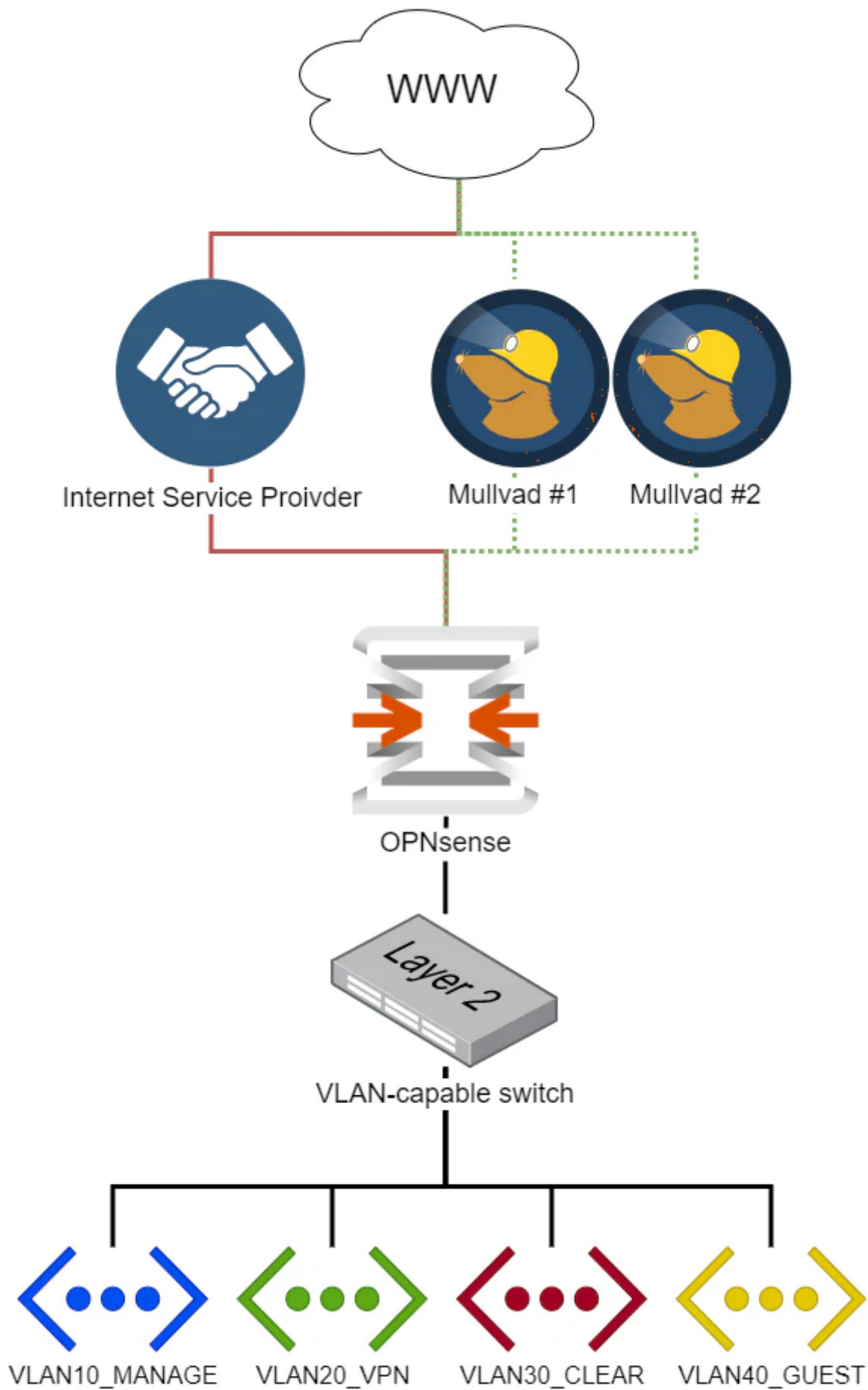


Baseline Setup

- [OPNsense Baseline Guide with Mullvad VPN Multi-WAN, Guest, and VLAN Support](#)

OPNsense Baseline Guide with Mullvad VPN Multi-WAN, Guest, and VLAN Support

2021-11-17 (updated: 2023-07-30)



This beginner-friendly, step-by-step guide walks you through the initial configuration of your OPNsense firewall. The title of this guide is an homage to the [pfSense baseline guide with VPN, Guest, and VLAN support](#) that some of you guys might know, and this is an [OPNsense](#) migration of it. I found that guide two years ago and immediately fell in love with the network setup. After researching for weeks, I decided to use OPNsense instead of pfSense. I bit the bullet and bought the [Deciso DEC630](#) appliance. Albeit expensive and possibly overkill for my needs, I'm happy to support the open-source mission of Deciso, the maintainers of OPNsense. The only thing I regret about the purchase is that I now can't afford the sexier-looking successor model, the [DEC690](#).

To configure OPNsense, I followed the instructions of the pfSense guide, taking notes on the differences. Some options moved to different menus or changed. As my notes grew, I decided to publish them as a guide on my website.

My goal was to create a comprehensive guide that's easy to follow. But I tried to strike a different balance regarding the brevity of the instructions compared to the pfSense guide. It's a matter of personal taste, but I find the instructions in that guide too verbose. I intentionally omit most of the repetitive "click save and apply" instructions and only list configuration changes deviating from defaults, making exceptions for important settings. I consider the OPNsense defaults stable enough for this approach in the hope of keeping the effort required to maintain this guide to a minimum.

I'm a homelab hobbyist, so be warned that this guide likely contains errors. Please, verify the steps yourself and do your research. I hope this guide is as helpful and inspiring to you as the pfSense guide was to me. Your feedback is always welcome and very much appreciated.

Overview

WAN

- DHCP WAN from a single Internet Service Provider (ISP)
- [Mullvad VPN](#) multi-WAN with gateway groups

LAN

We segregate the local network into several areas with different requirements.

Management Network (VLAN 10)

The Management network connects native management interfaces like WiFi access points and IPMI interfaces.

VPN Network (VLAN 20)

The primary LAN network uses the WireGuard VPN tunnels for outbound connections, maximizing privacy and security. If the VPN tunnels fail, outbound connections won't be possible. Exceptions to selectively route traffic through the ISP WAN gateway are possible.

“Clear” Network (VLAN 30)

General-purpose web access network that doesn't use VPN tunnels. All outgoing connections leave through the ISP WAN gateway. It serves as a backup network in case the VPN tunnels fail.

Guest Network (VLAN 40)

The network that visitors use. It allows unrestricted internet access. Local networks aren't accessible.

