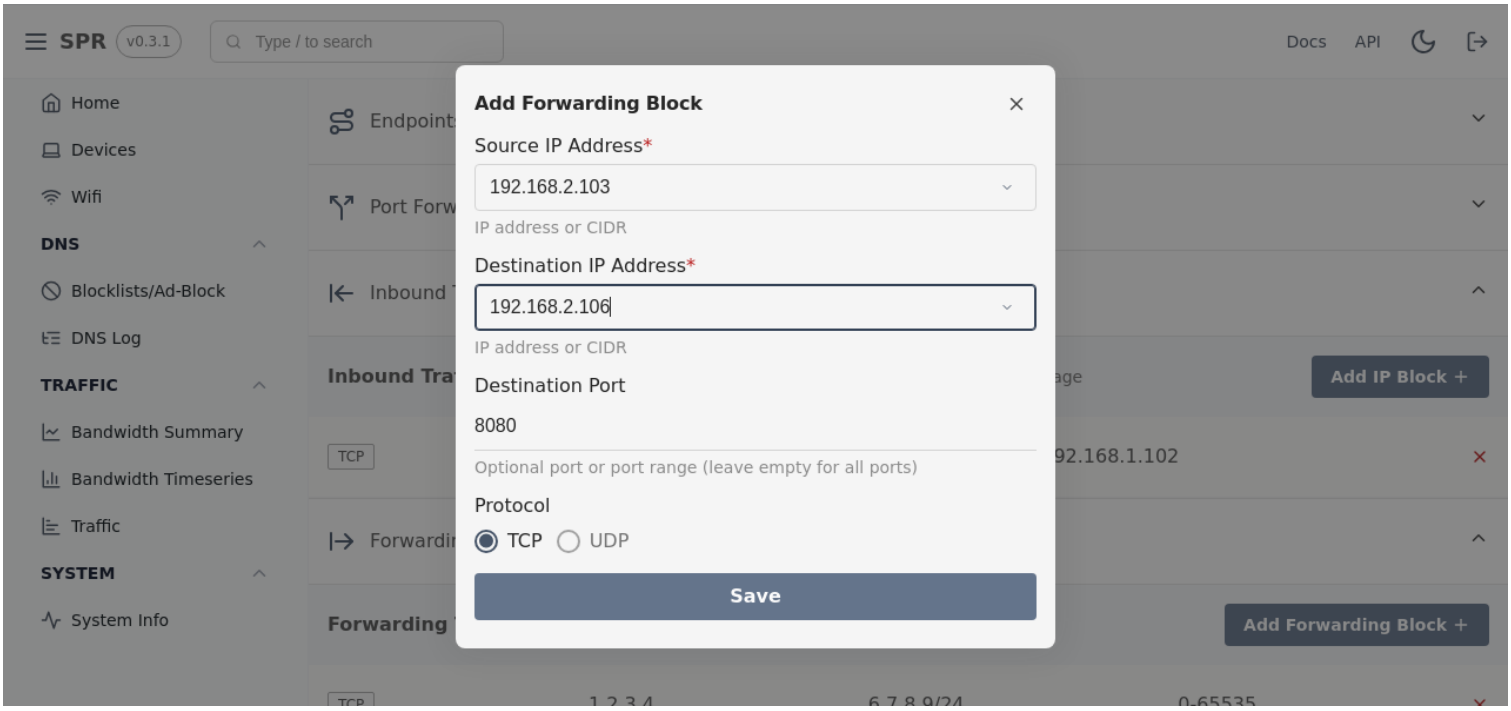
In the screenshot all traffic from source address *1.1.1.1* with destination address *192.168.2.106* will be blocked.

Forwarding Traffic Block

Add rules to block traffic at the FORWARDING stage.

Add a Forwarding Block

On the *Firewall* page expand *Forwarding Traffic Block* and click *Add Forwarding Block*.

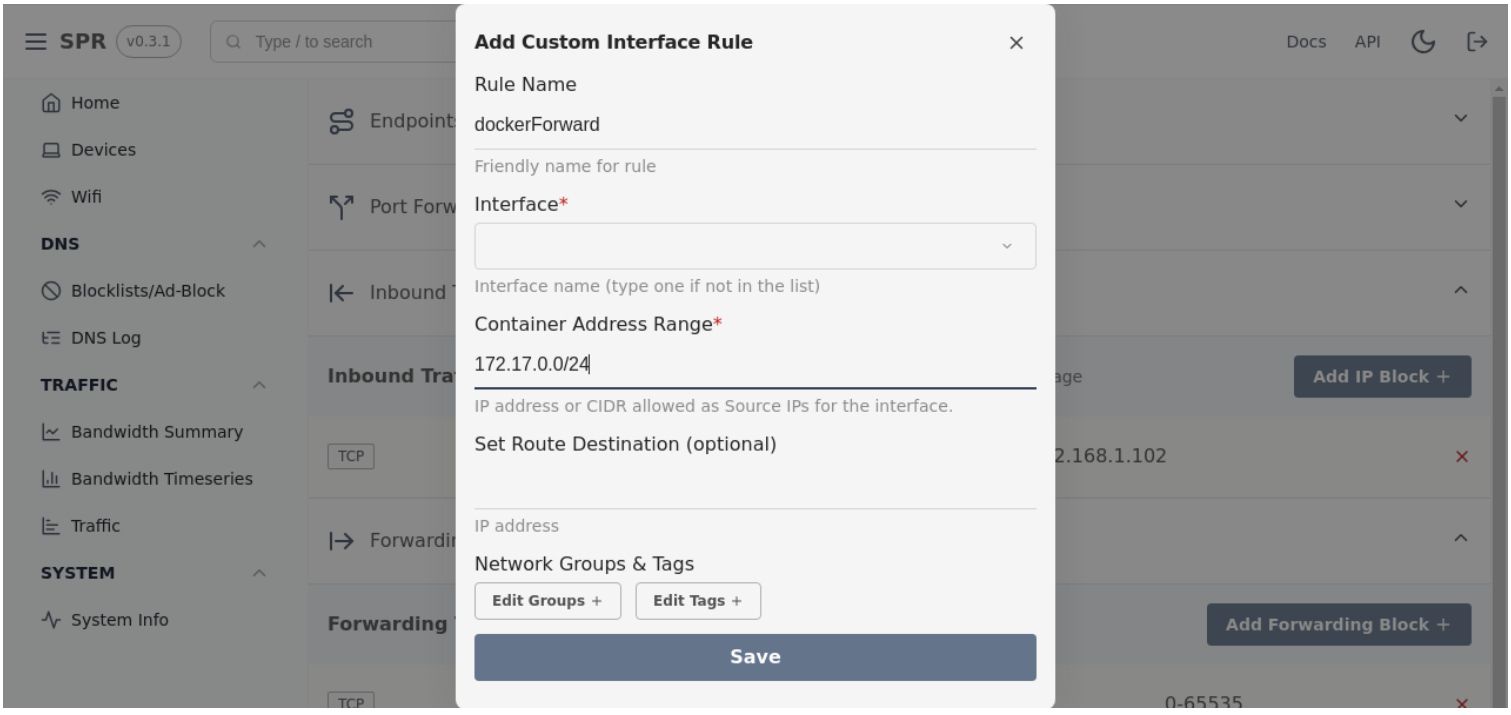


In the screenshot all traffic from source address *192.168.2.103* with destination address *192.168.2.106* on port *8080* will be blocked.

Example use is if you add a device to the lan group but want to block access on some ports.

Custom Interface Access

Manage network access for custom interface names and control access for docker networks.

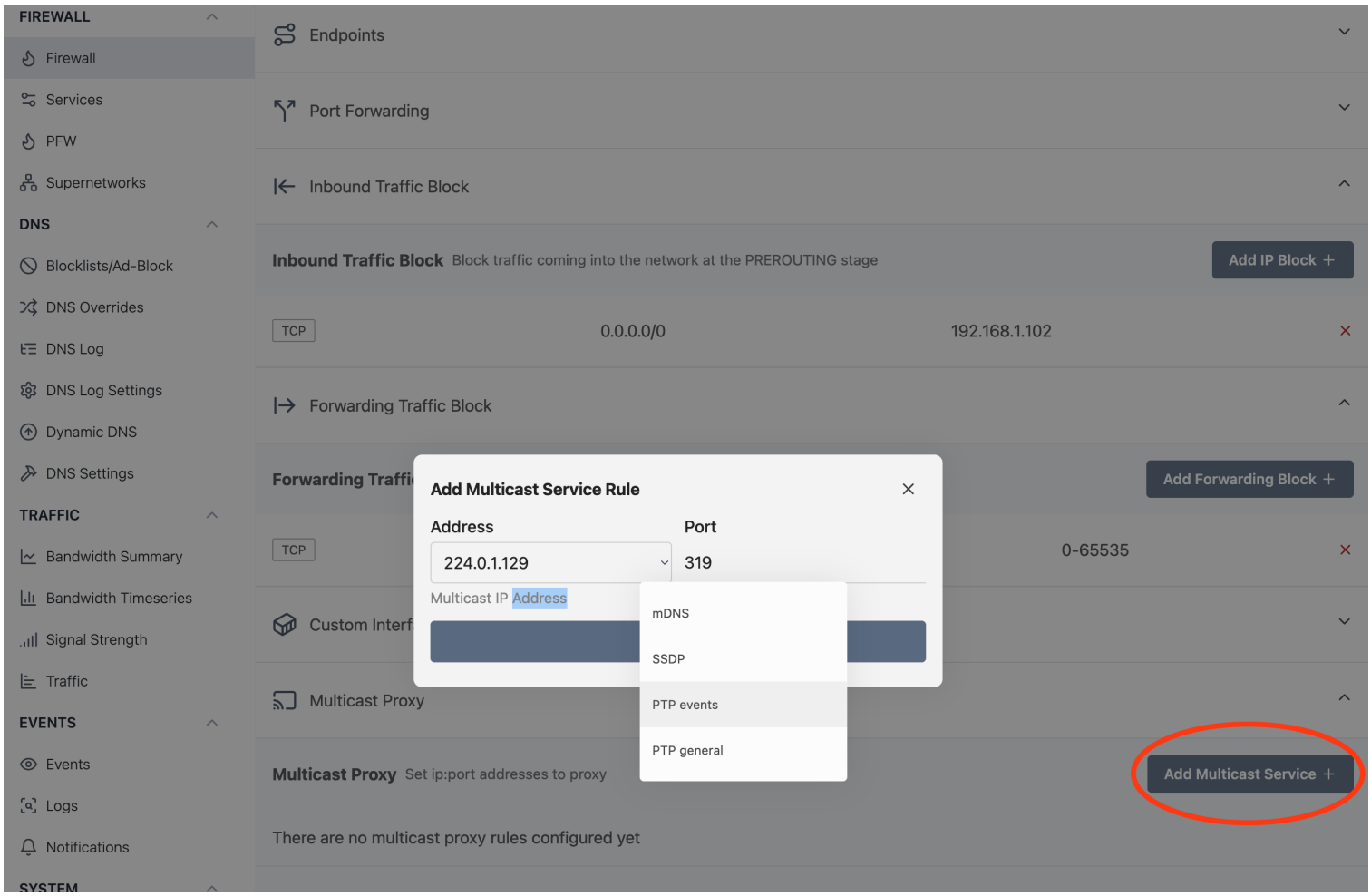


Use this to forward traffic to an interface running in a separate container.

See more in the repository for the spr-mitmproxy plugin for how this feature can be used.

Multicast Proxy

Set multicast ip:port addresses to proxy between devices. This allows discovery services such as SSDP/Zeroconf and mDNS in SPR. By dfeault only SSDP and mDNS are on. You may need to enable PTP or other services for streaming and device sync. If something is not working as expected, let us know, by filing an issue



A future release will enable tags to apply proxying to only a subset of devices.

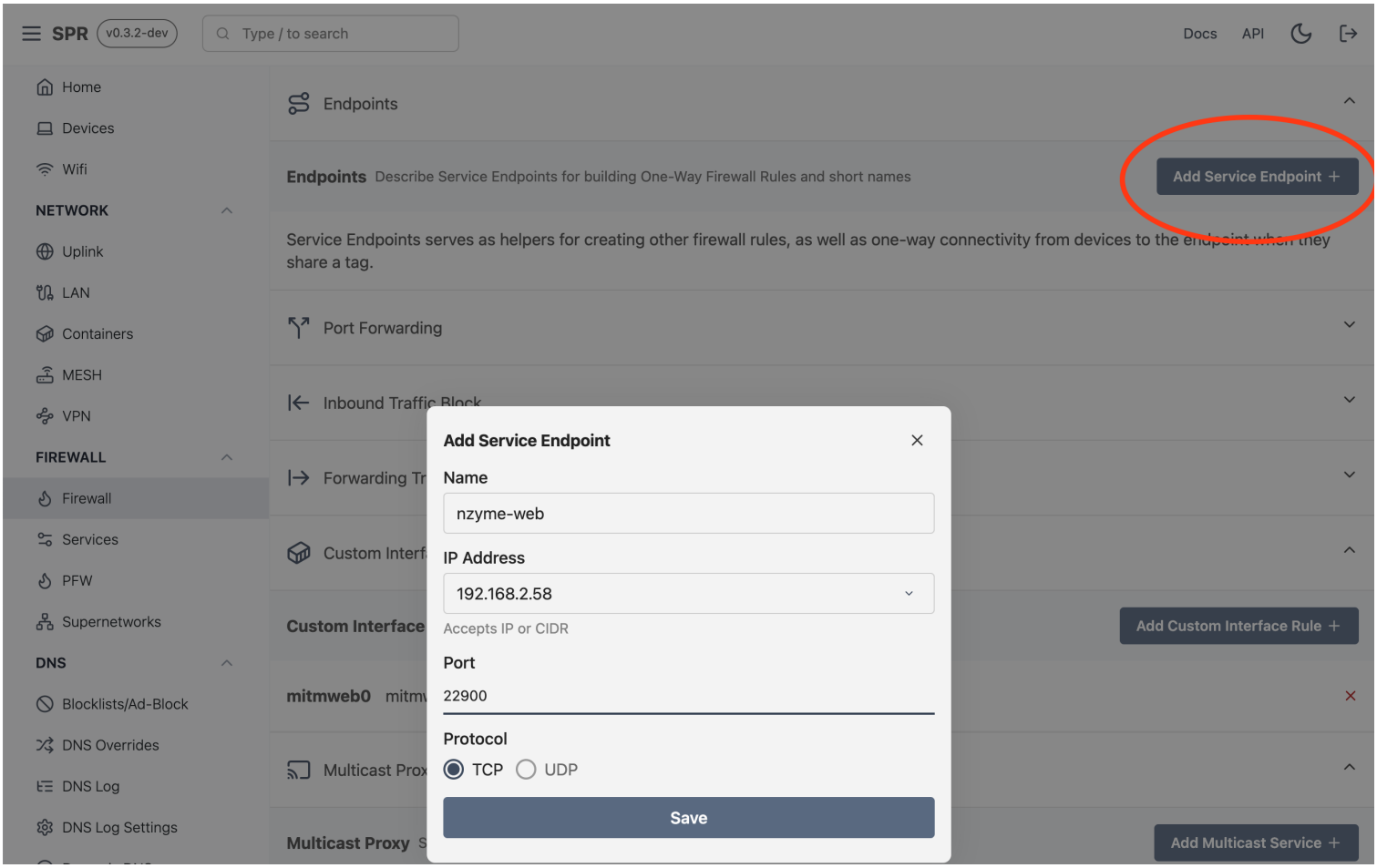
Endpoints

Service Endpoints serves as helpers for creating other firewall rules, as well as one-way connectivity from devices to the endpoint when they share a tag.

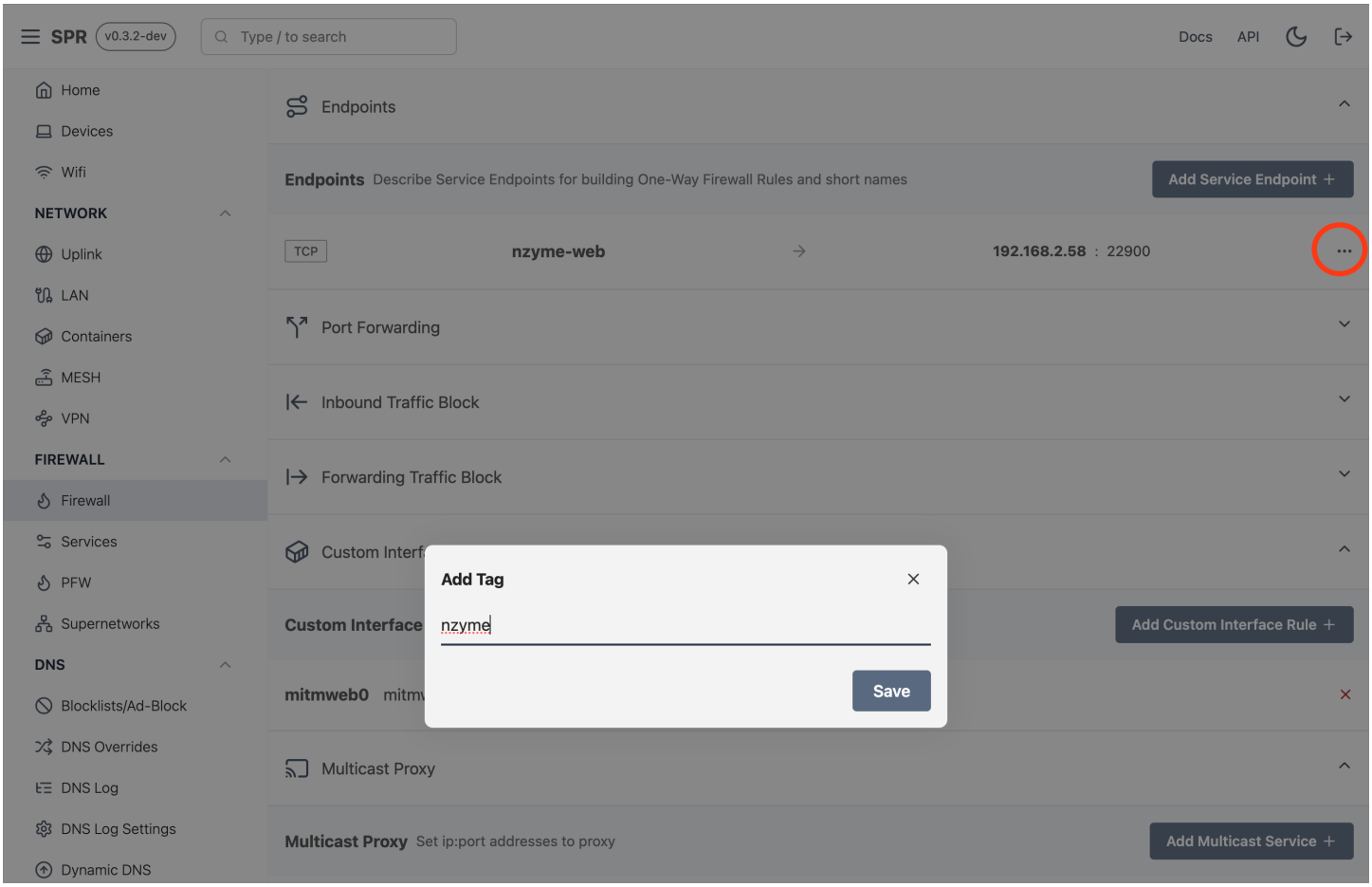
When devices are in the same group they have full access to each other. Device in the LAN group have one-way access to all devices via NAT.

Endpoints create a quick way to apply one-way connectivity a specific destination, by applying tags.

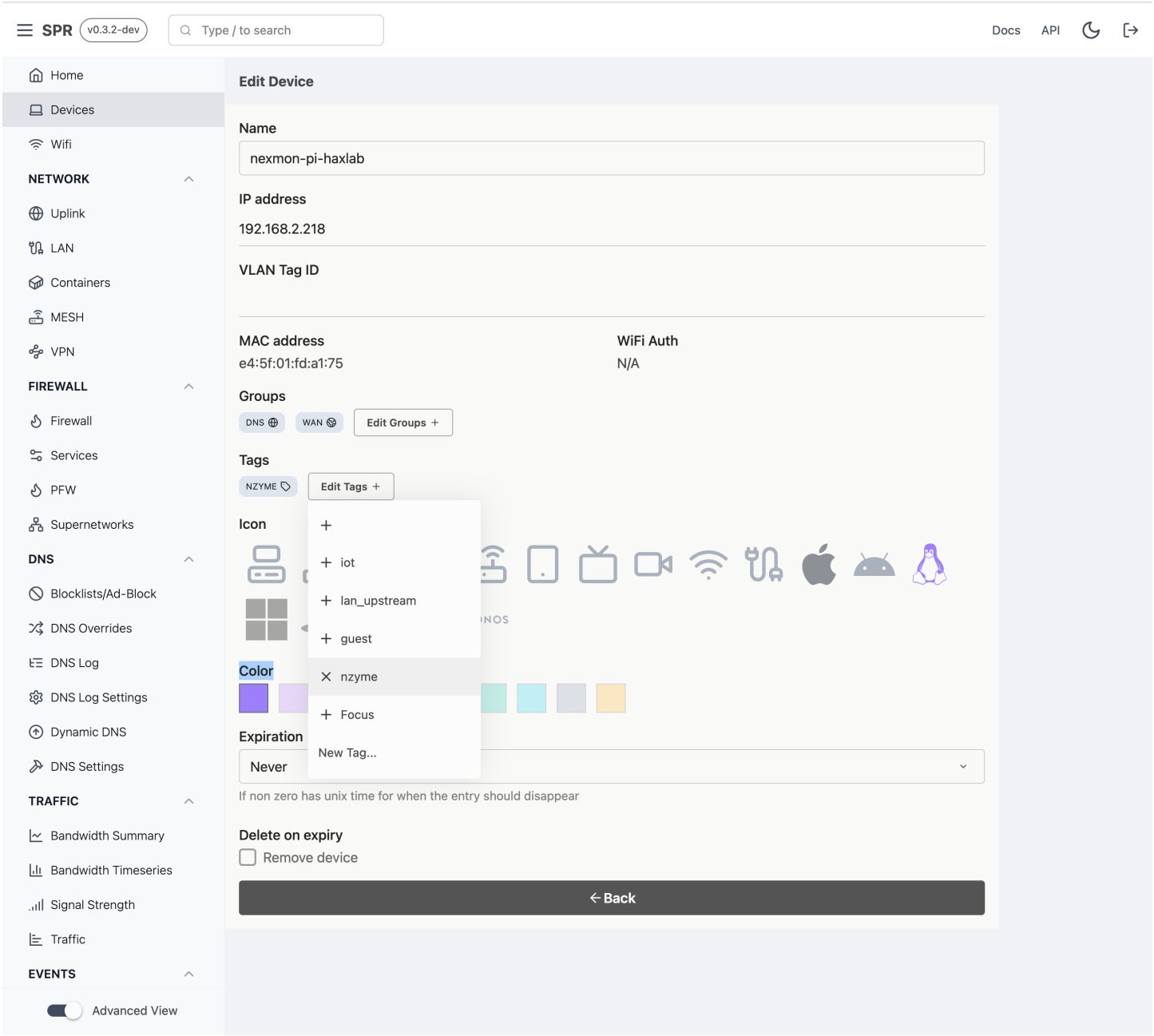
1. Create a service definition



2. Apply a tag


SPR
v0.3.2-dev
Type / to search
Docs
API
Home
Devices
Wifi
NETWORK
Uplink
LAN
Containers
MESH
VPN
FIREWALL
Firewall
Services
PFW
Supernetworks
DNS
Blocklists/Ad-Block
DNS Overrides
DNS Log
DNS Log Settings
Dynamic DNS
Endpoints
Endpoints Describe Service Endpoints for building One-Way Firewall Rules and short names
Add Service Endpoint +
TCP
nzyme-web
192.168.2.58 : 22900
Port Forwarding
Inbound Traffic Block
Forwarding Traffic Block
Custom Interf
Add Tag
nzyme
Save
Custom Interface
Add Custom Interface Rule +
mitmweb0
Multicast Proxy
Multicast Proxy Set ip:port addresses to proxy
Add Multicast Service +

3. Apply the same tag to the device that should have access to the endpoint



4. Example of device access before and after it has the tag

```
ubuntu@haxlab0:~$ curl -vv -m 3 192.168.2.58:22900
*   Trying 192.168.2.58:22900...
* Connection timed out after 3001 milliseconds
* Closing connection 0
curl: (28) Connection timed out after 3001 milliseconds
ubuntu@haxlab0:~$ # now set the tag on the device
ubuntu@haxlab0:~$ curl -vv -m 3 192.168.2.58:22900
*   Trying 192.168.2.58:22900...
* Connected to 192.168.2.58 (192.168.2.58) port 22900 (#0)
> GET / HTTP/1.1
> Host: 192.168.2.58:22900
> User-Agent: curl/7.88.1
> Accept: */*
>
* Empty reply from server
* Closing connection 0
curl: (52) Empty reply from server
ubuntu@haxlab0:~$
```

The other side, `192.168.2.58`, does not gain access to the device on `192.168.2.218` beyond receiving TCP connections on `:22900`.

Link Management

Uplink Configuration

Set DHCP settings or assign a Static IP

Enable a Wireless Uplink

Downlink Configuration (LAN)

Enable Wired LAN Interface

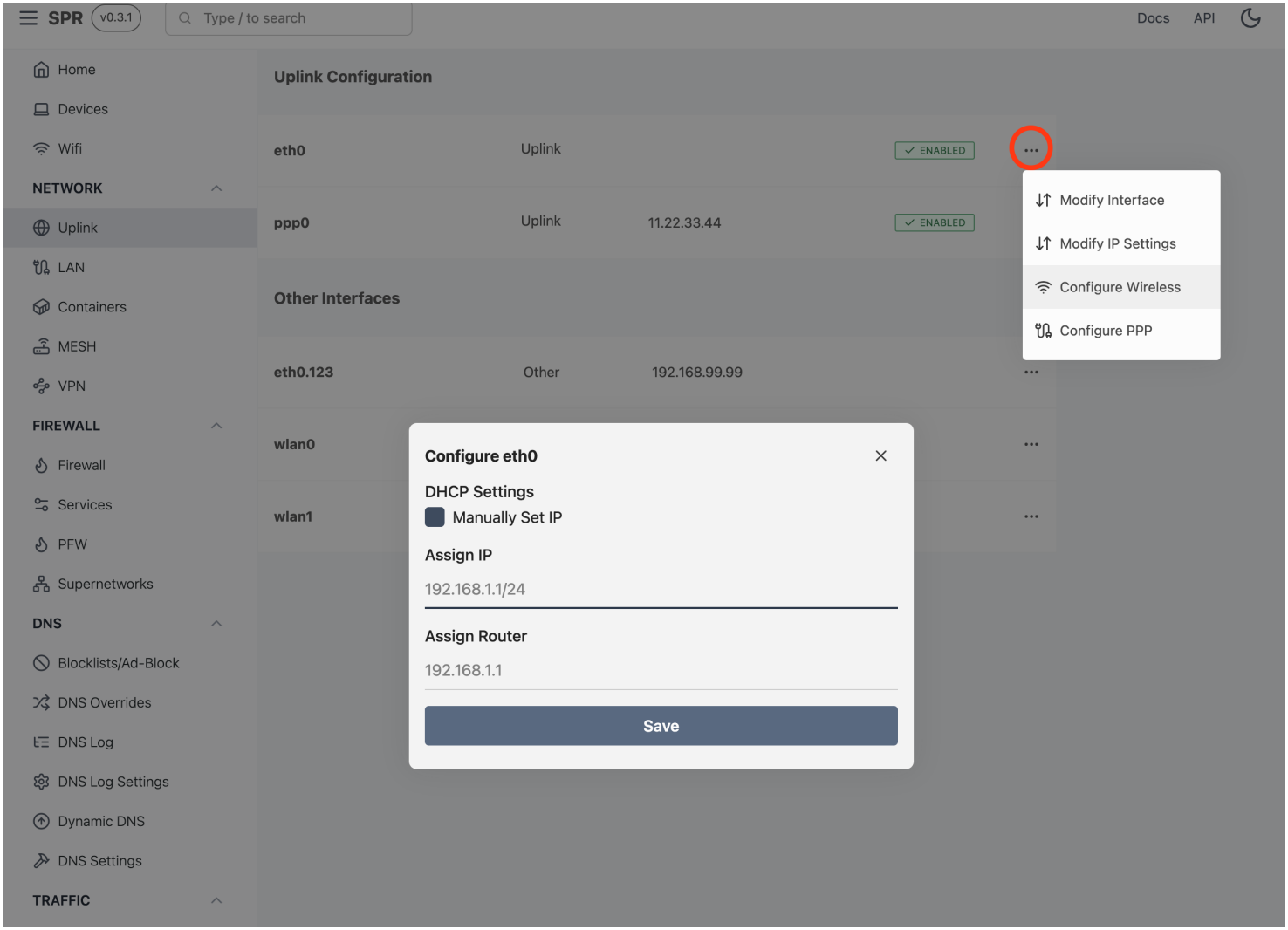
Enable VLAN Trunk Port

Multiple Uplinks

SPR experimentally supports multiple uplink interfaces. It will load balance new connections across them based on addresses. No additional setup is required beyond enabling multiple uplinks.

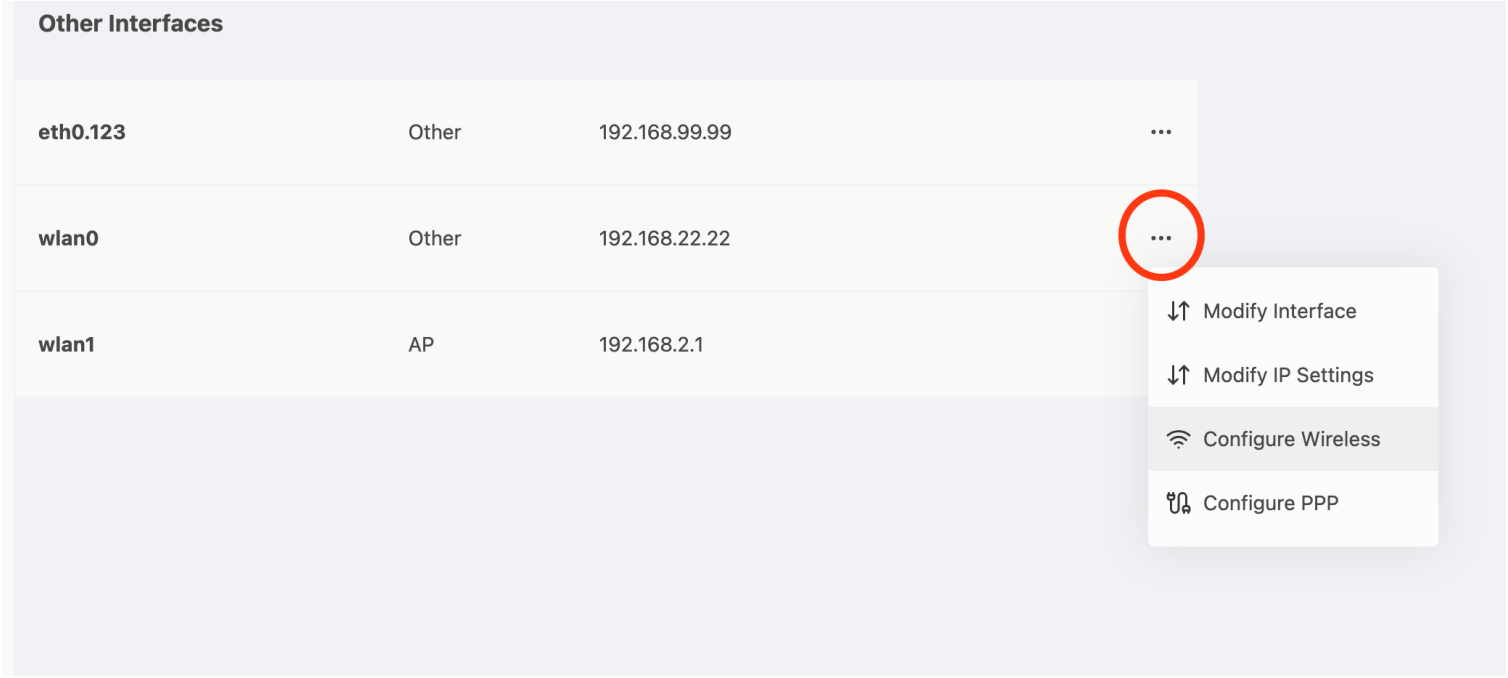
Set Uplink Interface IP

It is possibly to configure DHCP settings for an uplink interface.