LAN Network

“Native” VLAN, used to debug and test new configurations.

DNS Services

We'll configure a DNS resolver (Unbound), as well as a DNS forwarder (Dnsmasq) in OPNsense. Management and VPN networks will use the resolver, the Clear network will use the forwarder, and the Guest network will use Cloudflare as an external DNS resolver. [We'll dig into the details later.](#)

Hardware Selection and Installation

The original pfSense guide features a [large section of hardware recommendations](#) and [installation instructions](#).

As mentioned earlier, I bought the [Deciso DEC630](#) appliance, which is why I'm not advising on hardware choices. Have a look at the [official hardware sizing & setup guidelines](#) for more information. See also [Initial Installation & Configuration](#).

I verified this guide with a clean install of OPNsense version `21.7.5`.

Wizard

Navigate to `192.168.1.1` in your browser and login with default credentials:

- **Username:** root
- **Password:** opnsense

Click `Next` to leave the welcome screen and get started with the initial wizard configuration.

General Information

General Information	
Hostname:	<input type="text" value="OPNsense"/>
Domain:	<input type="text" value="corp.example.com"/>
Language:	<input type="text" value="English"/>
Primary DNS Server:	<input type="text" value="9.9.9.9"/>
Secondary DNS Server:	<input type="text" value="149.112.112.112"/>
Override DNS:	<input type="checkbox"/> Allow DNS servers to be overridden by DHCP/PPP on WAN
Unbound DNS	
Enable Resolver:	<input checked="" type="checkbox"/>
Enable DNSSEC Support:	<input checked="" type="checkbox"/>
Harden DNSSEC data:	<input checked="" type="checkbox"/>

I prefer using the DNS servers of [Quad9](#) over the ones of my ISP. Only the Clear network will use these anyway, as secured networks use Unbound instead. The Guest network will use Cloudflare DNS servers.

For the domain, I prefer to use a subdomain of a domain name I own, like `corp.example.com`. I only use this subdomain internally. I consider the `local.lan` pattern a relic of the past. To prevent our local network structure from leaking to the outside world, we'll later configure Unbound and Dnsmasq to treat the domain as private.

Domain	corp.example.com
Primary DNS Server	9.9.9.9
Secondary DNS Server	149.112.112.112
Override DNS	unchecked
Enable DNSSEC Support	checked
Harden DNSSEC data	checked

If you prefer using your ISP's DNS servers, leave the **Override DNS** option checked.

Time Server Information

Choose the NTP servers geographically closest to your location. I live in Switzerland, which makes the [servers from the ch.pool.ntp.org pool](#) the natural choice.

Time server hostname	0.ch.pool.ntp.org 1.ch.pool.ntp.org 2.ch.pool.ntp.org 3.ch.pool.ntp.org
Timezone	Europe/Zurich

Configure Interfaces

By default, the WAN interface obtains an IP address from your ISP via DHCP. DHCP is also configured for the LAN interface by default and has the IP `192.168.1.1`. It works for most people, so we just keep the defaults.

Set Root Password

Choose a strong root password and complete the wizard.

General Settings

Access

Navigate to **System** → **Settings** → **Administration**.

HTTP Redirect	
---------------	--

Disable web GUI redirect rule	checked
-------------------------------	---------

Permitting root user login and password login is a quick and dirty way of enabling SSH access, but I strongly discourage you from doing it. They are disabled for security reasons. I highly recommend using certificate- or [key-based authentication](#). If your device has a serial console port, like the Deciso DEC630, enabling SSH is not required.

Secure Shell	
Secure Shell Server	checked

Authentication	
Sudo	Ask password
Permit sudo usage for administrators with shell access.	

Navigate to **System** → **Access** → **Users** and add a new user.

Username	<choose a username>
Password	<choose a secure password>
Login shell	/bin/csh
Group Memberships	admins
Authorized keys	<valid SSH public key>

Configuring the SSH client and generating keys is out of scope for this guide, so I'll just recommend this [DigitalOcean tutorial covering SSH essentials](#).

Miscellaneous

Navigate to **System** → **Settings** → **Miscellaneous**.

Power Savings	
Use PowerD	checked
Power Mode	Hiadaptive

Choose **Cryptography settings** and **Thermal Sensors** settings compatible with your hardware.

Firewall Settings

Navigate to **Firewall** → **Settings** → **Advanced**.

Although IPv6 is something I want to use, it's out of scope for this guide, so we uncheck the following.

Allow IPv6	<input type="checkbox"/>
------------	--------------------------

When a rule uses a specific gateway and goes down, a rule gets created, sending traffic to the default gateway. Checking this option skips the creation of this rule.

Gateway Monitoring	
Skip rules	<input checked="" type="checkbox"/>

Depending on your hardware, you might want to tweak the following settings to improve performance.

Miscellaneous		
Firewall Optimization	<input type="text" value="conservative"/>	Tries to avoid dropping any legitimate idle connections at the expense of increased memory usage and CPU utilization.
Firewall Maximum Table Entries	<input type="text" value="2000000"/>	default is 1'000'000

We disable the auto-generated anti-lockout rule because we'll define it manually later.

Disable anti-lockout	<input checked="" type="checkbox"/>
----------------------	-------------------------------------

Checksum Offloading

For some hardware, checksum offloading doesn't work, particularly some Realtek cards. Rarely, drivers may have problems with checksum offloading and some specific NICs. If your hardware is incompatible with checksum offloading, disable it.

Navigate to **Interfaces** → **Settings**.

Hardware CRC	<input type="checkbox"/>	Disable hardware checksum offload
--------------	--------------------------	-----------------------------------

VLANs

Switch Choice

A 802.1Q-capable switch with properly configured VLANs is required. Check my [router on a stick VLAN configuration guide](#) to see an example setup with a [Mikrotik](#) switch.

VLAN Definitions

Typically, the `LAN` port also carries the VLAN traffic and functions as [trunk port](#). For me, the default is the `igb0` port. I chose it as the parent interface for all VLANs in the following steps.

Interface	Tag	PCP	Description	
igb0	10	0	VLAN10_MANAGE	 
igb0	20	0	VLAN20_VPN	 
igb0	30	0	VLAN30_CLEAR	 
igb0	40	0	VLAN40_GUEST	 

Navigate to **Interfaces** → **Other Types** → **VLAN** and add the VLANs.

Management VLAN

Parent	<code>igb0</code>
VLAN tag	<code>10</code>
Description	<code>VLAN10_MANAGE</code>

VPN VLAN

Parent	<code>igb0</code>
VLAN tag	<code>20</code>
Description	<code>VLAN20_VPN</code>

Clear VLAN

--	--



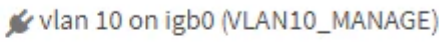

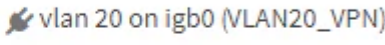

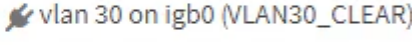







Parent	igb0
VLAN tag	30
Description	VLAN30_CLEAR

Guest VLAN

Parent	igb0
VLAN tag	40
Description	VLAN40_GUEST

VLAN Interfaces

We add an interface for each VLAN. Navigate to **Interfaces** → **Assignments**.

Interface	Network port	
<u>LAN</u>	 igb0	
<u>VLAN10 MANAGE</u>	 vlan 10 on igb0 (VLAN10_MANAGE)	
<u>VLAN20 VPN</u>	 vlan 20 on igb0 (VLAN20_VPN)	
<u>VLAN30 CLEAR</u>	 vlan 30 on igb0 (VLAN30_CLEAR)	
<u>VLAN40 GUEST</u>	 vlan 40 on igb0 (VLAN40_GUEST)	
<u>WAN</u>	 igb1	
New interface:	 igb2	
	Description	
	<input type="text"/>	

- Select `vlan 10`, enter the description `VLAN10_MANAGE`, and click `+`
- Select `vlan 20`, enter the description `VLAN20_VPN`, and click `+`
- Select `vlan 30`, enter the description `VLAN30_CLEAR`, and click `+`
- Select `vlan 40`, enter the description `VLAN40_GUEST`, and click `+`

Click .

VLAN Interface IPs

To easier remember which IP range belongs to which VLAN, I like the convention of matching the third octet of the IP with the VLAN ID. I.e., assigning the VLAN with the ID **10** the address 192.168.**10**.0/24.

i Enable

Enable Interface

i Lock

Prevent interface removal

i Device

igb0_vlan10

i Description

VLAN10_MANAGE

Generic configuration

i Block private networks

i Block bogon networks

i IPv4 Configuration Type

Static IPv4

i IPv6 Configuration Type

None

i MAC address

i MTU

i MSS

i Speed and duplex

Default (no preference, typically autoselect)

i Dynamic gateway policy

This interface does not require an intermediate system to act as a gateway

Hardware settings

i Overwrite global settings

Static IPv4 configuration

i IPv4 address

192.168.10.1

24

Interface: VLAN10_MANAGE

Select the `VLAN10_MANAGE` interface.

Enable Interface	<code>checked</code>
IPv4 Configuration Type	<code>Static IPv4</code>
IPv4 Address	<code>192.168.10.1/24</code>

Click `Save`.

Interface: VLAN20_VPN

Enable Interface	<code>checked</code>
IPv4 Configuration Type	<code>Static IPv4</code>
IPv4 Address	<code>192.168.20.1/24</code>

Interface: VLAN30_CLEAR

Enable Interface	<code>checked</code>
IPv4 Configuration Type	<code>Static IPv4</code>
IPv4 Address	<code>192.168.30.1/24</code>

Interface: VLAN40_GUEST

Enable Interface	<code>checked</code>
IPv4 Configuration Type	<code>Static IPv4</code>
IPv4 Address	<code>192.168.40.1/24</code>

VLAN Interface DHCP

We need to configure DHCP for each VLAN we created. I use `x.x.x.100-199` for dynamic and `x.x.x.10.10-99` for static IP address assignments. You might want to amend these ranges to your requirements.

Enable **Enable DHCP server on the VLAN10_MANAGE interface**

Deny unknown clients

Ignore Client UIDs

Subnet 192.168.10.0

Subnet mask 255.255.255.0

Available range 192.168.10.1 - 192.168.10.254

Range

from	to
192.168.10.100	192.168.10.199

Navigate to **Services** → **DHCPv4**.

DHCP: VLAN10_MANAGE

Select **VLAN10_MANAGE**.

Enable	<input checked="" type="checkbox"/>
Range	from <input type="text" value="192.168.10.100"/> to <input type="text" value="192.168.10.199"/>

Click **Save**.

DHCP: VLAN20_VPN

Enable	<input checked="" type="checkbox"/>
Range	from <input type="text" value="192.168.20.100"/> to <input type="text" value="192.168.20.199"/>

DHCP: VLAN30_CLEAR

Enable	<input checked="" type="checkbox"/>
Range	from <input type="text" value="192.168.30.100"/> to <input type="text" value="192.168.30.199"/>

DHCP: VLAN40_GUEST

Enable	<input checked="" type="checkbox"/>
Range	from <input type="text" value="192.168.40.100"/> to <input type="text" value="192.168.40.199"/>
DNS servers	<input type="text" value="1.1.1.1"/> <input type="text" value="1.0.0.1"/>

DHCP: LAN

Range	from <input type="text" value="192.168.1.100"/> to <input type="text" value="192.168.1.199"/>
-------	---

WireGuard VPN with Mullvad

In recent years, [Mullvad](#) has been my VPN provider of choice. When *That One Privacy Site* was still a thing, Mullvad was one of the top recommendations there. After reading the review, I decided to try it out and haven't looked back since. No personally identifiable information is required to register, and paying cash via mail works perfectly.

I decided to go with [WireGuard](#) because I'm fine riding the bleeding edge. ☐☐ For more detailed steps, check the official OPNsense documentation on setting up [WireGuard with Mullvad](#) and [WireGuard selective routing](#).

Please note that the FreeBSD kernel does not (yet) natively support WireGuard, so you must install it as a plugin. Possibly, this doesn't meet your stability, security, or performance requirements.

Navigate to **System** → **Firmware** → **Plugins** and install . Refresh the browser and navigate to **VPN** → **WireGuard**.

Remote Peers

Select your preferred WireGuard servers from the [Mullvad's server list](#) and take note of their names and public keys. It's worth spending some time to benchmark server performance before making a choice.

Enabled	Name	Endpoint Address	Allowed IPs
<input checked="" type="checkbox"/>	mullvad-ch5-wireguard	193.32.127.66	0.0.0.0/0
<input checked="" type="checkbox"/>	mullvad-ch6-wireguard	193.32.127.67	0.0.0.0/0

Select the **Endpoints** tab and click **Add**. Here is the configuration for the remote `ch5-wireguard` Mullvad endpoint.