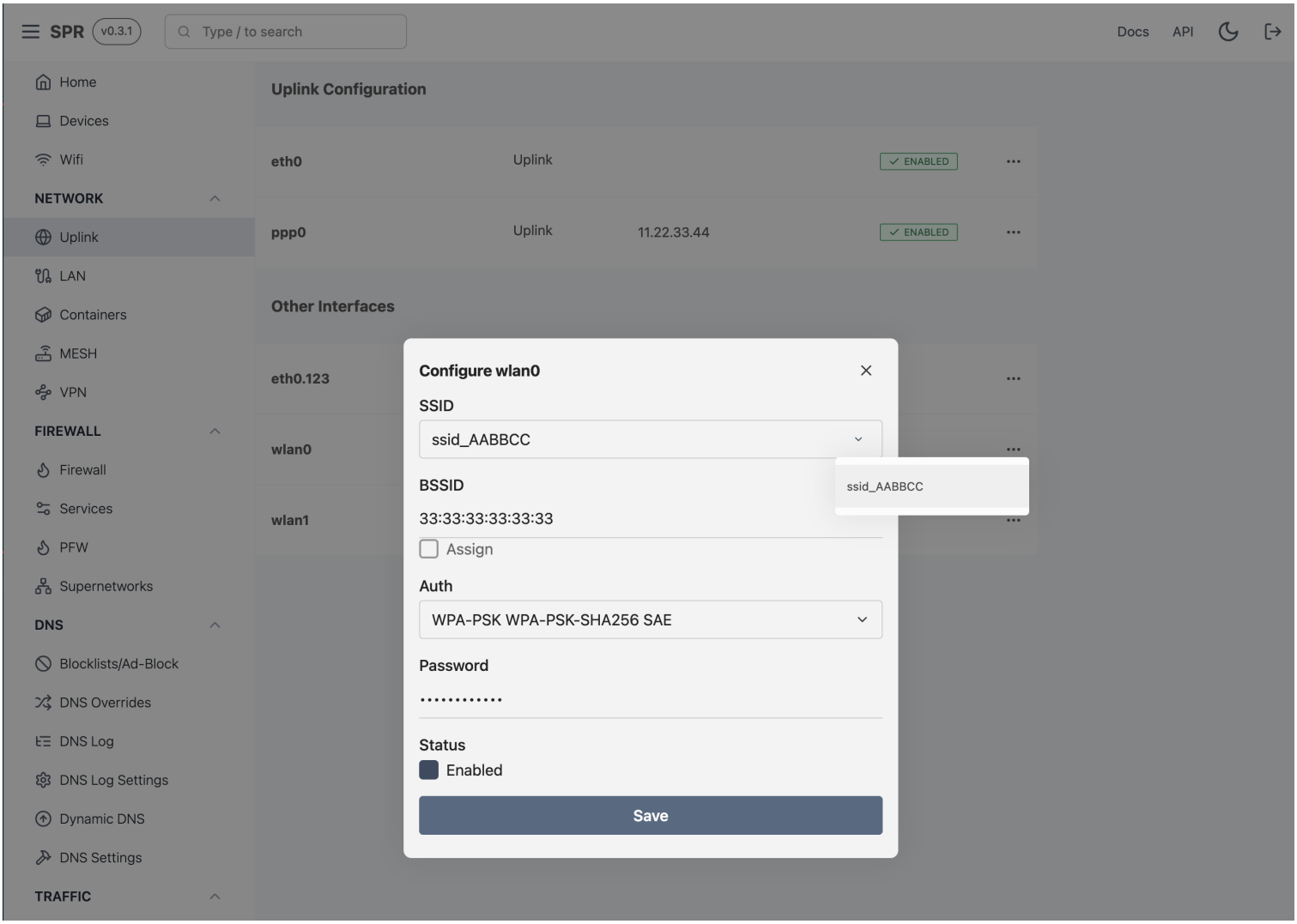


Enable a WiFi Uplink

In the uplink view, click Configure Wireless



And then fill out your settings



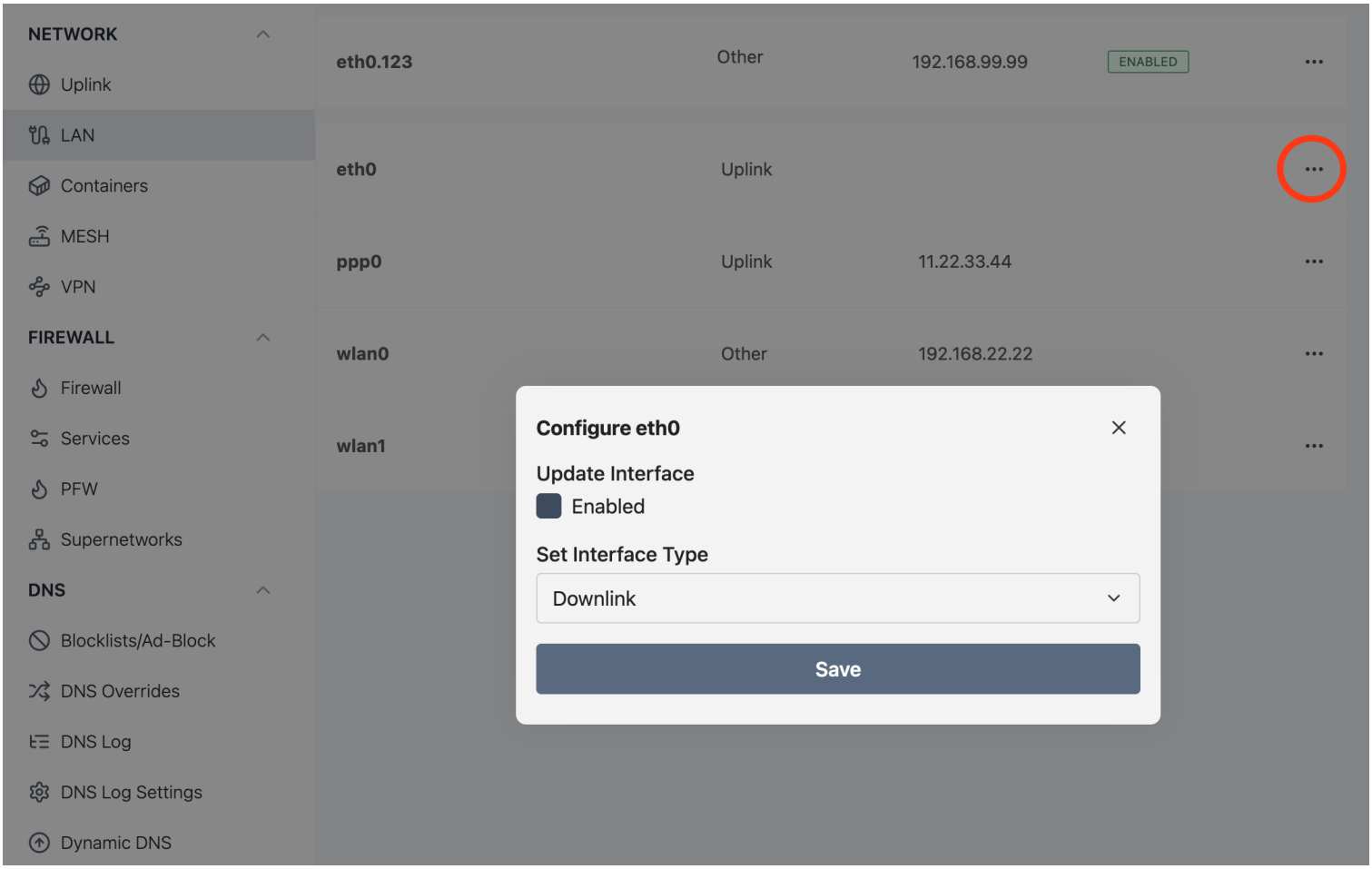
Enable Wired LAN Interface

Currently SPR only supports one Wired LAN interface. An upcoming release will support multiple links.

<details>
<summary>Adding a USB Ethernet on a PI</summary>

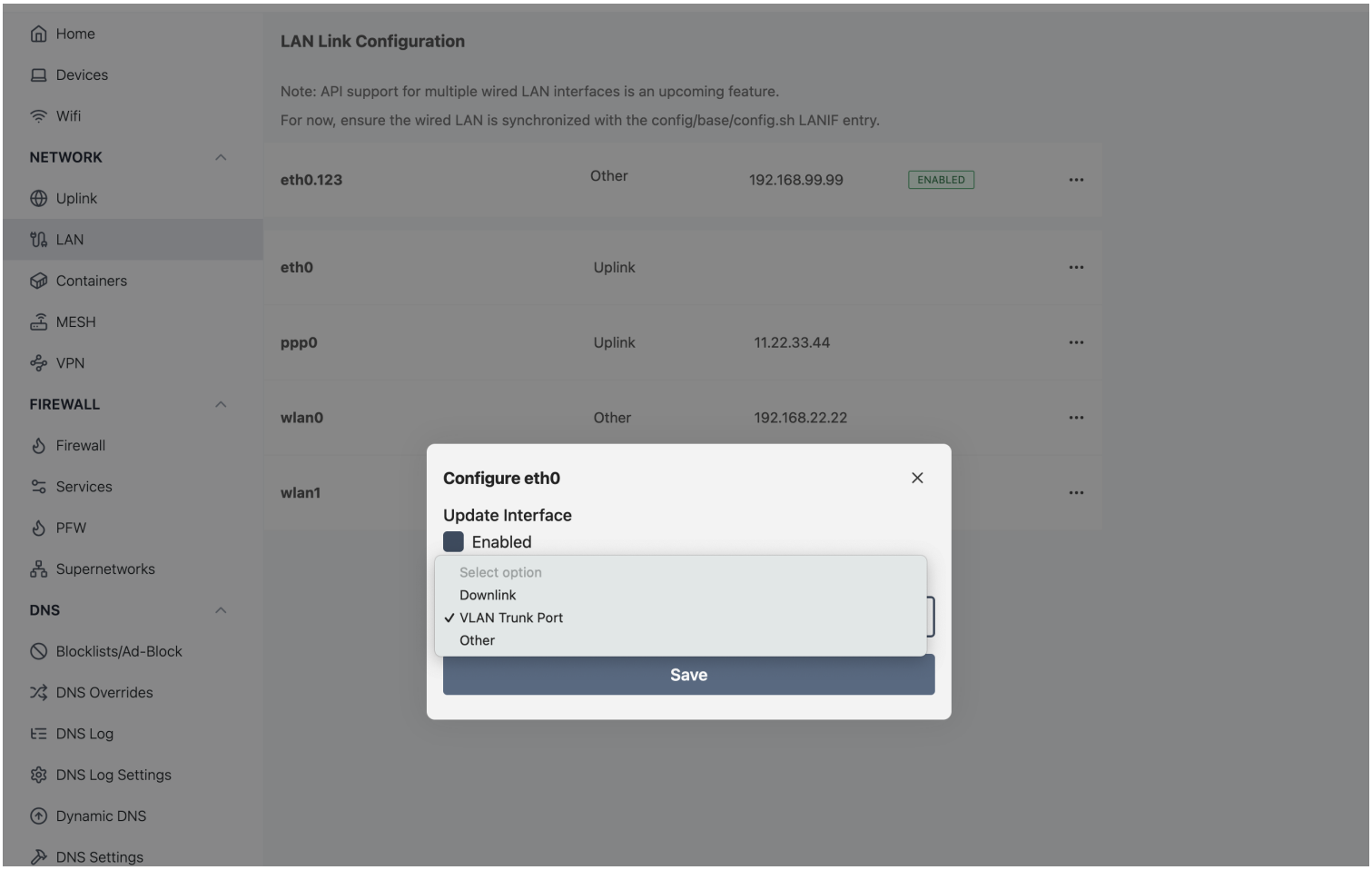
The UE 300 has been tested to run near line speed on the Pi (*950Mbps*). The U3 330 also works and provides additional USB 3.0 ports.
</details>

To enable it, click the ellipse and save

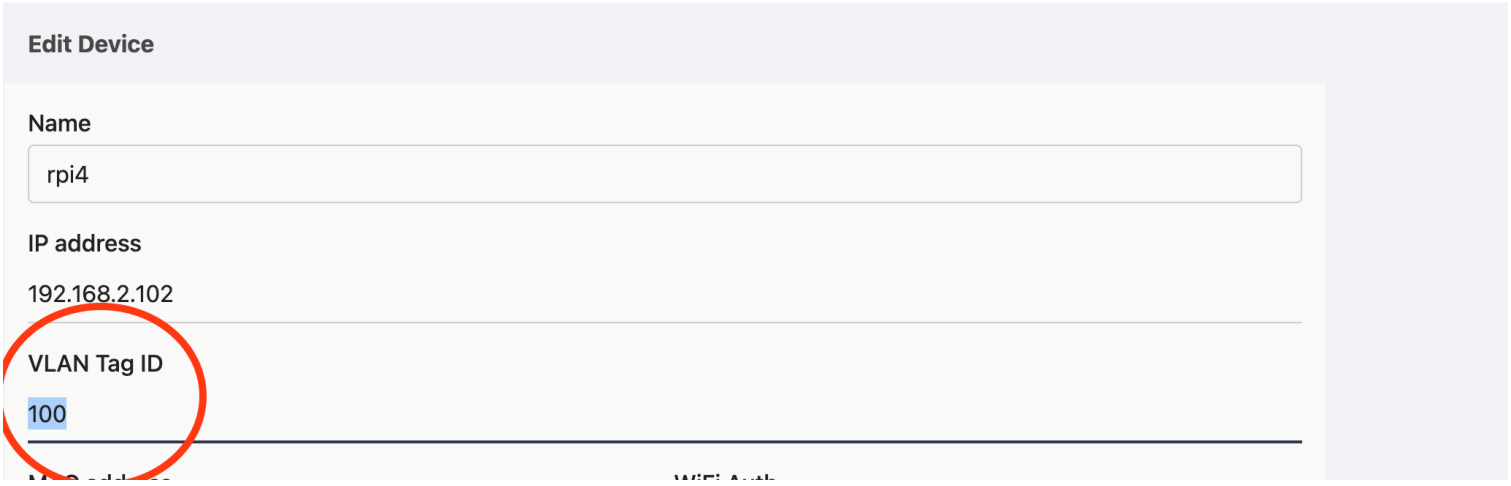


Enable VLAN Trunk Port

SPR has basic support for the downlink interface being a VLAN Trunk Port. This requires a managed switch. Refer to your switch manual for how to configure the VLAN assignment with 802.1Q.



Next, edit your device that is connected to the managed port and set the VLAN ID corresponding to that port.



Installing Extensions

Plugins are a mechanism to integrate additional containers running on the same device with SPR's API and UI. Many of the built-in containers are deployed as plugins, and third party plugins are fully supported.

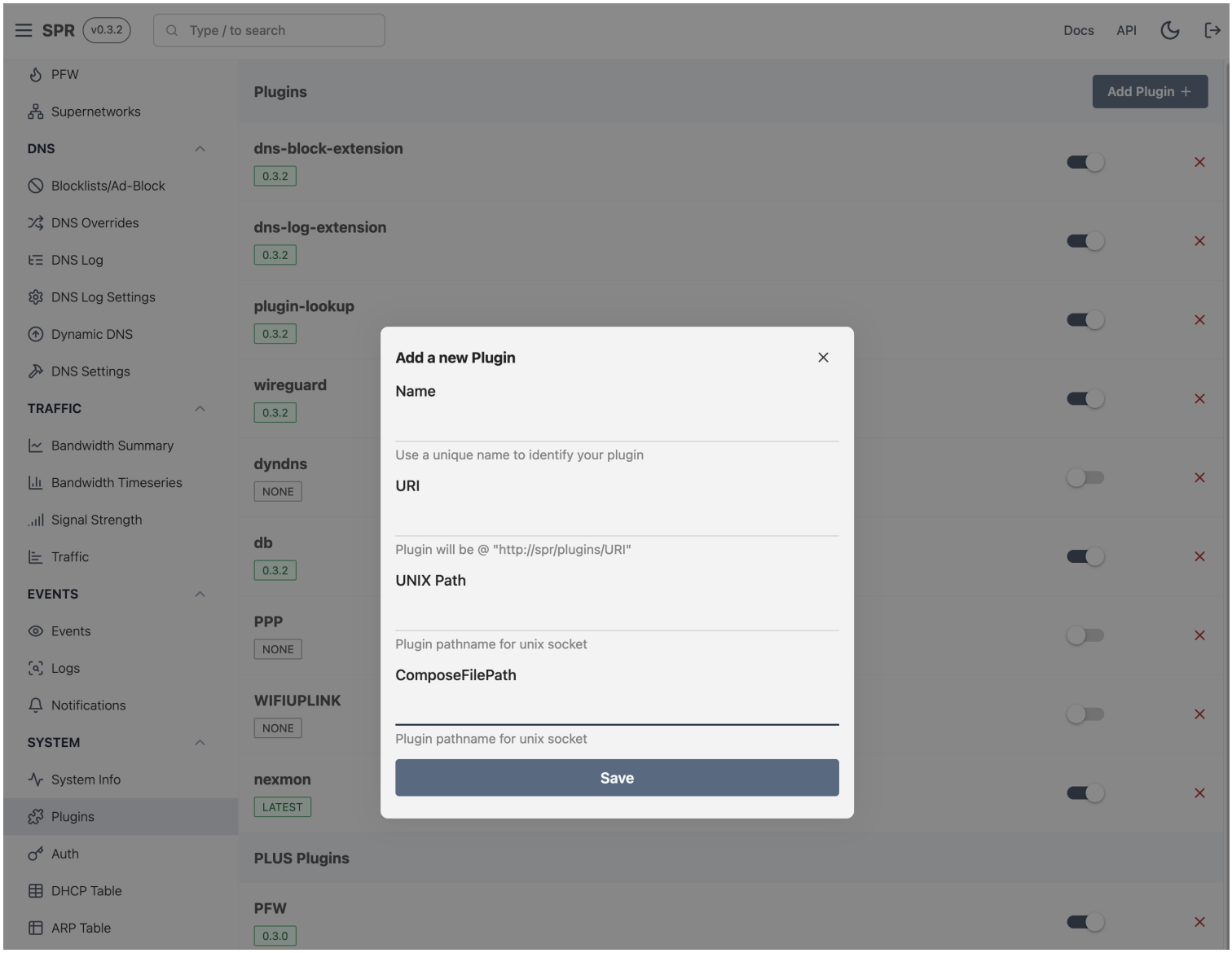
Note: we plan to streamline plugin installation in a future release.

Community Plugins

See the curated plugin list

Plugin Installation

A plugin can be enabled by navigating to the Plugins page and selecting `Add Plugin`.



`Name`: this is the plugin name

`URI`: This is used when the plugin extends the SPR API with additional API calls.

- Ex: specifying `nexmon` means that the API calls the plugin adds will be reachable under `http://spr/plugins/nexmon`

`UNIX Path`: This is the API's path to the unix socket the plugin provides

- Ex: `/state/plugins/nexmon/socket`

`ComposeFilePath`: This is the relative path to the docker compose path, so SPR auto-starts the plugin

- Ex: `plugins/spr-nexmon/docker-compose.yml`

- **Note** Currently `configs/base/custom_compose_paths.json` also needs to be updated to allow this path.

Auto-starting a plugin

For now, a strict whitelist is used to determine which compose file paths to run. To add your plugin to the whitelist, update:

`configs/base/custom_compose_paths.json`

- Example

```
["plugins/spr-nexmon/docker-compose.yml", "plugins/test/docker-compose.yml.yml"]
```

`

Troubleshooting

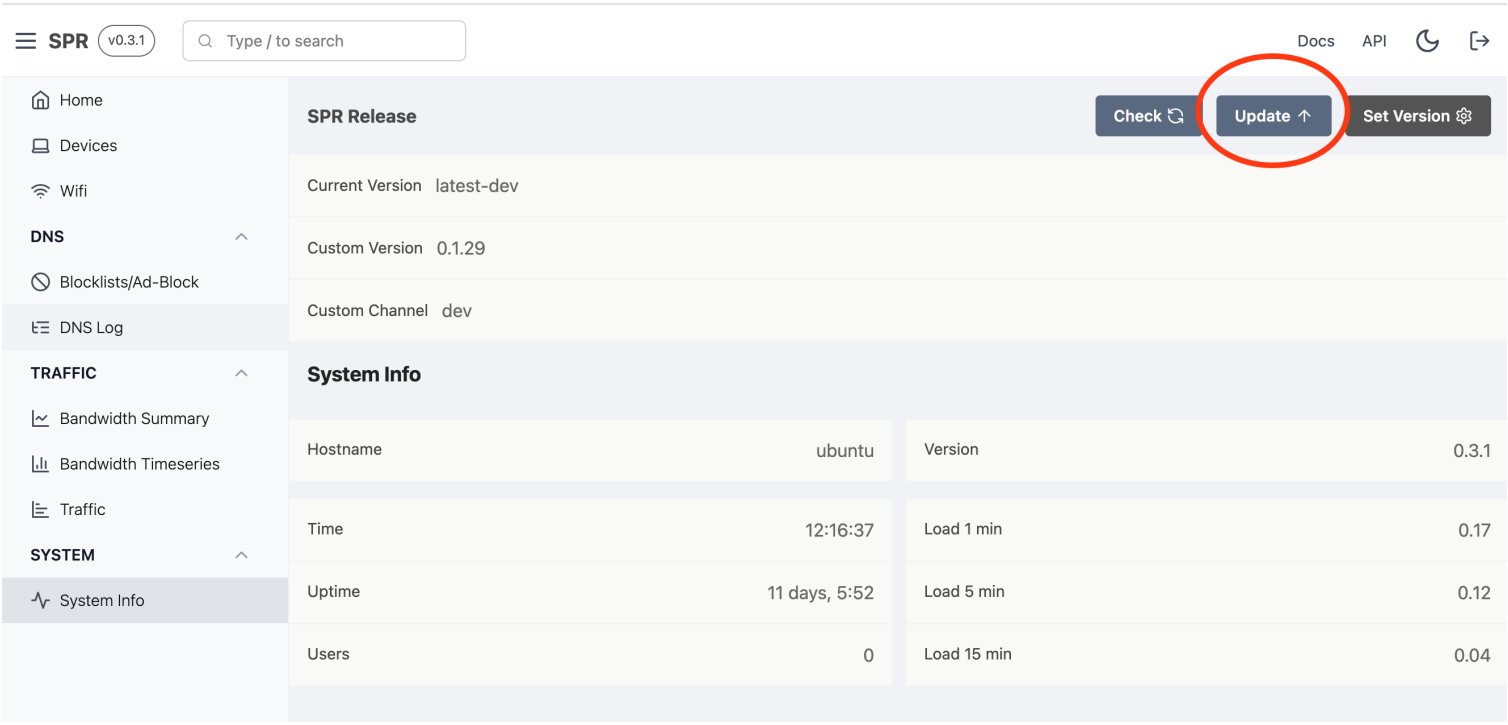
Something broken? File a ticket

See the Troubleshooting FAQ

Updating SPR

How To Update?