Name	<code>mullvad-ch5-wireguard</code>
Public Key	<code>/iivwlyqWqxQ0BVWmJRhcXIFdJeo0WbHQ/hZwuXaN3g=</code>
Allowed IPs	<code>0.0.0.0/0</code>
Endpoint Address	<code>193.32.127.66</code>
Endpoint Port	<code>51820</code>
Keepalive	<code>25</code>

To mitigate risks against DNS poisoning, resolve the server's hostname and enter its IP as **Endpoint Address**. You can do this by running `nslookup ch5-wireguard.mullvad.net` in a shell. Make sure to not confuse this address with the SOCKS5 Proxy Address from Mullvad's server list!

Repeat the steps above to add another server, e.g., `ch6-wireguard`. Note that all endpoint configurations use the **Endpoint Port** `51820`.

Local Peers

Select the **Local** tab, click `Add`, and enable the `advanced mode`.

Name	<code>mullvad0</code>
Listen Port	<code>51820</code>
Tunnel Address	<code><LEAVE EMPTY></code>
Peers	<code>ch5-wireguard</code>
Disable Routes	<code>checked</code>
Gateway	<code><LEAVE EMPTY></code>

Click `Save` to generate the WireGuard key pair. Click `Edit` and copy the generated **Public Key**.

Next, run the following shell command to get a Mullvad access token:

```
access_token=$( \
  curl -X 'POST' 'https://api.mullvad.net/auth/v1/token' \
    -H 'accept: application/json' -H 'content-type: application/json' \
    -d '{ "account_number": "YOUR MULLVAD ACCOUNT NUMBER" }' \
  | jq -r .access_token)
```

Then run the following command to create a *Mullvad Device* with DNS hijacking disabled:

```
curl -X POST https://api.mullvad.net/accounts/v1/devices \
  -H "Authorization: Bearer $access_token" -H 'content-type: application/json' \
  -d '{"pubkey":"YOUR PUBLIC KEY","hijack_dns":false}'
```

I cover the snippet above and Mullvad's DNS hijacking in another post: [Use Custom DNS Servers With Mullvad And Any WireGuard Client](#).

```
{
  "id": "d8f07004-4559-4d19-b58b-985b257cd115",
  "name": "uptown insect",
  "pubkey": "uf05jCni55uvioHM/eLBgyrrUMocEXsADPc20vYhF3k=",
  "hijack_dns": false,
  "created": "2023-07-30T02:08:41+00:00",
  "ipv4_address": "10.138.30.139/32",
  "ipv6_address": "fc00:bbbb:bbbb:bb01:d:0:a:1e8b/128",
  "ports": []
}
```

Copy the IPv4 IP address to the **Tunnel Address** field of the Wireguard local peer. Subtract one from the **Tunnel Address** and enter the result as **Gateway** IP. E.g., `10.105.248.50` for the example above. It's just a convention I like, but you can use any arbitrary, unused [private RFC1918 IP](#).

- Select `wg0`, add the description `WAN_VPN0`, and click `+`
- Select `wg1`, add the description `WAN_VPN1`, and click `+`

Enable the newly created interfaces and restart the WireGuard service after. It ensures the interfaces get an IP address from WireGuard.

VPN Gateways

Name	Interface	Protocol	Priority	Gateway	Monitor IP	RTT	RTTd	Loss	Status
WAN_DHCP6 (active)	WAN	IPv6	254			--	--	--	Online
WAN_DHCP (active)	WAN	IPv4	254			~	~	~	Online
WAN_VPN1	WAN_VPN1	IPv4	255	10.109.231.89	100.64.0.2	2.9 ms	0.3 ms	0.0%	Online
WAN_VPN0	WAN_VPN0	IPv4	255	10.105.248.50	100.64.0.1	3.1 ms	0.3 ms	0.0%	Online

Navigate to **System** → **Gateways** → **Single** and add the VPN gateways.

WAN_VPN0

Name	<code>WAN_VPN0</code>
Interface	<code>WAN_VPN0</code>
Address Family	<code>IPv4</code>
IP Address	<code>10.105.248.50</code>
Far Gateway	<code>checked</code>
Disable Gateway Monitoring	<code>unchecked</code>
Monitor IP	<code>100.64.0.1</code>

WAN_VPN1

Name	<code>WAN_VPN1</code>
Interface	<code>WAN_VPN1</code>
Address Family	<code>IPv4</code>

IP Address	10.109.231.89
Far Gateway	checked
Disable Gateway Monitoring	unchecked
Monitor IP	100.64.0.2

Monitoring IPs

Each VPN gateway requires a unique monitoring IP because setting a monitoring IP installs a static route. Optimally, the monitoring IP should be the least possible amount of hops away from the gateway. For Mullvad specifically, we can “abuse” the local infrastructure that’s available through a Mullvad connection. Any of the following IPs are only *one* hop away from the tunnel exit.

- 100.64.0.1 to 100.64.0.3 are [Mullvad’s ad-blocking and tracker-blocking DNS service servers](#)
- 10.64.0.1 is the local Mullvad gateway

You can easily verify the above by running `tracert 100.64.0.1` from a host connected to Mullvad.

Add Static IPv4 Configuration to the WireGuard Interfaces

OPNsense versions newer than 21.7.3 require adding static IPv4 configuration to the WireGuard interface. Otherwise, Unbound will use the default route despite setting the **Outgoing Network Interfaces** option. Other solutions exist, but I’m not sure which the “best” or most logical one is. As WireGuard integration matures, this section hopefully becomes obsolete. [You can find more information regarding this issue on GitHub.](#)

Navigate to **Interfaces** and edit the WireGuard interfaces.

IP Configuration: WAN_VPN0

IPv4 Configuration Type	Static IPv4
IPv4 address	10.105.248.51/32
IPv4 Upstream Gateway	WAN_VPN0 - 10.105.248.50

IP Configuration: WAN_VPN1

IPv4 Configuration Type	Static IPv4
-------------------------	-------------

IPv4 address	10.109.231.90/32
IPv4 Upstream Gateway	WAN_VPN1 - 10.109.231.89

Gateway Group



Navigate to **System** → **Gateways** → **Group** and click **Add**.

Group Name	WAN_VPN_GROUP
WAN_VPN0	Tier 1
WAN_VPN1	Tier 2 (failover)
Trigger Level	Packet Loss or High Latency

It's also possible to configure load balancing by putting multiple interfaces into the same tier.

Static Routes (Optional)

Defining static routes for the tunnel gateways is optional. It would be necessary, for example, if we want to consider the VPN gateways as default gateway candidates. It requires static routes to the ISP WAN gateway to keep the tunnel connections alive.

Disabled	Network	Gateway	Description
<input type="checkbox"/>	193.32.127.66/32	WAN_DHCP -  ...	Static route for m...
<input type="checkbox"/>	193.32.127.67/32	WAN_DHCP -  ...	Static route for m...