SPR can be updated from the `System Info` view



Auto Updates

Auto updates are not currently enabled and may be added in a future release.

Release Channels

The main release channel is `main`.

The `dev` branch publishes to the `dev` channel. This is not stable and not recommended outside of development.

It's also possible to roll back to a previous version by setting it.

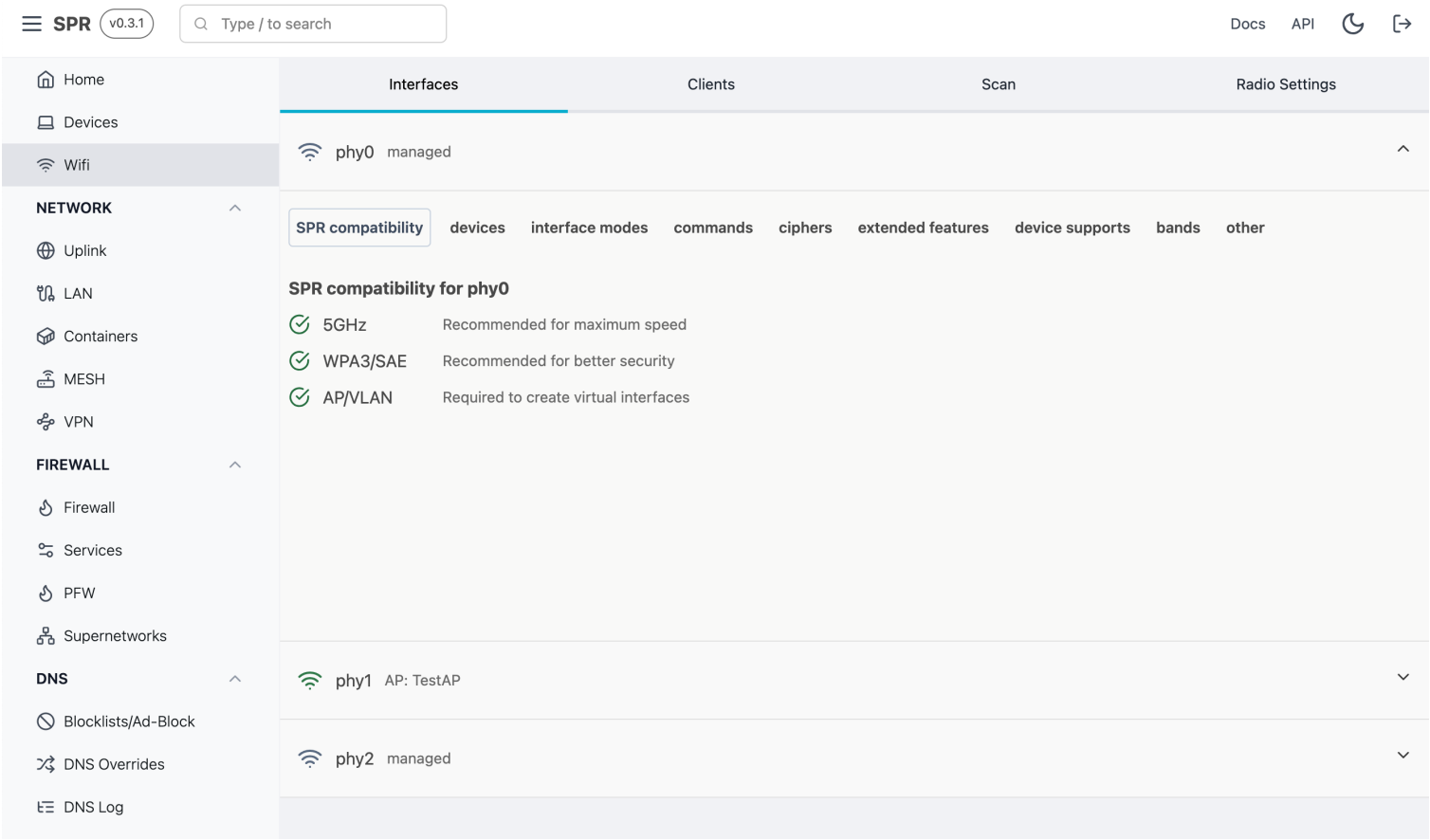
Updating from the command line

```
sudo -s
cd /home/spr/super/
docker compose pull
docker compose up -d
```

WiFi Settings

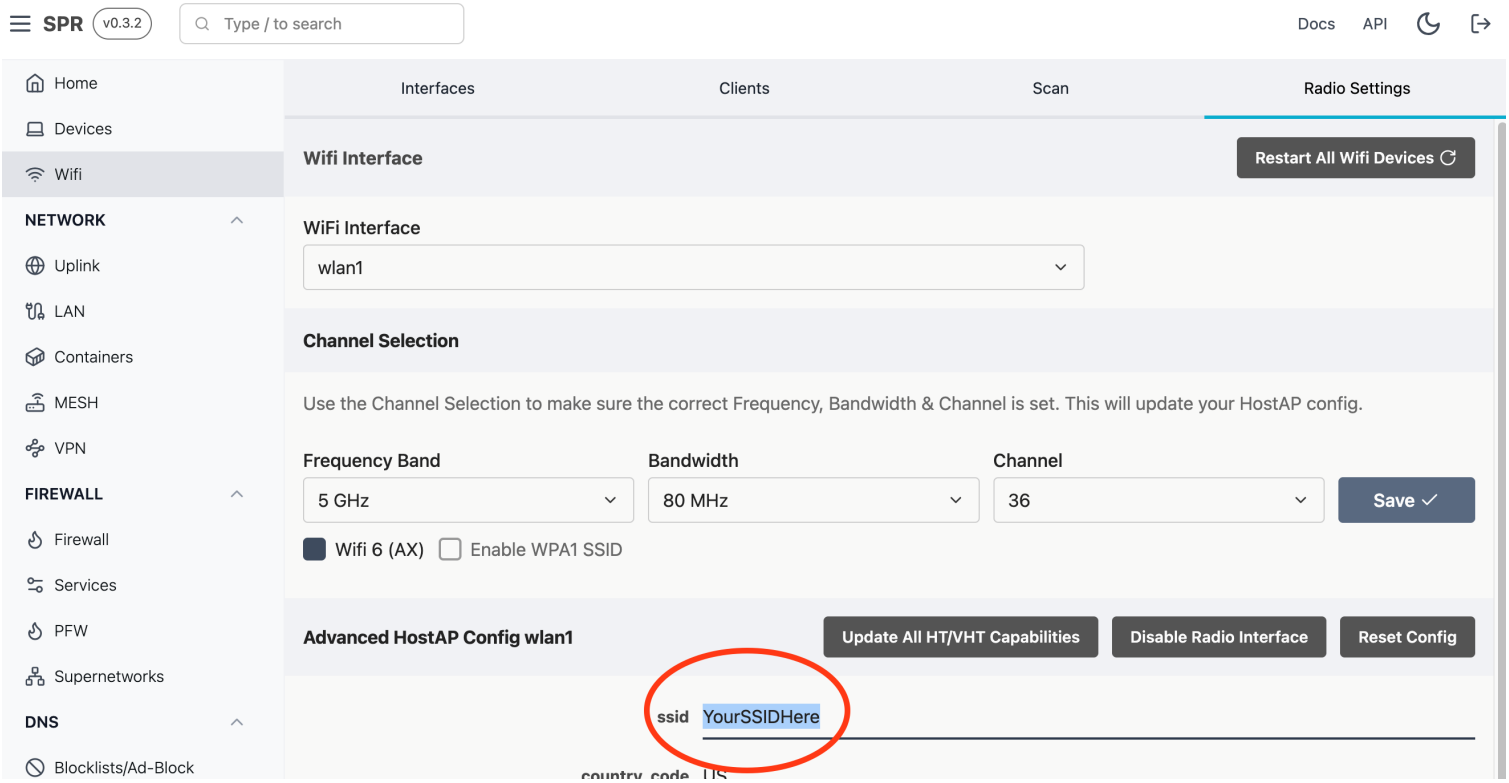
SPR Compability

Device isolation today requires a card with AP/VLAN support. This is presented under the Intefaces tab under wireless settings.

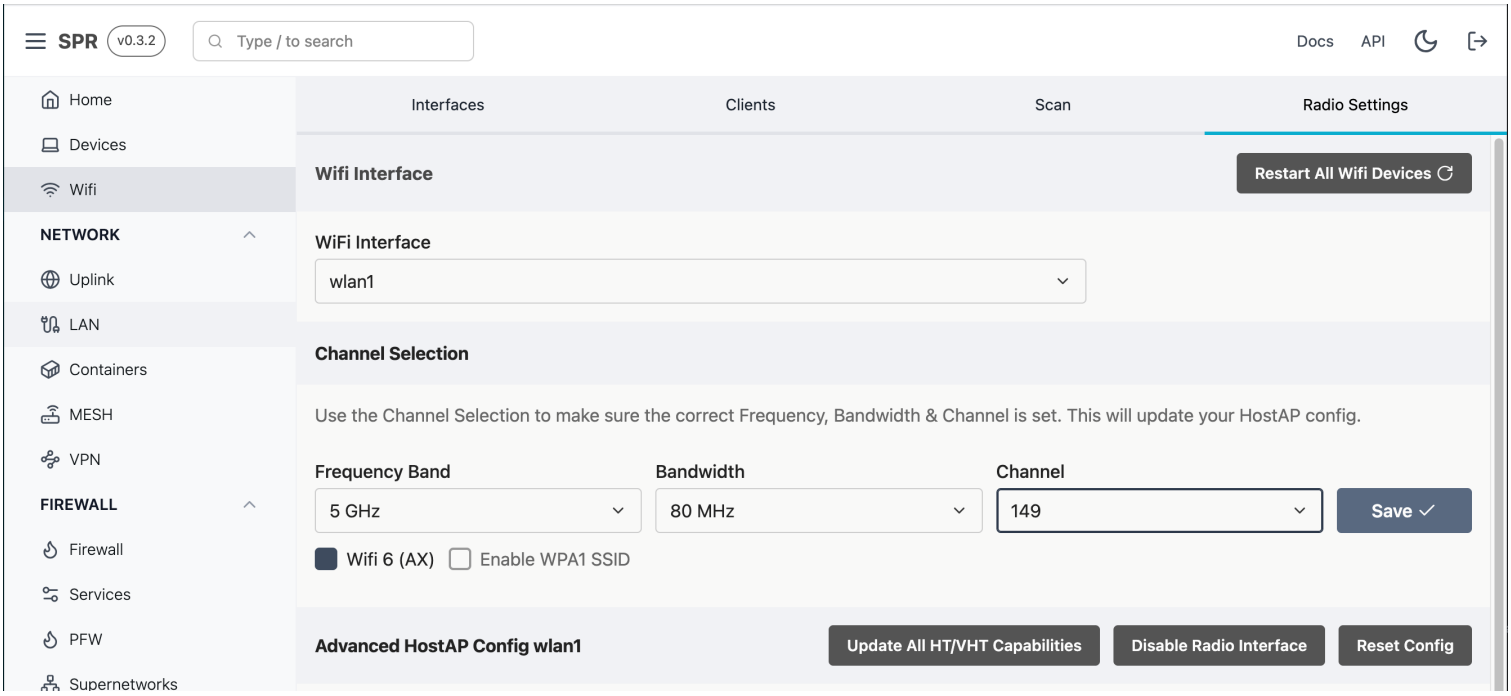


SSID

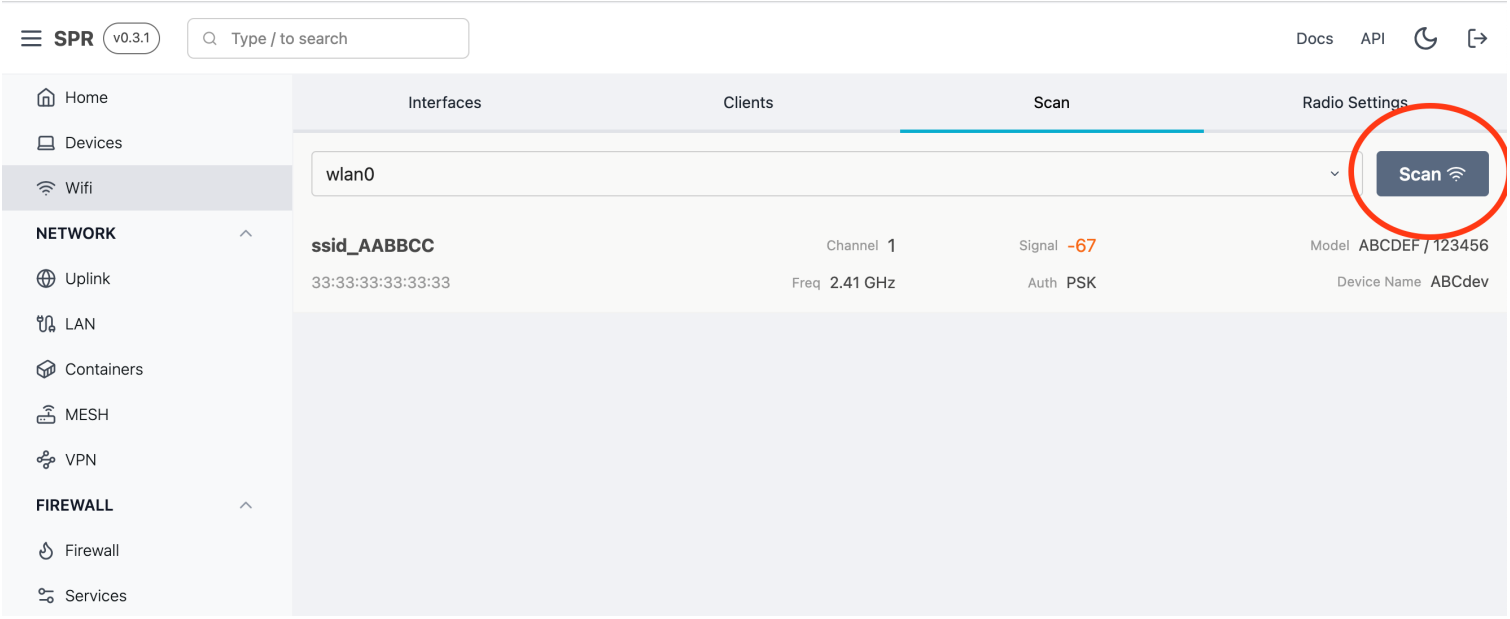
The SSID name can be set by navigating to WiFi ⇨ Radio Settings and typing in the new SSID. After hitting enter or leaving the field, it will update and restart with the new SSID.



Channel Configuration



You can also run a scan with an unused radio to try to determine available channels

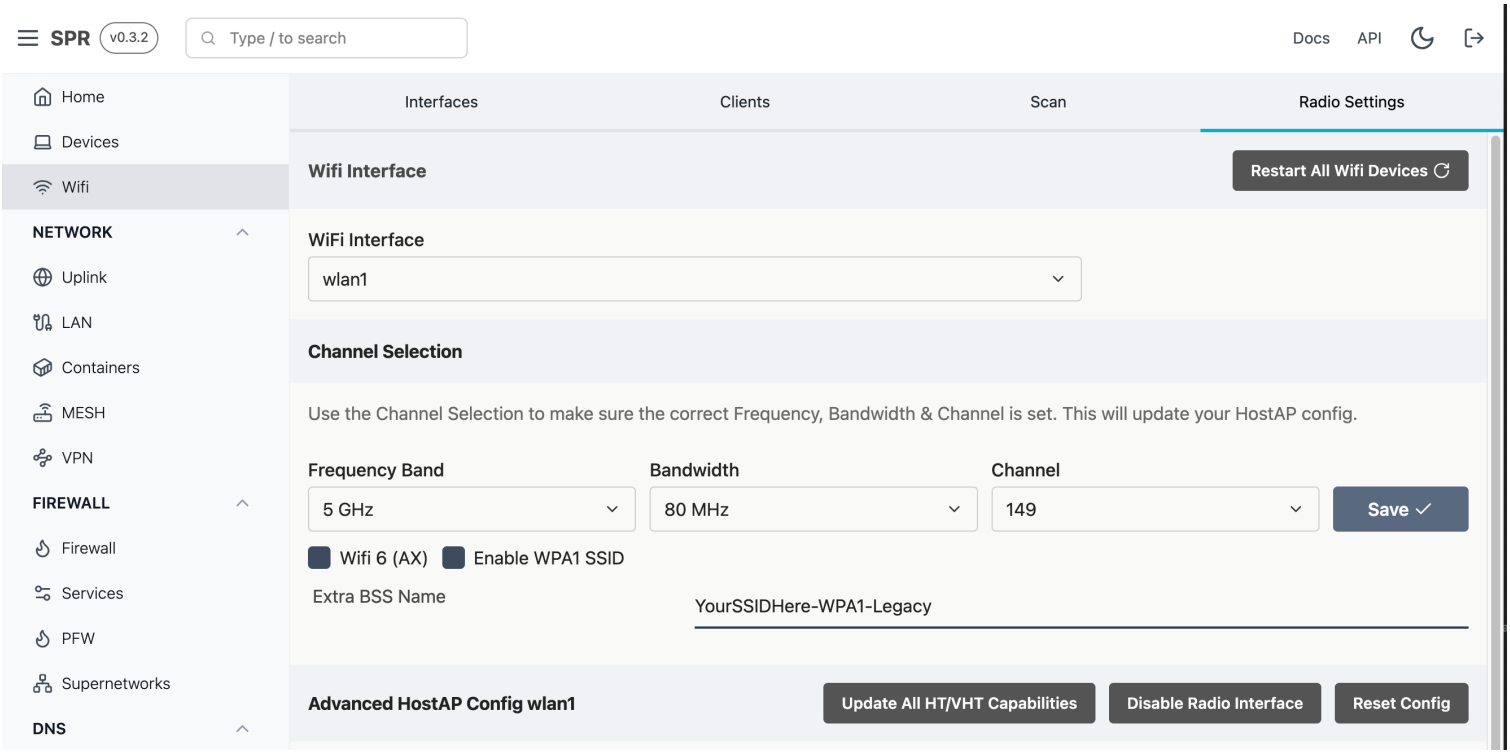


Enabling WiFi 6

SPR will detect if WiFi 6 is supported. If so, select the WiFi 6 button and hit save. This will configure the AP settings to support WiFi 6 protocol settings.