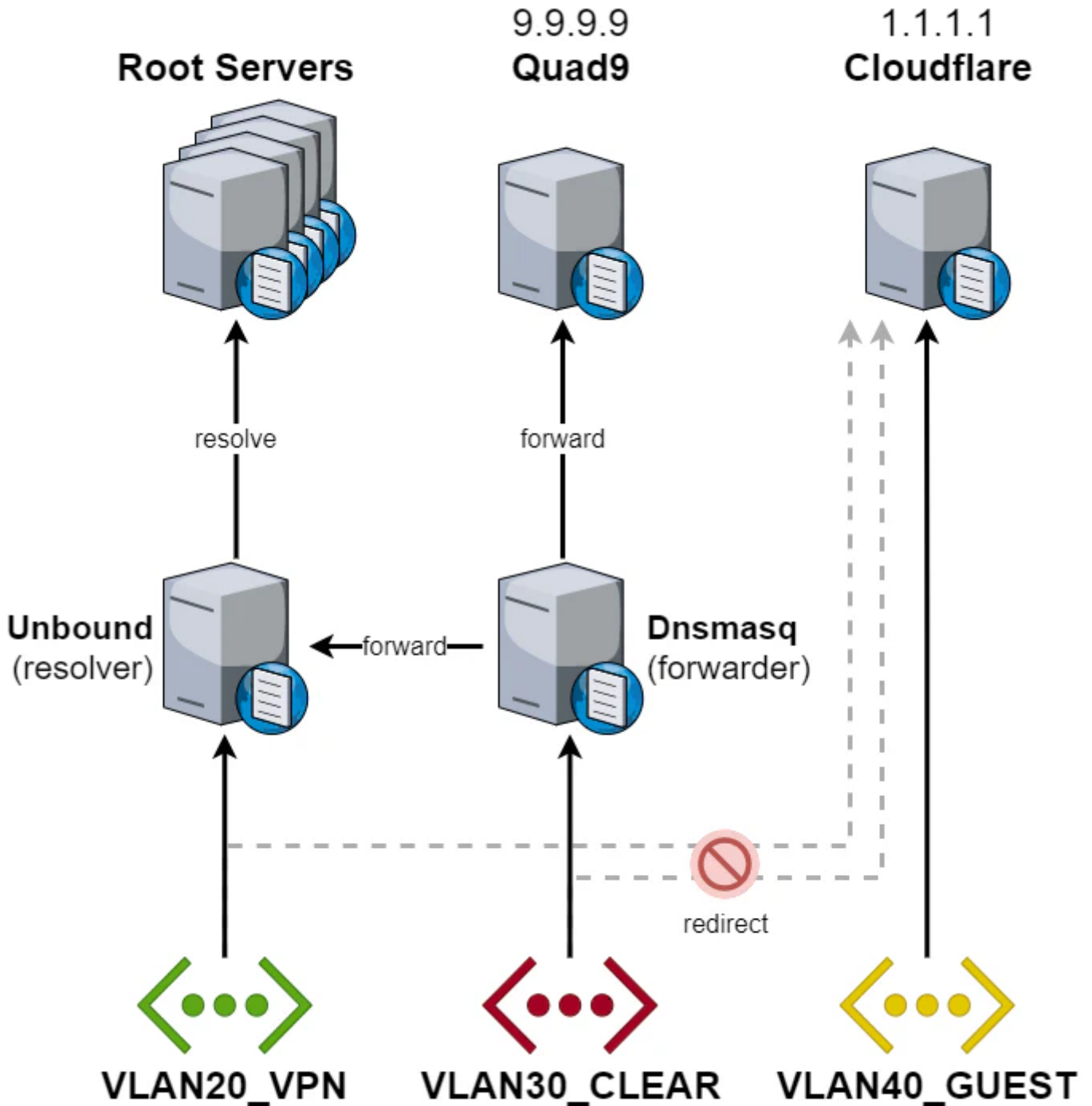
Navigate to **System** → **Routes** → **Configuration** and click **Add**.

Network Address	193.32.127.66/32
Gateway	WAN_DHCP
Description	Keep tunnels to mullvad-ch5-wireguard alive

Network Address	193.32.127.67/32
Gateway	WAN_DHCP

Description	Keep tunnels to mullvad-ch6-wireguard alive

DNS



OPNsense includes a DNS *resolver* (Unbound) and a DNS *forwarder* (Dnsmasq / Unbound in forwarding mode). Simple setups usually use one of either, but we'll use both. Because we'll also use Unbound and Dnsmasq for internal DNS resolution, we don't want to use them for the Guest network, as this would expose our internal network structure. That's the reason why we earlier

configured it to use Cloudflare DNS servers instead.

Like the name suggests, a DNS forwarder forwards DNS requests to an external DNS resolver of an ISP, Quad9, Cloudflare, or similar service provider. We'll configure the forwarder for the Clear network. In case the primary, secured networks lose connectivity, the Clear network can serve as a backup.

One of the advantages of self-hosting a DNS resolver is improved privacy. A resolver iteratively queries a chain of one or more DNS servers to resolve a request, so there isn't a single instance knowing all your DNS requests. It comes at the cost of speed when resolving a hostname for the first time. As Unbound's cache grows, the cost diminishes. We'll configure our primary networks to use Unbound.

We'll also keep DNS traffic from Unbound within the VPN tunnels. In the rare case of a VPN outage, we'll want local DNS services to fail and not leak through the ISP WAN. The reason for this isn't improved privacy as you might think. In some cases, this might even hurt your privacy. Why? Either your ISP or your VPN provider will see the iterative DNS requests Unbound sends. So it becomes a question of who you rather entrust with this data. But if there are no privacy benefits, why do it? Honestly, I don't require such a setup. I configured it for educational purposes and fun. Other reasons that don't affect me but other users are:

- ISP selling user data
- ISP enforcing censorship
- ISP hijacking DNS traffic to redirect it to their DNS resolver; this makes self-hosting a DNS resolver impossible

Let's summarize our goals:

- Use a DNS resolver for the management and VPN networks
- Resolve private domain hostnames for management and VPN networks
- Prevent DNS leaks from Unbound through the ISP WAN gateway
- Use DNS forwarding for the Clear network
- Use external DNS resolvers for the Guest network

Resolver (Unbound)

Navigate to **Services** → **Unbound DNS** → **General**.

Network Interfaces	<input type="checkbox"/> LAN <input type="checkbox"/> VLAN10_MANAGE <input type="checkbox"/> VLAN20_VPN
DNSSEC	<input checked="" type="checkbox"/> checked
DHCP registration	<input checked="" type="checkbox"/> checked
DHCP static mappings	<input checked="" type="checkbox"/> checked

Local Zone Type	static
Outgoing Network Interfaces	WAN_VPN0 WAN_VPN1

Navigate to **Services** → **Unbound DNS** → **Advanced**.

Hide Identity	checked
Hide Version	checked
Prefetch Support	checked
Prefetch DNS Key Support	checked
Harden DNSSEC data	checked

The final step is to add a custom [SOA record](#) to the local zone making Unbound the authoritative name server for `corp.example.com`. This way, we prevent Unbound from querying external name servers for the internal domain and exposing our network structure to the outside world. For [advanced Unbound configuration like this](#), we use [Templates](#).

Connect to OPNsense via serial console or SSH and add a `+TARGETS` file by running `sudo vi /usr/local/opnsense/service/templates/OPNsense/Unbound/+TARGETS` containing:

```
private_domains.conf:/usr/local/etc/unbound.opnsense.d/private_domains.conf
```

Add the template file by running `sudo vi /usr/local/opnsense/service/templates/OPNsense/Unbound/private_domains.conf` containing:

```
server:
  local-data: "corp.example.com. 3600 IN SOA opnsense.corp.example.com. root.example.com.
  2021110201 86400 7200 3600000 3600"
```

Here is a translation of what the SOA record means.

Name	corp.example.com
Record Type	SOA
Primary Name Server	opnsense.corp.example.com
Administrator Email	root@example.com

Serial	2021110201 (YYMMDDnn)
Refresh	86400 (24 hours)
Retry	7200 (2 hours)
Expire	3600000 (1000 hours)
TTL	3600 (1 hour)

Run the following to verify the configuration.

```
# generate template
configctl template reload OPNsense/Unbound
# show generated file
cat /usr/local/etc/unbound.opnsense.d/private_domains.conf
# check if configuration is valid
configctl unbound check
```

Forwarder (Dnsmasq)

Dnsmasq will forward DNS requests to the configured system DNS servers and 127.0.0.1 (Unbound). Earlier, you either explicitly configured them or decided to receive the DNS servers via DHCP from your ISP. Because Unbound already uses port 53, we'll use port 5335 for Dnsmasq. We'll later create rules to port forward DNS traffic to this port.

Navigate to **Services** → **Dnsmasq DNS** → **Settings**.

Enable	checked
Listen Port	5335
Do not forward private reverse lookups	checked

Forward reverse DNS lookups in the 192.168.0.0/16 range to Unbound by adding the following **Domain Overrides**. We additionally make Unbound the authoritative DNS server for corp.example.com.

Domain	IP	Description
168.192.in-addr.arpa	192.168.20.1	Forward reverse lookups of private IP addresses to Unbound

Domain	IP	Description
corp.example.com	192.168.20.1	Make Unbound the authoritative DNS server for private domain

Firewall

Here is an overview of what we want to implement with firewall rules.

- Allow internet access for specific ports through WAN and VPN
- Allow intranet communications
- Redirect outbound DNS traffic to either Unbound or Dnsmasq
- Redirect NTP traffic to OPNsense
- Block intranet access for the Guest network

	VLAN10	VLAN20	VLAN30	VLAN40	LAN
Internet	WAN	VPN + selective WAN	WAN	WAN	WAN
Intranet	pass	pass	pass	block	pass
ICMP	pass	pass	pass	pass	pass
Anti-lockout	yes	no	no	no	yes
DNS	Unbound	Unbound	Dnsmasq	external	Unbound
NTP	local	local	local	external	external

Interface Groups

We use [interface groups](#) to apply policies to multiple interfaces at once and reduce the number of required firewall rules significantly. Do not use them for WAN interfaces because they don't use the `reply-to` directive!

I'm honestly not sure if I went overboard with interface groups and over-abstracted things. Currently, I'm happy with the configuration, and I guess only time will tell how maintainable this approach is. I'd like to know what you think and would very much appreciate your feedback.

Name	Members	Description
IG_DNS_FORWARD	VLAN30_CLEAR	Interfaces forced to use Dnsmasq
IG_DNS_RESOLVE	VLAN10_MANAGE , VLAN20_VPN	Interfaces forced to use Unbound
IG_LOCAL	LAN , VLAN10_MANAGE , VLAN20_VPN , VLAN30_CLEAR , VLAN40_GUEST	All local interfaces
IG_NTP	VLAN10_MANAGE , VLAN20_VPN , VLAN30_CLEAR	Interfaces forced to use OPNsense as NTP server
IG_OUT_VPN	VLAN20_VPN	Interfaces allowing outbound VPN traffic and selective outbound WAN traffic
IG_OUT_WAN	LAN , VLAN10_MANAGE , VLAN30_CLEAR , VLAN40_GUEST	Interfaces allowing outbound WAN traffic

Navigate to **Firewall** → **Groups** and add the following interface groups.

IG_LOCAL

Name	IG_LOCAL
Description	All local interfaces
Members	LAN VLAN10_MANAGE VLAN20_VPN VLAN30_CLEAR VLAN40_GUEST

IG_OUT_WAN

Name	IG_OUT_WAN
Description	Interfaces allowing outbound WAN traffic
Members	LAN VLAN10_MANAGE VLAN30_CLEAR VLAN40_GUEST

IG_OUT_VPN

Name	IG_OUT_VPN
------	------------

Description	Interfaces allowing outbound VPN traffic and selective outbound WAN traffic
Members	VLAN20_VPN

IG_DNS_RESOLVE

Name	IG_DNS_RESOLVE
Description	Interfaces forced to use Unbound
Members	VLAN10_MANAGE VLAN20_VPN

IG_DNS_FORWARD

Name	IG_DNS_FORWARD
Description	Interfaces forced to use Dnsmasq
Members	VLAN30_CLEAR

IG_NTP

Name	IG_NTP
Description	Interfaces forced to use OPNsense as NTP server
Members	VLAN10_MANAGE VLAN20_VPN VLAN30_CLEAR

Aliases

We define a few reusable [aliases](#) that help us condense our firewall rules. Some of them might become hard to maintain as they grow, in which case you might want to consider nesting aliases.

Name	Type	Description	Content
PORTS_ANTI_LOCKOUT	Port(s)	OPNsense admin ports	22,443
PORTS_OUT_LAN	Port(s)	Ports allowed for intranet	21,22,53,80,123,161,443,3389,5001,5900,8...
PORTS_OUT_WAN	Port(s)	Ports allowed for internet	21,22,80,443,465,587,993,8080,8443,49152...
SELECTIVE_ROUTING	Host(s)	External hosts reachable from IG_OUT_VP...	