Legacy WPA1 Support

Unfortunately, some older devices do not support WPA2 or WPA3. If your card supports it, SPR can enable a secondary SSID with WPA1. It should have a different SSID name than the main SSID.



Tuning Capabilities

There are various capabilities available for 802.11 HT , 802.11AC (VHT), and 802.11AX (HE). SPR will auto-detect and assign these capabilities with the "Update All" button. They can also be selectively modified.

If you need additional options, please file an issue

Troubleshooting

If the wifi fails to start, try the following:

1. Hit Reset Config
2. Hit Enable HostAP
3. Re-configure your SSID name and channel settings and hit save

Overview

PLUS is our add-on package that lets users support the SPR project.

Site VPN

- Configuration
- Routing traffic to the Site VPN

Mesh

- Installing a Mesh Node

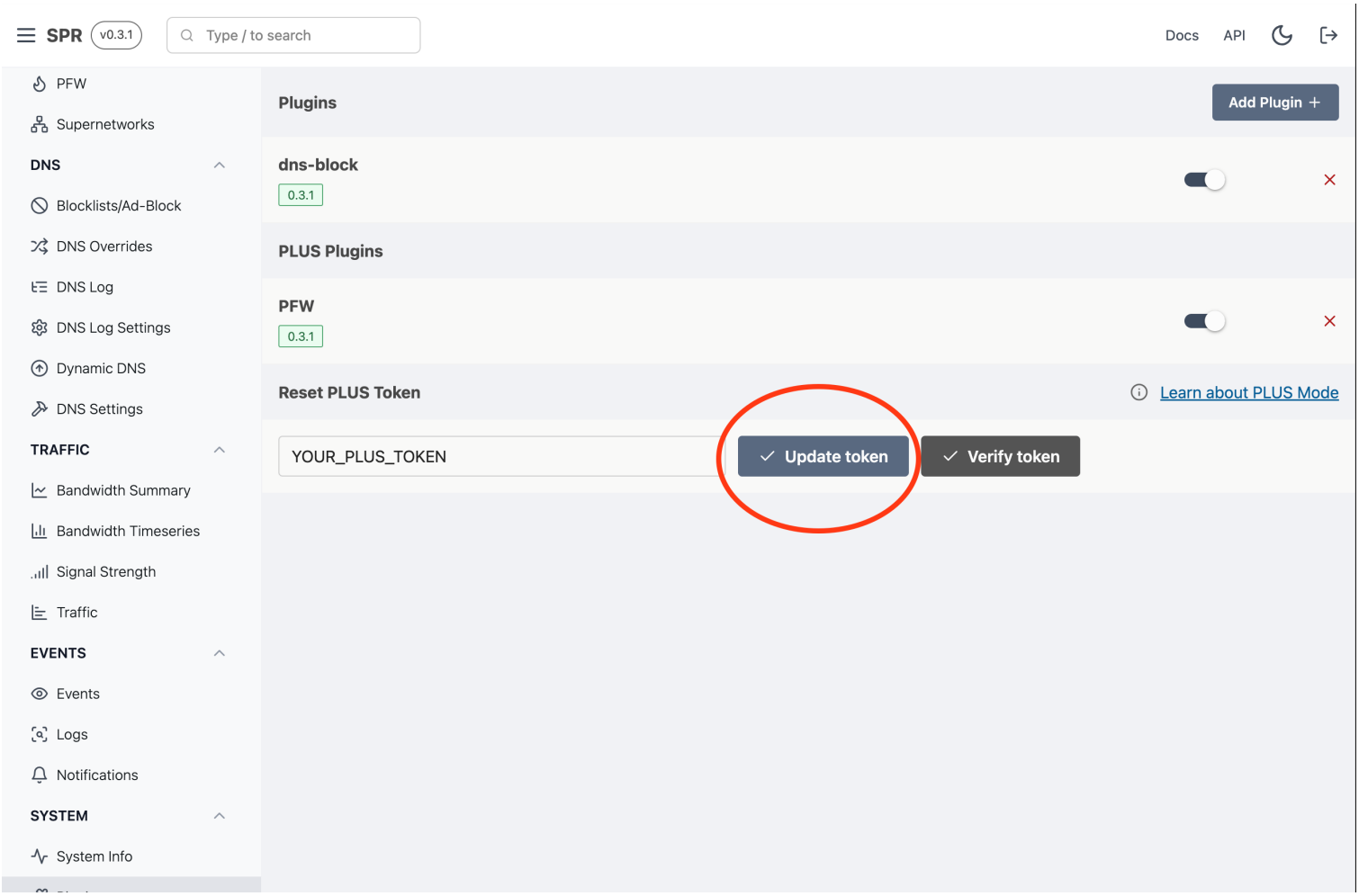
Programmable Firewall (PFW)

- Configuration
- scheduling dns block rules aka focus mode
- mitmproxy setup guides

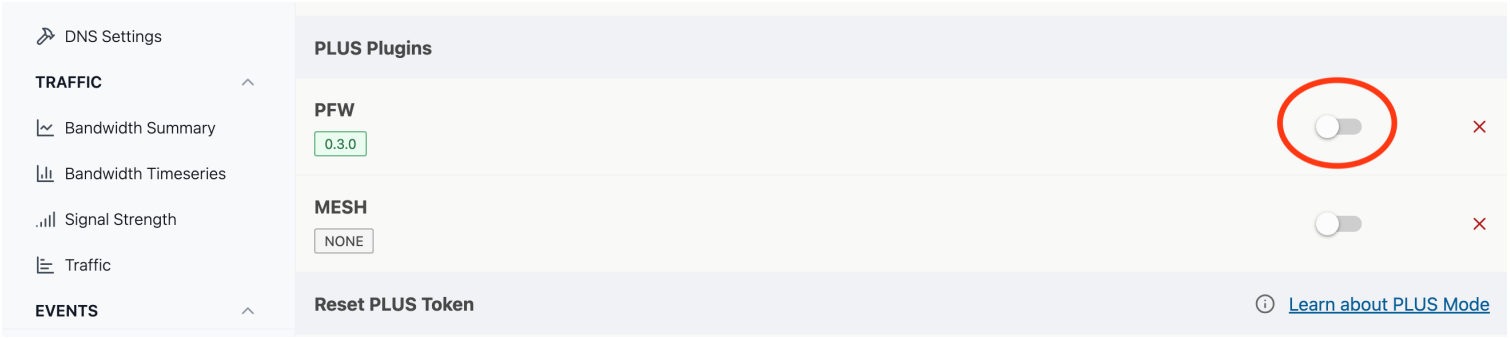
Setup Guide

After purchasing PLUS, an e-mail should arrive with the PLUS token.

Go to the plugins view, and paste the token to activate PLUS plugins.



Next, enable the plugins you'd like to use. Today PLUS ships with two extensions -- Mesh and PFW



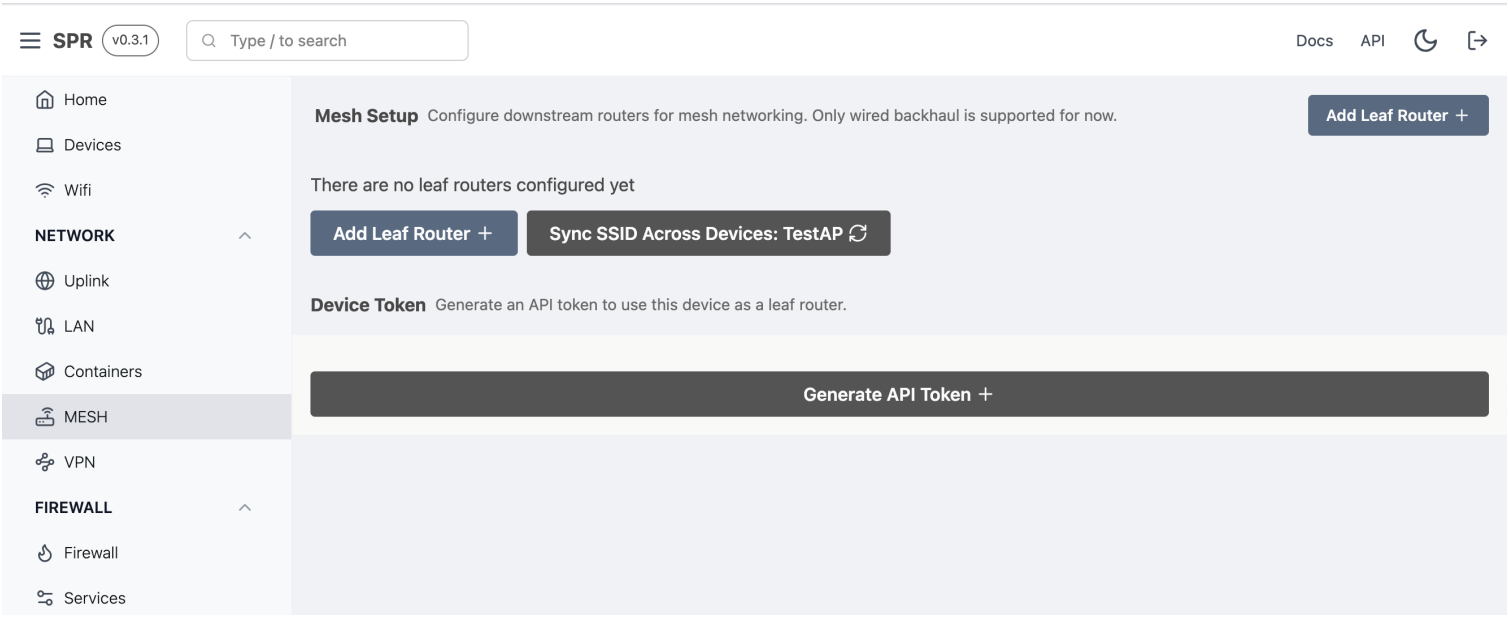
WiFi Mesh Support

Today Mesh support has been tested primarily with wired backhaul. SPR does not use 802.11s mesh networking for wireless backhaul but may do so in a future release

Install

To get started, install SPR on your mesh device, and enable PLUS and the Mesh plugin.

Next, visit the Mesh page and generate a leaf token.



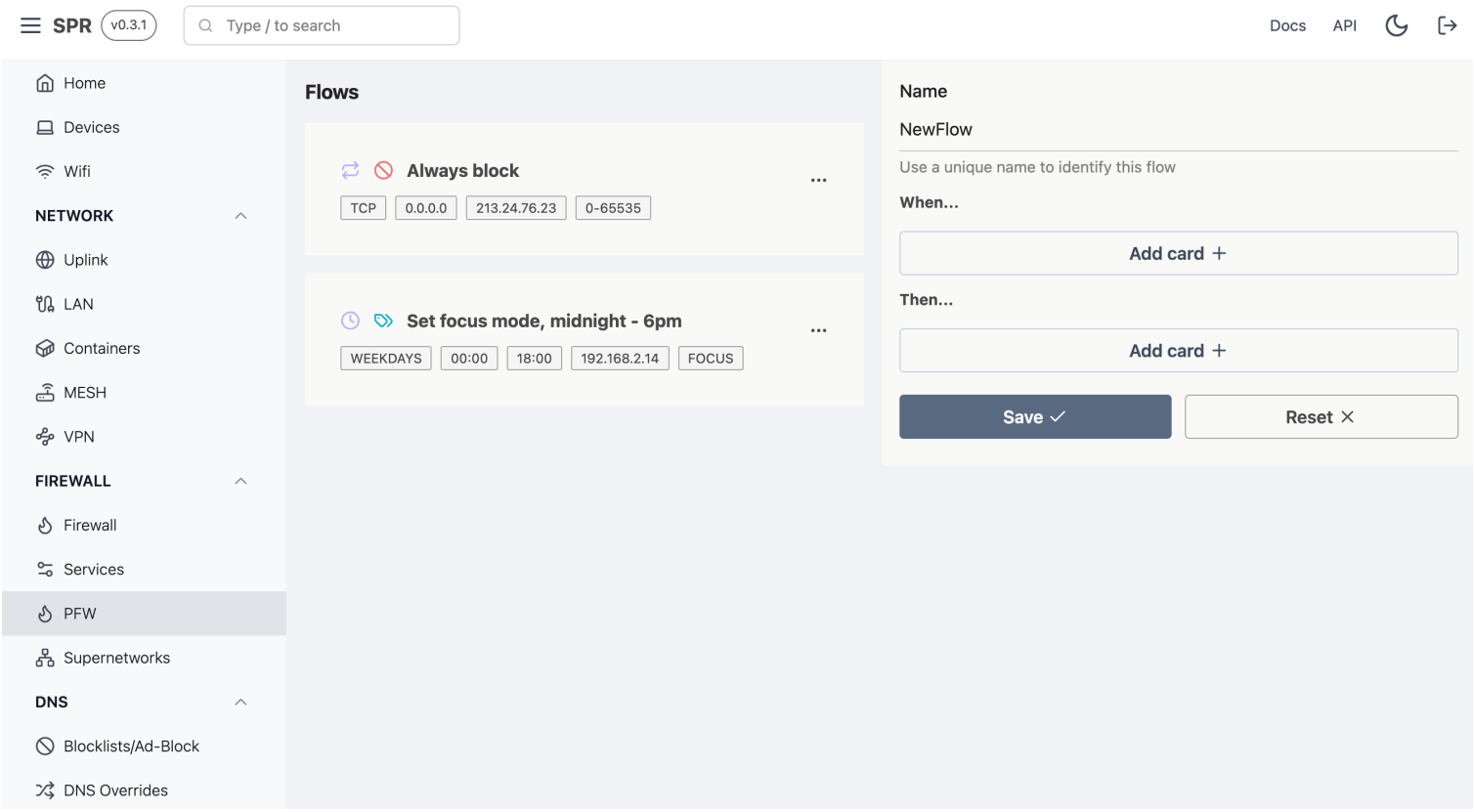
Copy the generated token, and then navigate back to the main SPR router.

Select the IP of the mesh router, and configure it with the key.

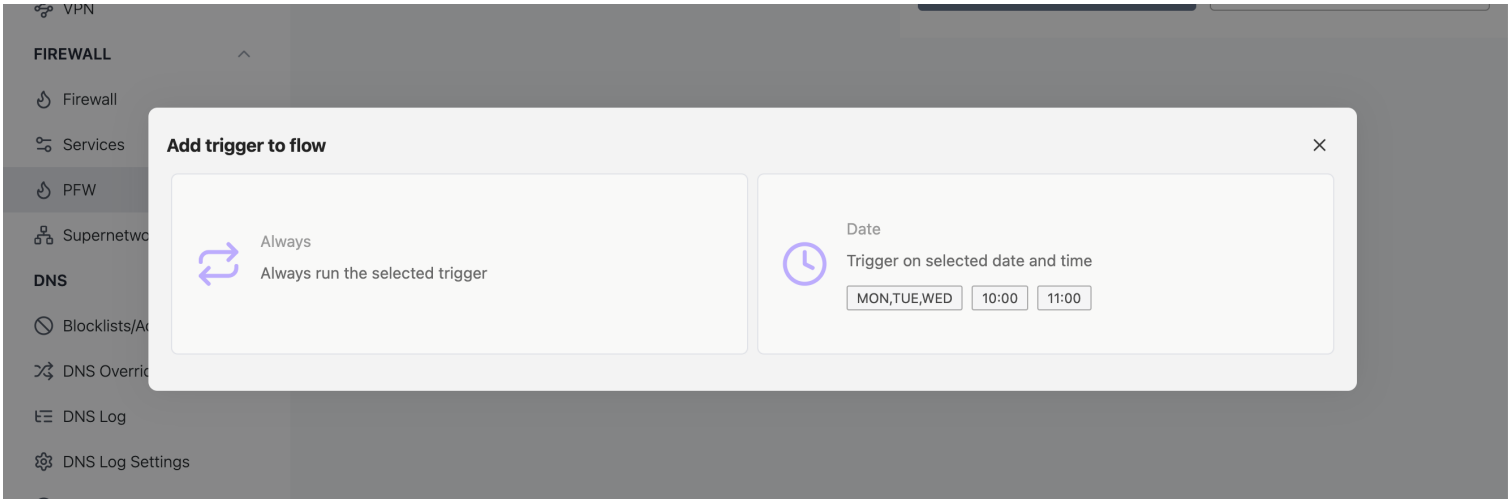
PFW Programmable Firewall

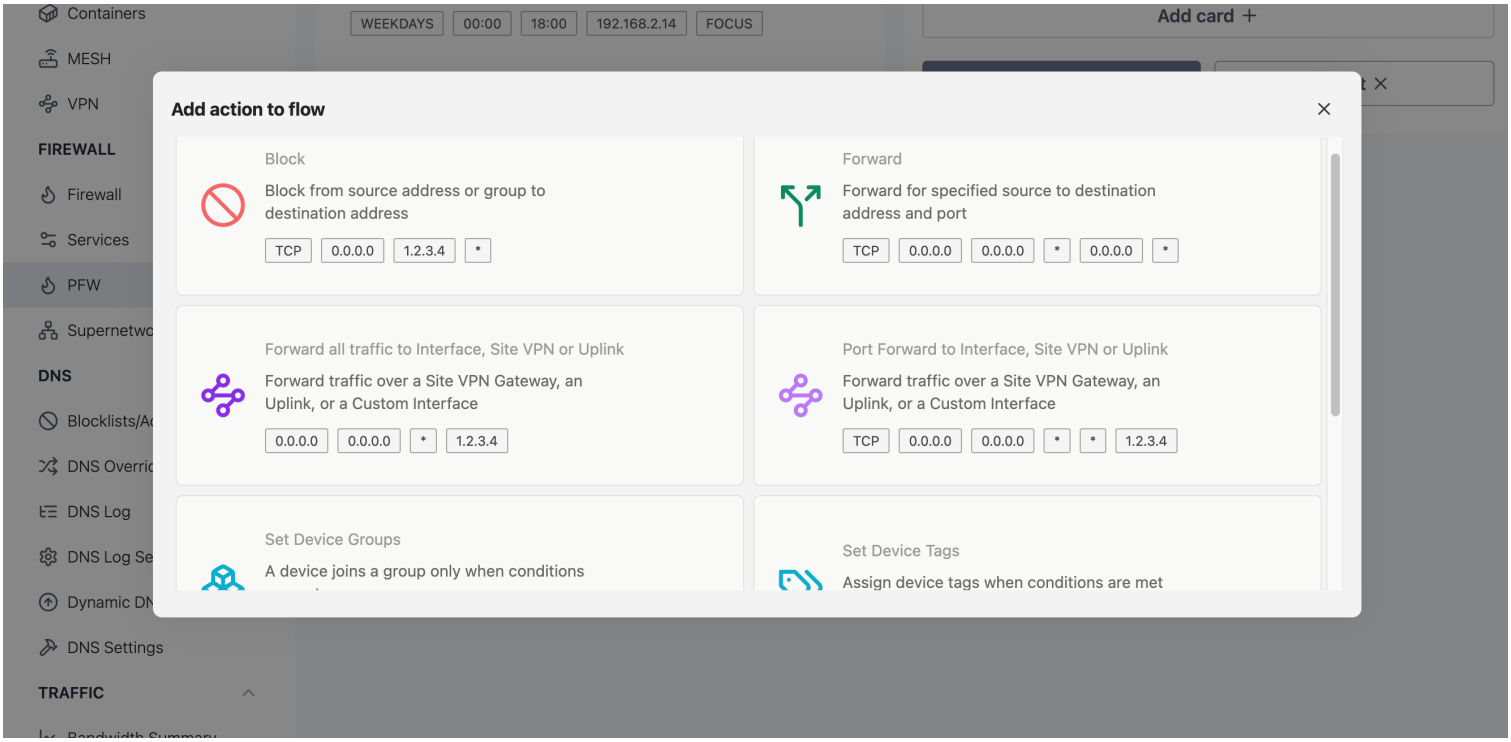
PFW allows for advanced firewall rules using policy based and DNAT.

It can also be used to schedule actions on the router, like joining groups or receiving tags at a specified time.



Configuration



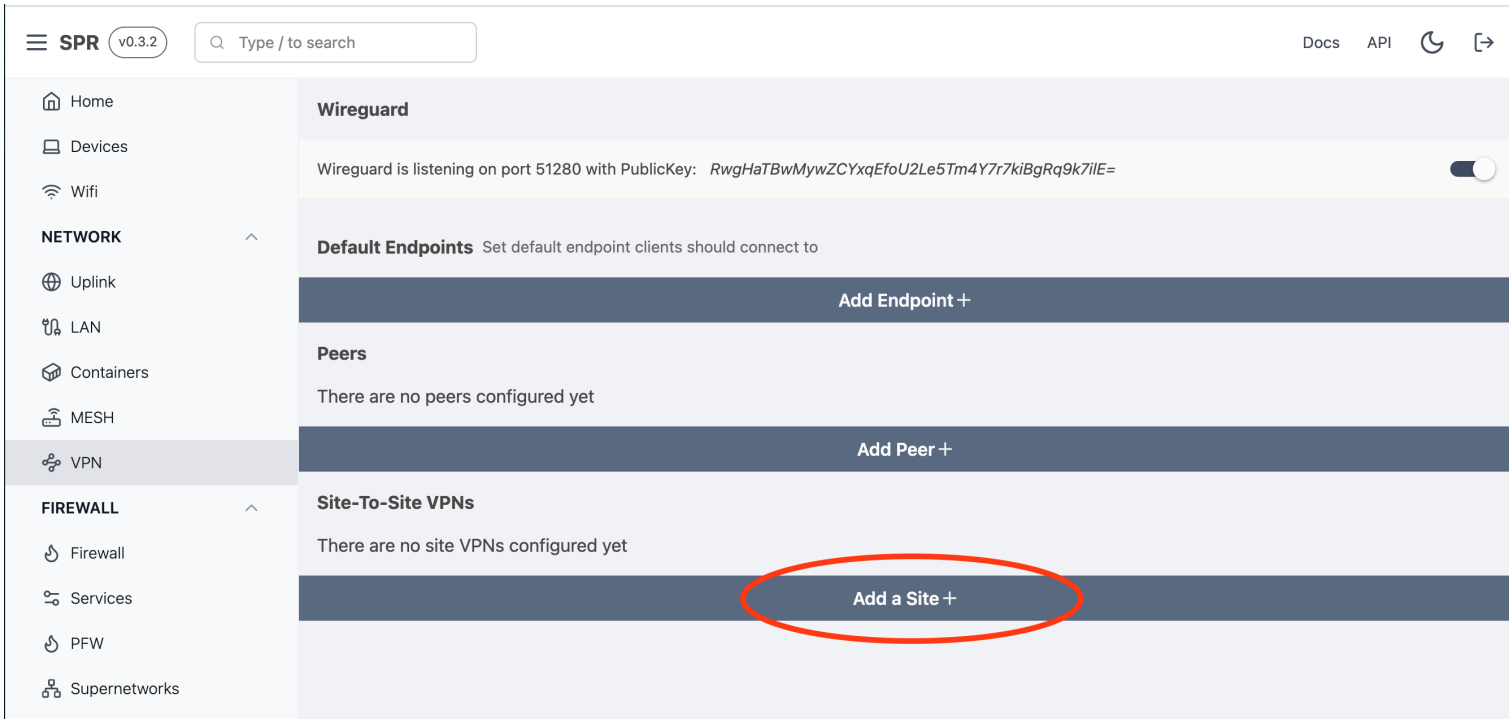

Containers
MESH
VPN
FIREWALL
Firewall
Services
PFW
Supernetwo
DNS
Blocklists/A
DNS Overri
DNS Log
DNS Log Se
Dynamic DN
DNS Settings
TRAFFIC
WEEKDAYS
00:00
18:00
192.168.2.14
FOCUS
Add card +
Add action to flow
Block
Block from source address or group to destination address
TCP
0.0.0.0
1.2.3.4
*
Forward
Forward for specified source to destination address and port
TCP
0.0.0.0
0.0.0.0
*
0.0.0.0
*
Forward all traffic to Interface, Site VPN or Uplink
Forward traffic over a Site VPN Gateway, an Uplink, or a Custom Interface
0.0.0.0
0.0.0.0
*
1.2.3.4
Port Forward to Interface, Site VPN or Uplink
Forward traffic over a Site VPN Gateway, an Uplink, or a Custom Interface
TCP
0.0.0.0
0.0.0.0
*
*
1.2.3.4
Set Device Groups
A device joins a group only when conditions
Set Device Tags
Assign device tags when conditions are met

Site VPN

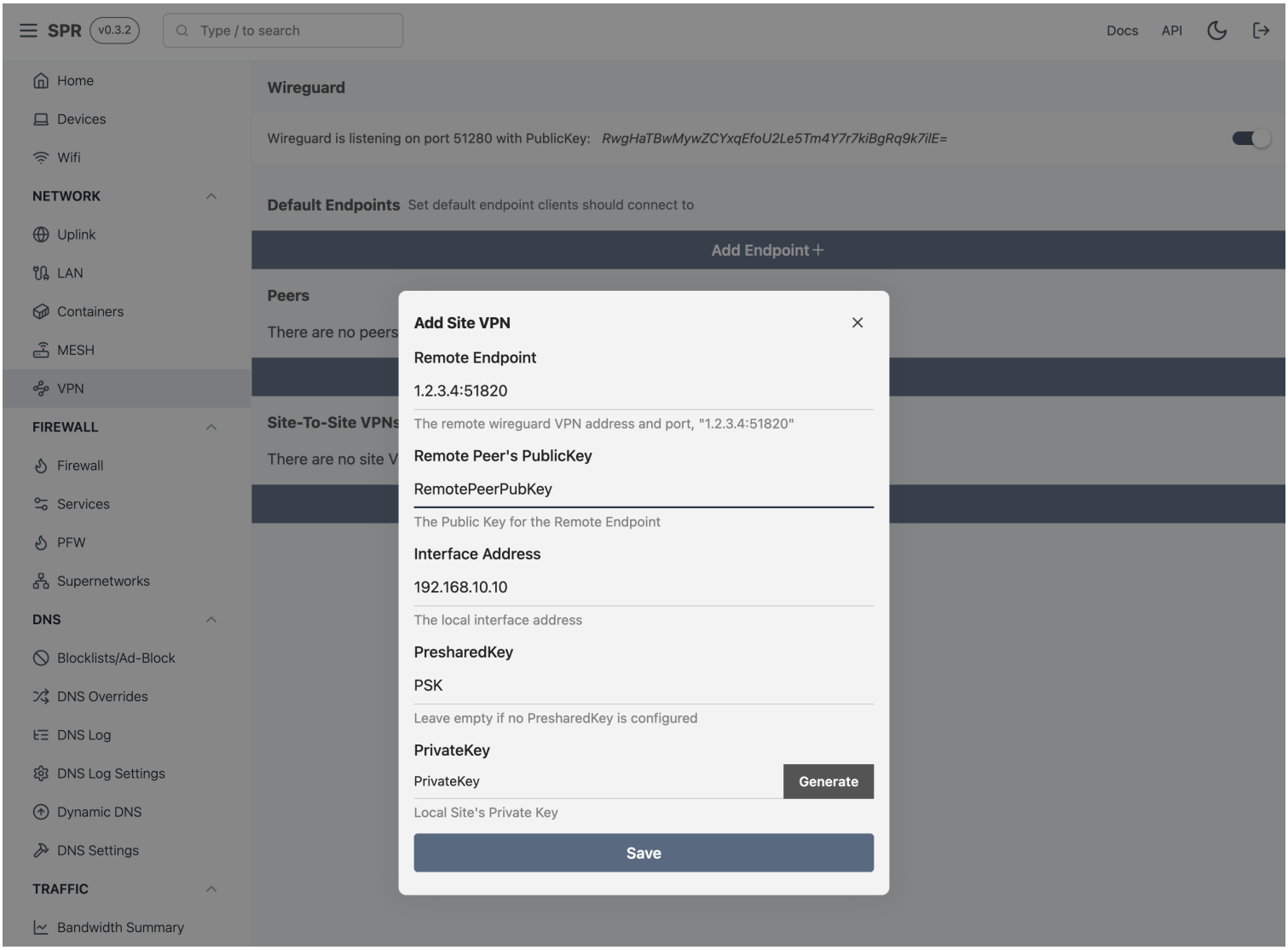
The PFW plugin from PLUS adds support for Site VPN Destinations with Wireguard.

Configuration

Once PFW is enabled, a new menu should appear under the VPN view.



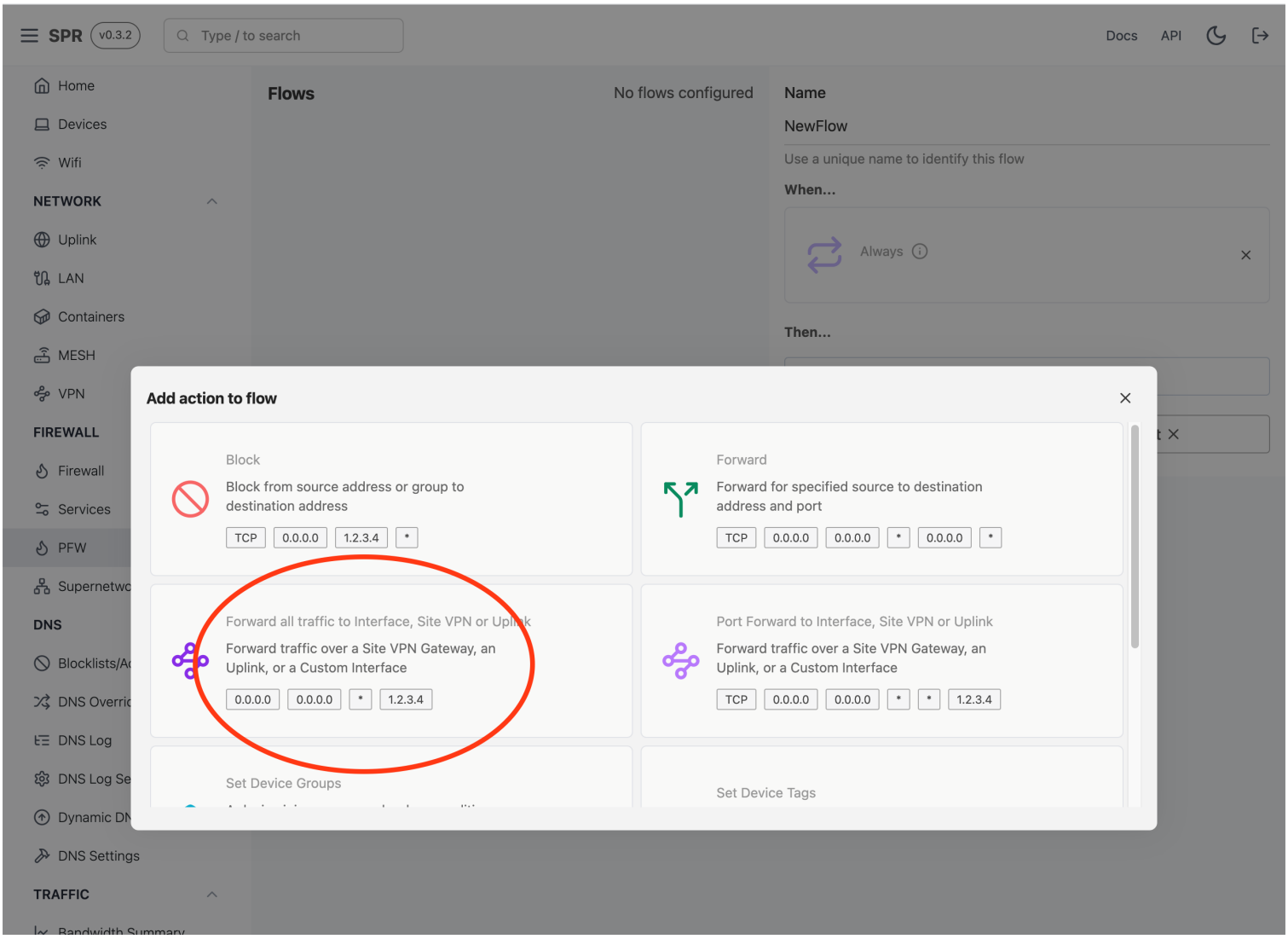
Next, fill out the wireguard details. The 'Interface Address' should be the Peer IP for SPR that the remote wireguard has assigned.



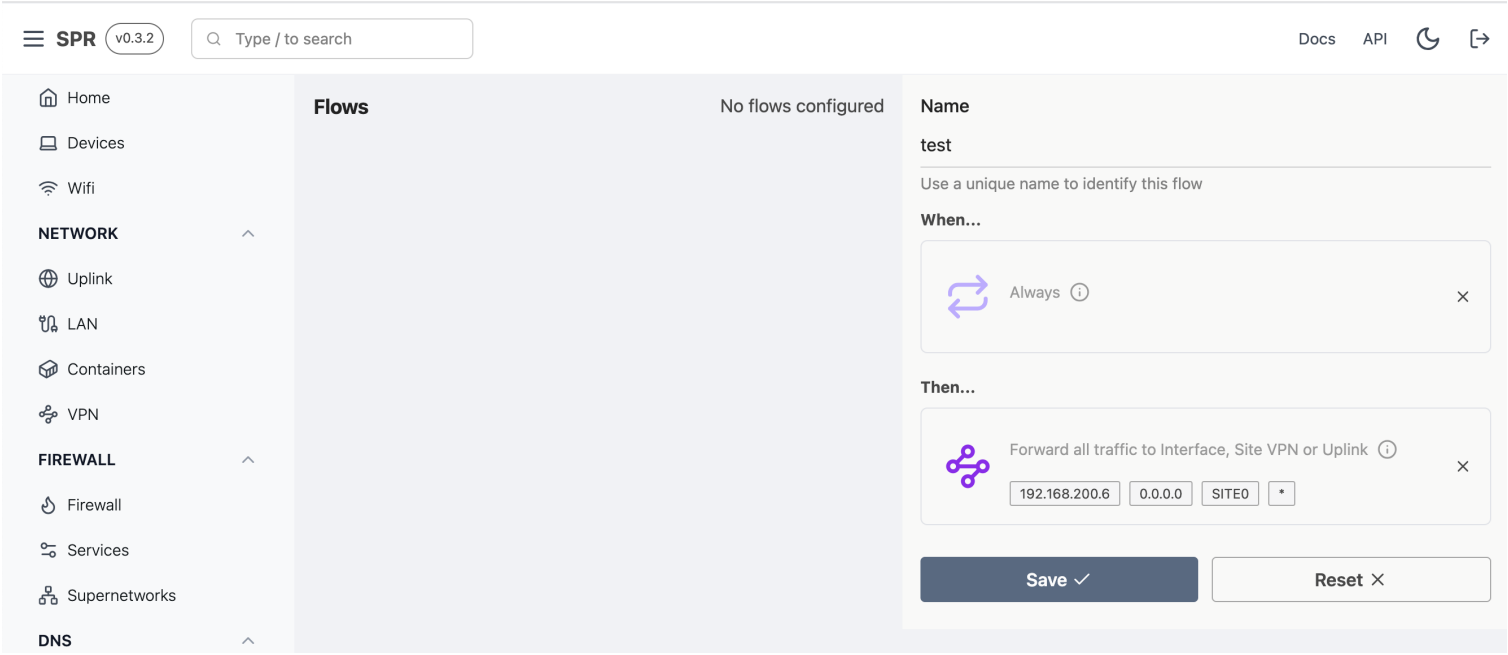
Routing Traffic

Next, we can use the `PFW` extension to create Policy rules that redirect traffic over the site interface.