Navigate to **Firewall** → **Aliases** and create the following aliases.

Selective Routing Addresses

Services like banks might object to traffic originating from known VPN endpoints. We selectively route traffic from the VPN VLAN through the default WAN gateway.

Name	SELECTIVE_ROUTING
Type	Host(s)
Description	External hosts reachable from IG_OUT_VPN networks through WAN

If you're having issues with a service not working due to VPN, add the hostname to this alias, e.g., `netflix.com`.

Admin / Anti-lockout Ports

Name	PORTS_ANTI_LOCKOUT
Type	Port(s)
Content	443 (Web GUI) 22 (SSH)
Description	OPNsense admin ports

Ports Allowed To Communicate Between VLANs

Allowed ports for intranet traffic. Amend the list depending on your needs.

Name	PORTS_OUT_LAN
Type	Port(s)
Description	Ports allowed for intranet

Content:

- 53 DNS
- 5353:5354 mDNS
- 123 NTP
- 21 FTP
- 22 SSH
- 161 SNMP
- 80 HTTP
- 8080: HTTP alt / UniFi device and application communication
- 443 HTTPS

- 8443 HTTPS alt / UniFi application GUI/API as seen in a web browser
- 8880 UniFi HTTP portal redirection
- 10001 UniFi device discovery
- 5001 iPerf
- 623 IPMI
- 5900 VNC
- 3389 RDP
- 49152:65535 ephemeral ports

Ports Allowed to Communicate with the Internet

Allow ports for egress internet traffic. Amend the list depending on your needs.

Name	PORTS_OUT_WAN
Type	Port(s)
Description	Ports allowed for internet

Content:

- 21 FTP
- 22 SSH
- 80 HTTP
- 8080 HTTP alt
- 443 HTTPS
- 8443 HTTPS alt
- 465 SMTPS
- 587 : SMTPS
- 993 : IMAPS
- 49152:65535 ephemeral ports

A Fair Warning about Egress Filtering

As you add applications, you will be constantly amending the PORTS_OUT_WAN list. Depending on the application, the required ports may be poorly documented, so you'll have to figure them out by inspecting the firewall logs. As other users have mentioned in the comments, blocking all egress traffic for all VLANs by default is probably not worth the hassle. Personally, I've given up on egress filtering altogether because of the administrative overhead that comes with it.

It is useful for high-security VLANs connecting devices such as cash registers in a retail store. Another example is VLANs with many untrusted IoT devices that have noisy telemetry. Putting them into a VLAN with egress filtering prevents them from "calling home".

If you create the alias ALL_PORTS = 1:65535 and add it to the **Content** field of the PORTS_OUT_WAN alias, you can disable all egress filtering with the option of re-enabling it again later.

NAT

Network Address Translation (NAT) is required to translate private to public IP addresses. We have the following requirements.

- Translate `IG_OUT_WAN` and `IG_OUT_VPN` network addresses to the `WAN` address range. Translating `IG_OUT_VPN` to `WAN` allows selective routing.
- Translate `IG_OUT_VPN` network addresses to the `WAN_VPN0` address range.

Interface	Source	Port	Destination	Port	Address	Port	Port	Description
WAN	<code>IG_OUT_WAN</code> net	*	*	*	Interface address	*	NO	<code>IG_OUT_WAN</code> to WAN
WAN	<code>IG_OUT_VPN</code> net	*	*	*	Interface address	*	NO	<code>IG_OUT_VPN</code> to WAN
WAN_VPN0	<code>IG_OUT_VPN</code> net	*	*	*	Interface address	*	NO	<code>IG_OUT_VPN</code> to WAN_VPN0
WAN_VPN1	<code>IG_OUT_VPN</code> net	*	*	*	Interface address	*	NO	<code>IG_OUT_VPN</code> to WAN_VPN1

Navigate to **Firewall** → **NAT** → **Outbound**.

Select `Manual outbound NAT rule generation` and add the following rules.

`IG_OUT_WAN` to WAN

Interface	<code>WAN</code>
Source address	<code>IG_OUT_WAN</code> net
Description	<code>IG_OUT_WAN</code> to WAN

`IG_OUT_VPN` to WAN

Interface	<code>WAN</code>
Source address	<code>IG_OUT_VPN</code> net
Description	<code>IG_OUT_VPN</code> to WAN

`IG_OUT_VPN` to WAN_VPN0

Interface	WAN_VPN0
Source address	IG_OUT_VPN net
Description	IG_OUT_VPN to WAN_VPN0

IG_OUT_VPN to WAN_VPN1



Interface	WAN_VPN1
Source address	IG_OUT_VPN net
Description	IG_OUT_VPN to WAN_VPN1

Rules

Navigate to **Firewall** → **Rules**.

Anti-Lockout

Before adding any other rules, we add the anti-lockout ones on the `VLAN10_MANAGE` and `LAN` networks, so we can't lock ourselves out. ☐☐

Protocol	Source	Port	Destination	Port
 IPv4 TCP/UDP	*	*	This Firewall	PORTS_ANTI_LOCKOUT 











Select **Floating** and add the following rule.

Action	Pass
Interface	LAN <code>VLAN10_MANAGE</code>
Protocol	TCP/UDP
Source	any
Destination	This Firewall
Destination port range	PORTS_ANTI_LOCKOUT
Description	Anti-lockout

`This Firewall` is a pre-defined alias representing all interface addresses of OPNsense.

Allow Intranet Pings

We allow ICMP pings for the entire local network. Pings are maliciously abusable, so you may want to put stricter rules into place if required.

	Protocol	Source	Port	Destination	Port
  	IPv4 ICMP	IG_LOCAL net	*	*	*
  	IPv4+6 *	IG_LOCAL net	*	IG_LOCAL net	*
  	IPv4 TCP/UDP	IG_LOCAL net	*	IG_LOCAL net	PORTS_OUT_LAN 

Select **IG_LOCAL** and add the following rule.

Action	Pass
Interface	IG_LOCAL
TCP/IP Version	IPv4
Protocol	ICMP
ICMP type	Echo Request
Source	IG_LOCAL net
Description	Allow intranet pings

Reject Intranet Traffic By Default

By default, we *reject* traffic on local interfaces instead of *blocking* it. *Block* drops packets silently. *Reject* returns a “friendly” response to the sender. To be able to override this rule, unchecking **Quick** is crucial! To use [Firewall Logs](#) to review blocked ports and amend our port list alias if necessary, we enable logging on this rule.