Select the `Forward all traffic to ...Site VPN or Uplink` action



Fill out the parameters, selecting the Client/Group/Tag to apply the rule to. Select the `site0` destination itnerface. The `destination` can be left blank for Site VPNs.



Now outbound traffic from the selected device will go out over the Site VPN.

DNS Split Tunnel

Note that DNS request still go through the main router DNS service. In a future release, a parameter will be available to also route DNS queries through the Site VPN.

Verifying connectivity

In an upcoming release, status will be visibile in the UI. For now, users can run the following command on SPR

```
docker exec -it superwireguard wg show
```

```
interface: wg0
  public key: PUBKEYPUBKEY=
  private key: (hidden)
  listening port: 51280

interface: site0
  public key: PUBKEYPUBKEY=
  private key: (hidden)
  listening port: 52538

peer: PEERPUBKEYPUBKEY=
```

```
  preshared key: (hidden)
  endpoint: 1.2.3.4:51280
  allowed ips: 0.0.0.0/0
  latest handshake: 11 seconds ago
  transfer: 272.20 MiB received, 50.05 MiB sent
```

And check that the `site0` interface has the correct peer IP

```
docker exec -it superwireguard ip -br addr show site0
```

```
site0            UNKNOWN        192.168.241.2/32
```

Base

The base service establishes the SPR system configuration and initializes the firewall. It also configures performance tuning parameters for managing irq balancing.

The main configuration variables are found in config/base/config.sh

Firewall Configuration

The firewall uses NFTable rulesets defined in base/scripts/nft_rules.sh

The forwarding and input policies are default drop.

The following ports can be exposed to WAN by enabling UPSTREAM_SERVICES_ENABLE in `configs/base/config.sh`:

- sshd (tcp 22),
- api (port 80 or 443 with SSL),
- iperf3 (tcp 5201)
- wireguard (udp 51280)

OR by updating them in the UI under the Firewall settings.

On LAN the following services are available:

- DHCP tied to the authenticated MAC address over WiFi or all wired LAN devices
- DNS for devices in the dns_access group
- 1900, 5353 multicast repeater to all devices for SSDP and MDNS
- The API (port 80, 443)
- SSH (tcp port 22)

Routing to devices on the LAN or to WAN only happens for authenticated, approved MAC addresses.

⇨ View the code

Database

The database service is powered by bolt.

> Bolt is a pure Go key/value store inspired by Howard Chu's LMDB project. The goal of the project is to provide a simple, fast, and reliable database for projects that don't require a full database server such as Postgres or MySQL."

The API communicates with SPR over a unix socket, located at `state/plugins/db/socket` and is documented here.

⇨ View the code

DHCP

DHCP is powered by CoreDHCP. CoreDHCP is an extensible DHCP client and server purely written in golang.

SPR maintains a fork with one additional plugin:

Tiny Subnets

This plugin will call into the core API to get DHCP client addresses and options to assign.

After receiving a DHCP request, it will query the API with the following parameters

```
type DHCPRequest struct {
        MAC        string
        Identifier string
        Name       string
        Iface      string
}
```

And the API will respond with IP, Router, DNS, and Lease time to construct a packet

```
type DHCPResponse struct {
        IP        string
        RouterIP  string
        DNSIP     string
        LeaseTime string
}
```

⇨ View the code

DHCP Client

To remove attack surface, SPR uses CoreDHCP as a memory-safe DHCP client. If that fails, it will fall back to the Ubuntu dhclient implementation.

IPv6

Note: IPv6 is not supported at this time by the CoreDHCP client.

⇨ View the code

DNS

CoreDNS is an extensible golang dns server. It powers kubernetes and many other services today. The server is configured to use DNS over HTTPS upstream for all requests and handles DNS for wireguard and wifi clients.

The DNS Service runs off CoreDNS with custom plugins

- Ad Blocking
- DNS Rebinding Protection
- JSON Log

DNS Configuration Files:

- Corefile

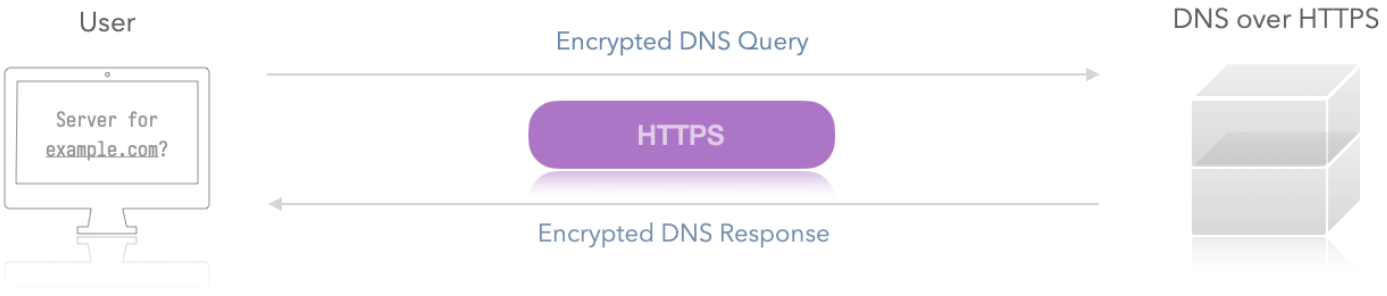
Local Mappings

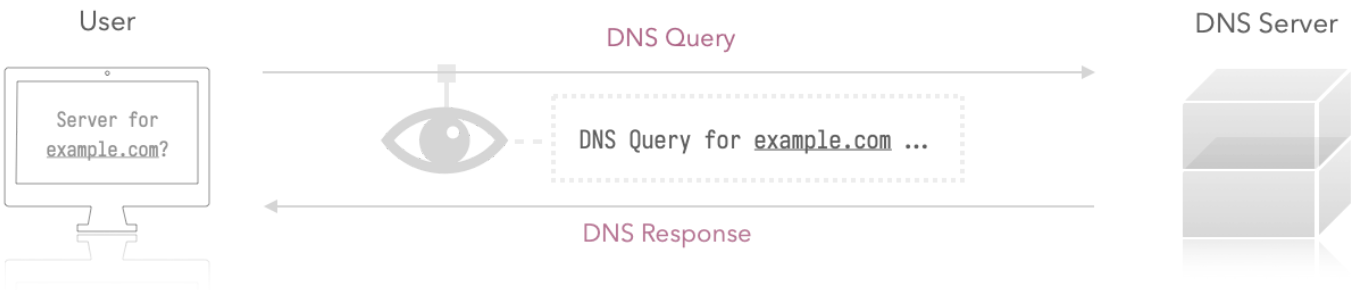
CoreDNS is configured to use Local Mappings of names from DHCP. If a device DHCPs with a client name of "test", "test.lan" resolves with the LAN IP address.

```
hosts /state/dns/local_mappings {
  ttl 60
  reload 30s
  fallthrough
}
```

DNS over HTTPS

The config for SPR is using DNS over HTTPS by default for all upstream requests.





⇨ View the code

Dynamic DNS

The DYNDNS plugin runs godns under a docker container, under the default docker bridge.

This plugin is dynamically started when enabled.

It can be configured under the `Dynamic DNS` view when enabled.

⇨ View the code

Extensions

The API can be extended with plugins. Containers can expose unix sockets that the API will reverse proxy into and make available for clients. See the API docs for the default API extensions or check the example plugin in the super repository.

A list of curated plugins is available here

Read more about how plugins are configured in the API overview.

Multicast UDP Proxy

The multicast proxy forwards multicast packets across VLANs and network interfaces. The service is written in golang and uses transparent UDP sockets to forward packets.

By default it provides MDNS and SSDP. More multicast services can be configured under the multicast firewall settings.

⇨ View the code

Packet Logs

This service receives packets over NFLog netlink messages.

The packet info is sent to the sprbus where clients subscribing to the *nft*-prefix gets notified. It's easier to talk to sprbus for packet inspection but also available by packet_logs.

Example: The db service can enable storage of logs by adding the topic to `configs/db/config.json` under the *SaveEvents* key.

See also: sprbus

The Groups

Group 0

```
chain INPUT  { ...
$(if [ "$WANIF" ]; then echo "iifname $WANIF log prefix \"wan:in \" group 0";
fi)
$(if [ "$WANIF" ]; then echo "iifname ne $WANIF log prefix \"lan:in \" group
0"; else echo "log prefix \"lan:in \" group 0"; fi)

}

chain FORWARD { ...

$(if [ "$WANIF" ]; then echo "oifname $WANIF log prefix \"wan:out \" group 0";
fi)
$(if [ "$WANIF" ]; then echo "oifname ne $WANIF log prefix \"lan:out \" group
0"; else echo "log prefix \"lan:out \" group 0"; fi)
```

}

wan:in

Input from the upstream interface ($WANIF)

lan:in

Input from all other devices (wireguard, wireless clients, wired devices)

wan:out

Packets forwarded upstream to the internet over the $WANIF interface

lan:out

Packets forwaded to any other non-upstream interface

Group 1 - Dropped packets

```
log prefix "drop:private " group 1
counter log prefix "drop:forward " group 1
counter log prefix "drop:input " group 1
log prefix "drop:mac " group 1
```

drop:private

This prefix marks packets that were dropped because they were headed upstream to a private network address, but blocked from doing so because they were not in a permitted group

drop:forward

Packets that were dropped during forward

drop:input

Input packets into SPR that were dropped

drop:mac

Packets that were dropped because of an strict MAC filtering in the INPUT chain in the FORWARD chain.

⇨ View the code

Inspecting packets

Retrieve JSON packet logs on SPR with:

```
docker exec -it superpacket_logs /stream-json-logs > log.json
```

will log packets for 20 seconds, can specify with `-timeout` flag.

Packets can be inspected with `jq`, see following section for fields. Raw data is available and base64 encoded.

Script to inspect traffic

Example script with gum - a tool for glamorous shell scripts.

Install dependencies:

```
apt install jq
go install github.com/charmbracelet/gum@latest
```

```
#!/bin/sh
# packet_logs json stream build if not running on spr:
# cd packet_logs/stream-json-logs && go build -o stream
```

```
# ./stream > log.json
F="$PWD/log.json"
F_CSV="${F}.csv"
BIN_STREAM="docker exec -it superpacket_logs /stream-json-logs"

log_stream() {
    gum spin -s moon --title "Logging traffic... 20s" -- sh -c "$BIN_STREAM >
$F"
}

table() {
F_UDP='[.Timestamp,"UDP",.Prefix,
([.IP.SrcIP,.UDP.SrcPort|tostring]|join(":")),
([.IP.DstIP,.UDP.DstPort|tostring]|join(":"))]'
F_TCP='[.Timestamp,"TCP",.Prefix,
([.IP.SrcIP,.TCP.SrcPort|tostring]|join(":")),
([.IP.DstIP,.TCP.DstPort|tostring]|join(":"))]'

cat "$F" \
    | jq -r -c "if .UDP!=null then $F_UDP elif .TCP!=null then $F_TCP else
empty end | @csv" \
    | sed 's/"//g' > "$F_CSV"

IS_TABLE=0

if [ $IS_TABLE -eq 1 ]; then
    SEL_ROW=$(gum table -c "ts, proto, prefix, src, dst" -w 30,8,10,20,20 --
height 20 -f "$F_CSV")
else
    SEL_ROW=$(cat "$F_CSV" \
        | sed 's/,/ /g' \
        | gum filter --no-fuzzy --indicator.foreground="99" --
match.foreground="99" --height 20)
fi

SEL_TS=$(echo $SEL_ROW|sed 's/,/\t/g'|awk '{print $1}')

if [ -z "$SEL_TS" ]; then
    exit
fi

SEL_JSON=$(cat "$F" | jq "select(.Timestamp == \"$SEL_TS\")")

echo "$SEL_JSON" | gum pager
}
```

```
gum style --foreground 99 --border double --border-foreground 99 --padding "0
4" --margin 1 "SPR packet logs cli"
gum input --placeholder="Press ENTER to start"

if [ ! -f "$F" ]; then
    log_stream
fi

while true; do table; done
```

save the script in packetlogs.sh and run it:

```
./packetlogs.sh
```

OUI & MAC Lookups

This plugin provides api endpoints to query for IP address ASN & MAC address OUI information

For ASN lookups its using this: https://iptoasn.com/data/ip2asn-v4.tsv.gz

And the OUI vendor list from Wireshark: https://gitlab.com/wireshark/wireshark/-/raw/master/manuf

Files are downloaded on startup of the container ⇨ View the code

PPP

SPR can be run as the point of entry for home internet.

PPPoE is supported with the standard ubuntu ppp daemon. To configure it, see the Uplink view, or the uplink/ppp API endpoint documentation

This service is off by default and dynamically started when enabled.

⇨ View the code

SPRbus

SPRbus is the event bus used in SPR to send and subscribe to events.

⇨ View the code

Usage

- db is listening for events and store these in a database
- packet logs send events when netfilter rules are triggered
- api for notifications
- api publish event for access log
- dns send events on domain lookup or block

Available events

- dns:block:event
- dns:override:event
- dns:serve:192.168.2.2
- log:api
- log:www:access
- nft:lan:in
- nft:lan:out
- nft:wan:in
- nft:wan:out
- nft:drop:private
- nft:drop:forward
- nft:drop:input
- nft:drop:mac
- www:auth:user:success

Example Events

- *wifi:auth:success* is published when a device connect
- *device:save* is published when a device is updated

View the API documentation for sprbus here

By default *log:api*, *dns:block:event*, *dns:override:event*, *dns:serve:* events are stored in the database. The log items can be viewed under *System -> Logs*. If you want to store more events you can add them in the web ui under *System -> System Info -> Database*.

Command line tools

See cmd/main.go

```
cd cmd/; make
./sprbus --help
```

remote

```
export TOKEN="SPR-API-TOKEN"
./sprbus --addr 192.168.2.1
```

local

```
./sprbus
```

example topics

```
#www and api logs
./sprbus -t log
# device and wifi events
./sprbus -t device,wifi
#network traffic
./sprbus -t nft
```

network traffic in json, no timeout and pipe to jq

```
./sprbus -t nft -j --timeout 0 | jq .
```

publish test event

```
./sprbus -t test:event -p '{"msg": "testevent1234"}'
```

example showing how to publish events.

Development

See example/main.go

using default sprbus:

```
//publish json string
sprbus.PublishString("wifi:station:event", "{\"json\": \"data\"}")

//publish object
sprbus.Publish("www:auth:user:fail", map[string]string{"username": username})

//subscribe
go sprbus.HandleEvent("wifi", func (topic string, json string) {
    fmt.Println("wifi event", topic, json)
})
```

Custom unix socket server and client

See example/main.go for code to setup a custom unix socket server and client

Superd

About

The superd service can restart SPR services and download PLUS extesions.

The API communicates with SPR over a unix socket, located at `state/plugins/superd/socket` and documented here.

⇨ View the code

VPN

About

VPN is powered by Wireguard (© Jason A. Donenfeld).

The service is listening on udp port 51280.

Wifi Uplink

This is a built-in extension that is dynamically started when a wireless uplink is configured under the `Uplink` page.

The plugin will run `wpa_supplicant` to connect to the configured access point.

The management of the `/configs/wifi_uplink/wpa.json` configuration for this plugin is handled under the core API service.

⇨ View the code

Wifid

The wifi service runs Hostap with some patches for better WPA3 support that will be submitted upstream at some point in the future.

The service supports multiple radio interfaces, and will run parallel hostap daemons to manage them.

When a station successfully authenticates, fails to, or disconnects: an action script is ran to inform the API as well as helper program. This communication happens over a dedicated unix socket documented here.

Once a station authenticates successfully, a helper program is kicked off to grant permission to DHCP from the client's approved MAC address. An XDP filter is employed to block stations from making DHCP requests for arbitrary MAC addresses.

⇨ View the code

API Overview

View the OpenAPI Documentation here

The API service exists for communication between service containers and to support external requests from the web front end or CLI tools.

The internal APIs run over unix sockets and rely on filesystem namespaces for authentication. Currently there are a few internal APIs exposed to containers over unix sockets:

- Support for wifid service accepting stations
- Setting up dynamic firewall rules for DHCP clients
- Support for wireguard peers

⇨ View the code

API Plugins

A list of curated plugins is available here

API plugins let other docker services expose web APIs with unix sockets that are relayed with a reverse proxy.

To add a new plugin update `configs/base/api.json` or use the UI to enable it.

If the plugin should be started by SPR, then make sure that the compose path is added to the whitelist. To do so, update `configs/base/custom_compose_paths.json`

Example dyndns plugin

```
{
  "Plugins": [
    {
      "Name": "dyndns extension",
      "URI": "dyndns",
      "UnixPath": "/state/plugins/dyndns/dyndns_plugin",
      "Enabled": true,
```

```
      "ComposeFilePath": "dyndns/docker-compose.yml"
    }
  ]
}
```

You can also talk to the spr api directly to list/add/delete plugins - see the api documentation for plugins.

Or in the UI navigate to *System -> Plugins*. Note, SPR for now will not accept arbitrary compose file paths. Instead, update `configs/base/custom_compose_paths.json` with the relative path to the plugin.

Query the http API

It is recommended to create a token to talk to the API (more info about authentication here). In the Admin UI, click ***Add Auth Token*** under *System -> Auth*. Use this token for authorization:

```
export TOKEN="paste-token-here"
curl -s -H "Authorization: Bearer $TOKEN" 192.168.2.1/plugins
```

Query a plugin API

If developing a plugin on the same host as spr you can talk to a specific plugins unix socket.

Example - talk to db service to get stats:

```
pwd
/home/spr/super
sudo curl -s --unix-socket ./state/plugins/db/socket 0/stats
```

SPR Event Bus

sprbus is an event bus for publishing and subscribing to events. The server routing messages between services is setup in the api service.

Clients connect to `/state/api/eventbus.sock`, either subscribing to a topic or publishing events for other clients to handle.

The sprbus command line tool can be used to inspect live events:

See the github repository for more examples.

Read more about SPRbus

Authentication

Configuration

On the device, the following files contain credentials for access.

- `config/auth/auth_users.json` is a JSON file with a dictionary for username, password pairs
- `config/auth/auth_tokens.json` is a JSON file with a list of authentication tokens

Basic Authentication

The API supports Basic Authentication based on the `auth_users` file, using the Basic Schema.

To implement this, a client should include an "Authorization: Basic" header with the credentials formatted as `base64(username:password)`. For a javascript example, see the frontend's Api.js.

Bearer Tokens

The API also supports Bearer Tokens, based on the `auth_tokens` file.

To implement this, a client should include an "Authorization: Bearer" token. See Swagger's page for more examples.

WebAuthN

WebAuthN will support passwordless authenication. Support is a work in progress and is currently disabled. The following endpoints will be available.

GET /register/?username=username

POST /register/

GET /login/?username=username

POST /login/

SSL Support

The API service looks for a certificate at `configs/base/www-api.crt` and the corresponding key `configs/base/www-api.key`. If they exist the api will listen on port 443 for TLS-encrypted requests.

Use the provided script to generate a self-signed certificate.

Enable SSL web api

1. **Generate a certificate**

```
D=./ ./api/scripts/generate-certificate.sh
```

2. **Restart api container**

```
docker-compose restart api # (or restart api-virt if using the virtualized
network variant)
```

3. **Verify the SSL service is running**

```
curl -k https://127.0.0.1
```

4. **Open port 443 for WAN access (optional)**

NOTE This is not recommended if running SPR on the internet.

```
echo "UPSTREAM_SERVICES_ENABLE=1" >> configs/base/config.sh
docker-compose restart api # (or restart api-virt if using the virtualized
network variant)
```

Frequently Asked Questions

SPR stands for Secure Programmable Router

SPR is Linux software for running a hardened wifi network that also makes it easy to add and manage devices. Devices are isolated into individual VLANs and then connected securely into the rest of the network.

- SPR is built to support the leading edge of Linux's networking features, while applying best in class security practices and modern coding standards. The focus is on making usable micro-segmentation with zero-trust networking possible, which is not simple to configure with OpenWRT.
- OpenWRT powers many of the proprietary consumer wifi routers on the market today and was originally intended as a replacement for proprietary embedded firmware. Some routers allow replacing the vendor's OpenWRT with open source builds of the OpenWRT firmware.
- SPR is designed to run in docker containers on systems with a bit more memory and storage, opening up many possibilities like hosting voice assistants, network fuzzers, and media servers. However, it likely won't work as a replacement for embedded router firmware.
- OpenWRT tries to optimize builds for embedded devices without much storage space or memory. It supports a tremendous range of devices and hardware, although older devices are losing support due to storage and memory limitations.
- SPR is built mostly with golang and a react frontend. Where possible, memory-safe languages with good security track records are preferred over native code such as C or code that is difficult to write securely, like PHP.

- OpenWRT is built mostly with C, Shell Scripts, and Lua/LUCI for the web front end.

How do I update SPR?

You do not need to reflash your system. From the UI: go to *System Info -> SPR Release*. You can run ***Check*** to see if there's an update and hit ***Update***.

From the CLI: Go to the SPR directory (`/home/spr/super/`), Run:

```
cd /home/spr/super
git pull
docker-compose pull
docker-compose up -d
```

How is SPR different from an ordinary network and what is a supernetwork?

SPR places each WiFi device into its own VLAN and subnet, using per-device passphrases. When combined together, the devices form a supernetwork. The VLAN isolation creates strong hardening features. Devices can not sniff each other's traffic, they can not perform ARP/MAC spoofing, and they can not communicate with each other without being granted access while they may still be able to access the internet.

Is there any telemetry or statistics sent from SPR to Supernetworks or Third Parties?

No. This can be confirmed by viewing the code in the github repo or if you prefer, look at the network traffic from SPR

What are groups vs tags?

Groups in SPR refer to network access and which devices should be able to communicate with one another. There are three special, built-in groups:

- **wan** : the device can communicate with the internet
- **dns** : the device can make DNS queries
- **lan** : the device can communicate with all other devices

When custom groups are created, all of the devices in that group can communicate with each other. For example, a custom ***gaming*** group could be created for devices that need to access one another, or a ***media*** group for streaming to TVs.

Tags are an additional mechanism for organizing devices and applying special features to them. Today there is one built-in tag, ***lan_upstream***.

Custom tags can be used with DNS block lists, to apply blocklists to only select devices. Place the tag with both the list and the devices it should apply to. For example, a user can set a ***focus*** tag on specific devices, and create a dns block list under the ***focus*** tag.

Custom tags can be used with PLUS's Programmable Firewall plugin. An advanced feature is to use PFW to apply tags on a schedule. The ***focus*** tag could be applied from 9AM-5pm for example.

How does the "lan_upstream" tag work?

By default, SPR prevents devices from accessing LAN addresses upstream of SPR. This is useful to restrict access to other subnets that SPR may be on. If a user does want a device to be able to access LAN networks upstream of SPR, the device should have the ***lan_upstream*** tag applied to grant access.

Does SPR work with iCloud Keychain Sync?

Yes - however you need to set the same password on each of the iOS devices that are in the same keychain. Without this, they would sync the wrong password to each other and lock each other out of the network.

Can I try SPR without the hardware?

Yes. You can run SPR in docker, either locally or on a cloud instance. NOTE: wifi-features will not be available on MacOS & Windows

Can I run SPR without a wifi-card?

Yes. SPR runs great as a VPN service as well. See: Virtual Setup Guide to setup SPR with VPN and DNS support

Why does SPR need AP/VLAN mode?

AP/VLAN is used to place each wifi station into a VLAN with its own virtual interface. Not all drivers may support this feature.

It is possible to use SPR for wifi without this but it is not recommended. To do so run hostapd with VLANs disabled (set `per_sta_vif=0`), and under `base/config/config.sh` set LANIF to your wifi interface (i.e.`wlan1`). With this configuration, MAC spoofing and packet injection across devices is possible, as with an ordinary wifi network.

Does SPR run on x86 / x86-64?

Yes. We publish docker containers for both arm64 and x86-64. See: Building the project to build from source.

Does SPR support extensions?

SPR supports plugins running as docker containers. See: Extensions Documentation

Which wifi drivers work with SPR?

The MT76 family of drivers has been best tested. Mt76x2u, mt7915, mt7915e have seen the most use.

Note that iwlwifi, from intel, disables AP mode, and so the popular ax210/ax200 cards are not today compatible with hostapd. It is possible to run some AP with wpa_supplicant but important features are missing. Contributions to get these working with SPR are welcome but it may not be feasible.

Recommended features for SPR:

- WPA3 Support
- AP/VLAN mode

If you have SPR installed you can see if your card is supported under *Wifi -> Interfaces -> SPR compatibility*

Does SPR support Wifi 6?

Yes.

Does SPR support Mesh Networking?

Mesh is currently a PLUS plugin. It supports mesh nodes with wired backhaul. Mesh networking (802.11s) is not currently configurable for a wireless backhaul from the API, but can be applied by configuring wpa_supplicant manually.

What is PLUS?

Plus offers extended features & lets you back the development of SPR

Read more about SPR PLUS

What is PFW?

PFW is a ***P**rogrammble **F**ire**w**all* available to PLUS users. It allows scheduling and event based firewall rules. It supports advanced features such as per-device rerouting to site-to-site VPNs and docker containers, and scheduled focus mode.

Think I've found a bug, where can I report it?

The best place to file an issue is our Github Issue Tracker

Do you have a mobile app for the admin interface?

The iOS app is available on App Store.

Can I use the mobile app for Virtual SPR?

Yes!

If you have setup SPR using the Virtual Setup Guide you can login to SPR (192.168.2.1) when connected to the VPN.

Can I run a dev branch of this project?

Yes, See *System -> Releases*

What Operating System is SPR based on?

Ubuntu Linux 23.04. It can run on a variety of Linux hosts though.

Do you have a custom Linux kernel?

The Clearfog release is running a custom build. The Raspberry Pi image is using the default kernel for ubuntu.

Where can I learn more about Wifi security?

Check out our turtles ctf challenges & write-ups

Troubleshooting

<details>
<summary>Device can't connect using WPA3</summary>

Some IOT devices may have problems with WPA3 support, or even incorrectly detect WPA3 as an Open Network. Try adding the device with WPA2 and connect again. Some IOT may not even support WPA2, and require WPA1.
</details>

<details>
<summary>How can I set a custom subnet for my SPR network?</summary>

System -> Supernetworks
</details>

<details>
<summary>I'm running other containers on my SPR & they have no internet connection</summary>

If SPR is not running, make sure to setup the firewall rules. Make sure WANIF is configured with your upstream interface in config/config.sh and try running the base/docker_nftables_setup.sh script. SPR disabled docker's reliance on IPtables and so custom NFTable scripts are required for docker containers to reach the internet.
</details>

<details>
<summary>How can I debug dropped packets?</summary>

1. Check the events page for `nft:drop:`` events. If they are not recorded, enable them first under event settings. Dropped packets may be under` nft:drop:mac`,` nft:drop:forward`,` nft:drop:input`, or` nft:drop:private`
2. Retrieve JSON packet logs with

```
docker exec -it superpacket_logs /stream-json-logs
```
</details>

3. Or build the sprbus tool and connect with an API token. You can generate an API token in the UI under "Auth-> Add Auth Token"

Security

Contact Information

Email spr-security [at] supernetworks.org or reach out on the discord chat

Security Goals

Router is secure against compromises via the web services, remote uplink, or local network attack surfaces

Practical to use strong passwords for wifi devices

One compromised device should not be able to impersonate other devices on the network or intercept their network traffic

Devices can only communicate to systems they are explicitly allowed to. No spoofing.

Key Security Features

Multi-PSK & VLANs

SPR places each WiFi device into its own VLAN. The device password and MAC address combination is used to authenticate into the DHCP assigned VLAN. The device does not need to be aware it is in a VLAN, except that DHCP has provided a /30 "tiny" network, and communications to other LAN devices should be routed over the AP.

There is no limit to the number of VLANs and a user does not have to assign devices to VLANs.

No MAC spoofing and other layer 2 network pivoting

Firewall rules enforce the MAC address for the authenticated device to block MAC spoofing. Further OS configuration blocks ARP spoofing from interfaces on a VLAN. The packet forwarding to other devices

is default deny. If a device is part of the all devices LAN group, or is in a group with other devices then traffic will be allowed.

GTK are unique per VLAN so devices can't bypass the router to communicate. TDLS is disabled.

These rules are also enforced with mesh networking, supported today in SPR PLUS over wired backhaul.

Multicast Limitation

Currently the multicast proxy will relay multicast traffic to all devices. A further hardening step is to enforce routing policy for multicast traffic as well.

Upstream LAN Traffic Blocked By Default

Typically, users of SPR will plug the SPR into their existing network which will be called an upstream LAN. By default, SPR will block traffic to upstream Private LANs rfc1918 for devices, unless the `lan_upstream` tag is enabled. This prevents SPR devices from accessing upstream private addresses.

WPA3 Support

WPA3 uses the Simultaneous Authentication of Equals (SAE) protocol for authentication. The Key Exchange can not be sniffed and cracked as with WPA2 (PBKDF2 based) because it's a zero knowledge-proof of the password.

WPA3 Also provides for Management Frame Protection (MFP) 802.1w which is optional for WPA2 but mandatory in WPA3.

Practical Limitations of WPA3

iOS Device QR-Code WPA2 Downgrade

iOS has a long standing flaw where networks with WPA3 that are scanned with a QR Code are later saved as WPA2. As a result, SPR supports both WPA2 and WPA3 for devices.

Many devices don't support WPA3 yet, some still require WPA1 even

Since not all devices support WPA3, a bssid, SPR runs MFP with mixed mode (ieee80211w=1).

Network Visibility

SPR provides for DNS, traffic monitoring capabilities as well as authentication logs for the APIs.

Threat Actors

Remote Internet Attacker

Anyone on the internet that can send packets to the WAN/Uplink interface

Man In The Middle / Malicious ISP

An attacker with a man in the middle position on the uplink

Supply Chain Attacker

An attacker looking to insert code into the SPR project to compromise routers

Physical Proximity Attacker (Evil Neighbor)

An attacker with physical proximity to WiFi

Inside Perimeter Attacker (Evil Guest)

An attacker with physical access

Compromised Device Attacker (Implant)

An attacker operating from a compromised device, authenticated on the network

Threat Vectors

Network Flaws

Weak Passphrase / Password Reuse

ARP Spoofing

MAC Spoofing

DHCP MAC Spoofing

VLAN Hopping

Insecure Private Requests from Web Browsers

Software Implementation Flaws

Memory corruption

Command Injection

XSS, CSRF

DNS Cache Poisoning

Response Splitting Attacks

802.11 Flaws

Cryptographic Vulnerabilities

Password Cracking

Frag Attacks

MITM

AP Isolation Bypass

Packet in Packet Attacks

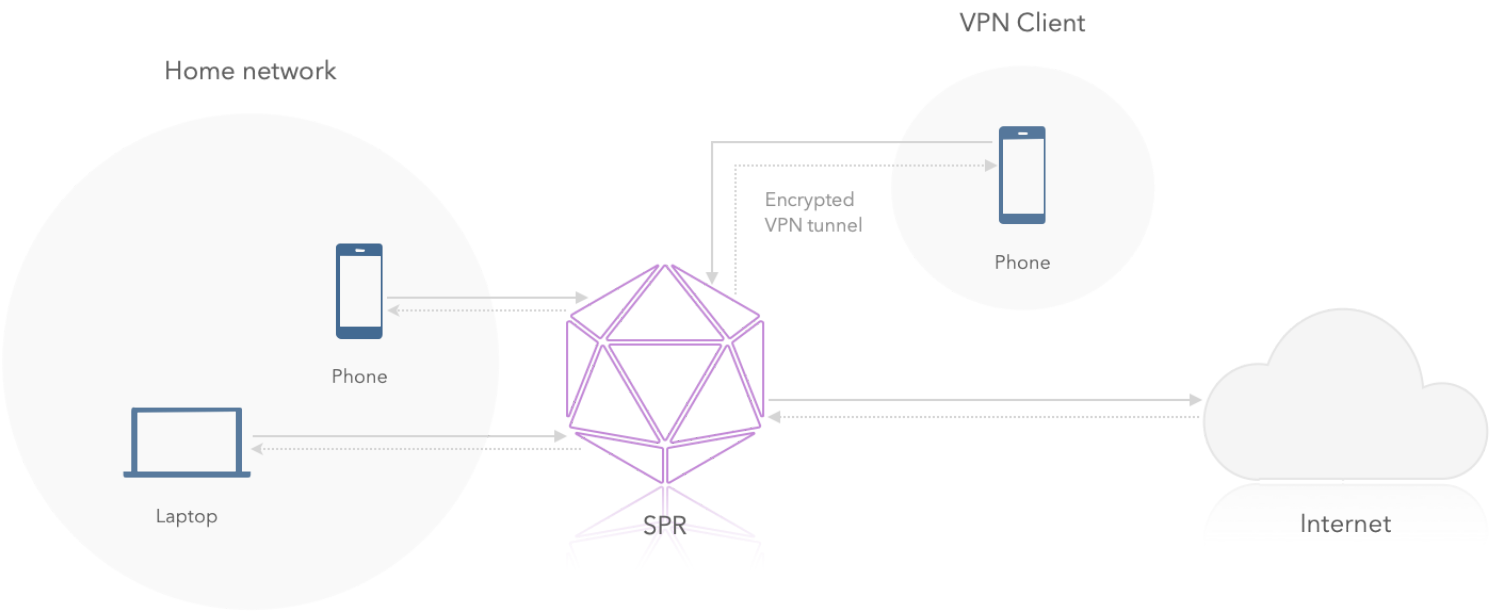
VPN Overview

SPR support multiple modes of VPN connections:

- connect *from* the internet to your home network
- connect *to* another network using a vpn tunnel

VPN Client

Example: Connect to your home network when traveling.



This is useful if you always want to have the same setup (adblock, firewall rules) from your phone or laptop, or want to be able to access your home network when traveling.

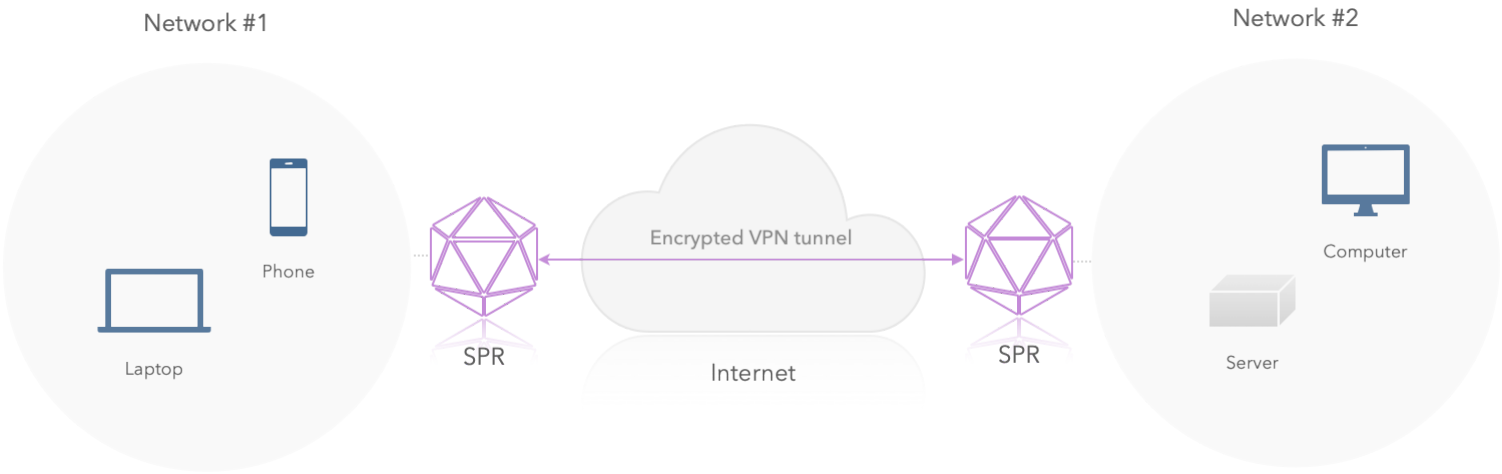
Add a peer

See the Virtual Setup Guide on how to add a vpn peer.

Note: If you link the created pubkey to an already configured device it will use the same IP address.

Site-to-Site VPN

A site-to-site VPN can be used to link two networks together. Example: another spr instance, cloud network.



Setup site-to-site VPN

See the PLUS Site VPN Configruation

PFW support

More advanced rules can be setup using the *"Forward to Site VPN"* action in PFW. Example:

- Only for specific devices
- Run at a specific time during the day, only on weekdays