Select **IG_LOCAL** and add the following rule.

Action	Reject
Quick	unchecked
Interface	IG_LOCAL
TCP/IP Version	IPv4+IPv6
Protocol	any
Source	IG_LOCAL net
Destination	IG_LOCAL net

Log	<input checked="" type="checkbox"/>
Description	Reject intranet traffic by default

Allow Intranet Traffic

We only allow intranet traffic on the ports defined in the `PORTS_OUT_LAN` alias. We'll override this rule for the `VLAN40_GUEST` network later, so we must uncheck the **Quick** option again. For the Management network, you might want to consider stricter rules, as well.

Select **IG_LOCAL** and add the following rule.

Action	Pass
Quick	<input type="checkbox"/>
Interface	IG_LOCAL
Protocol	TCP/UDP
Source	IG_LOCAL net
Destination	IG_LOCAL net
Destination port range	PORTS_OUT_LAN
Description	Allow intranet traffic

Allow Internet Traffic

We allow internet traffic on `PORTS_OUT_WAN` for `IG_OUT_WAN` networks.

	Protocol	Source	Port	Destination	Port
	IPv4 TCP/UDP	IG_OUT_WAN net	*	!IG_LOCAL net	PORTS_OUT_WAN












Select **IG_OUT_WAN** and add the following rule.

Action	Pass
Quick	<input type="checkbox"/>
Interface	IG_OUT_WAN
Protocol	TCP/UDP
Source	IG_OUT_WAN net
Destination / Invert	<input checked="" type="checkbox"/>

Destination	IG_LOCAL net
Destination port range	PORTS_OUT_WAN
Description	Allow internet traffic through WAN

We later want to enable unrestricted internet access on the Guest network, so make sure to uncheck the **Quick** option!

Next, we allow internet traffic on PORTS_OUT_WAN for the IG_OUT_VPN networks.

	Protocol	Source	Port	Destination	Port	Gateway
   	IPv4 TCP/UDP	IG_OUT_VPN net	*	SELECTIVE_ROUTING 	PORTS_OUT_WAN 	*
   	IPv4 TCP/UDP	IG_OUT_VPN net	*	! IG_LOCAL net	PORTS_OUT_WAN 	WAN_VPN_GROUP

Select **IG_OUT_VPN** and add the following rules to configure selective routing.











Action	Pass
Interface	IG_OUT_VPN
Protocol	TCP/UDP
Source	IG_OUT_VPN net
Destination	SELECTIVE_ROUTING
Destination port range	PORTS_OUT_WAN
Description	Allow selected internet traffic through WAN

Action	Pass
Protocol	TCP/UDP
Source	IG_OUT_VPN net
Destination / Invert	checked
Destination	IG_LOCAL net
Destination port range	PORTS_OUT_WAN

Description	Allow internet traffic through WAN_VPN0
Gateway	WAN_VPN_GROUP

Restrict Guest Network

Select **VLAN40_GUEST** and add the following rules.

	Protocol	Source	Port	Destination	Port
  	IPv4 TCP/UDP	VLAN40_GUEST net	*	This Firewall	PORTS_ANTI_LOCKOUT 
  	IPv4 TCP/UDP	VLAN40_GUEST net	*	IG_LOCAL net	*
  	IPv4 TCP/UDP	VLAN40_GUEST net	*	! IG_LOCAL net	*

To block Web GUI and SSH access from the Guest network, we block traffic to any OPNsense interface on the `PORTS_ANTI_LOCKOUT` ports. We enable logging for this rule to be able to see if any guests try to access OPNsense.

Action	Block
Interface	VLAN40_GUEST
Protocol	TCP/UDP
Source	VLAN40_GUEST net
Destination	This Firewall
Destination port range	PORTS_ANTI_LOCKOUT
Log	checked
Description	Block admin ports

We block access to other local networks and also enable logging for the rule.

Action	Block
Interface	VLAN40_GUEST
Protocol	TCP/UDP
Source	VLAN40_GUEST net
Destination	IG_LOCAL net

Log	<input checked="" type="checkbox"/>
Description	Block traffic to local networks

Finally, we enable unrestricted internet access on Guest networks.

Action	Pass
Interface	VLAN40_GUEST
Protocol	TCP/UDP
Source	VLAN40_GUEST net
Destination / Invert	<input checked="" type="checkbox"/>
Destination	IG_LOCAL net
Description	Unrestricted internet access

LAN Network For Testing And Debugging

I just keep the pre-defined “LAN to any” rules. I periodically reconfigure this network for testing and debugging and don’t use it for anything else.

	Protocol	Source	Port	Destination	Port	Gateway	Schedule	Description
								Automatically generated rules
	IPv4 *	LAN net	*	*	*	*	*	Default allow LAN to any rule
	IPv6 *	LAN net	*	*	*	*	*	Default allow LAN IPv6 to any rule

Redirect Outbound DNS Traffic

To prevent clients from explicitly querying outbound DNS and leaking information to the outside, we redirect any outbound DNS traffic to Unbound or Dnsmasq.

Interface	Proto	Source		Destination		NAT	
		Address	Ports	Address	Ports	IP	Ports
IG_DNS_FORWARD	TCP/UDP	IG_DNS_FORWARD net	*	*	53 (DNS)	127.0.0.1	5335
IG_DNS_RESOLVE	TCP/UDP	IG_DNS_RESOLVE net	*	! IG_DNS_RESOLVE net	53 (DNS)	127.0.0.1	53 (DNS)

Navigate to **Firewall** → **NAT** → **Port Forward** and add the following rules.

Interface	IG_DNS_FORWARD
Protocol	TCP/UDP
Source	IG_DNS_FORWARD net
Destination	any
Destination port range	DNS
Redirect target IP	127.0.0.1
Redirect target port	5335
Description	Redirect any DNS traffic to Dnsmasq

Interface	IG_DNS_RESOLVE
Protocol	TCP/UDP
Source	IG_DNS_RESOLVE net
Destination / Invert	checked
Destination	IG_DNS_RESOLVE net
Destination port range	DNS
Redirect target IP	127.0.0.1
Redirect target port	DNS
Description	Redirect outbound DNS traffic to Unbound

Redirect Outbound NTP Traffic

To sync the time of all our devices on the network to OPNsense, we redirect all NTP traffic.

```
IG_NTP      UDP      IG_NTP net      *      !IG_NTP net      123 (NTP) 127.0.0.1 123 (NTP)
```

Navigate to **Firewall** → **NAT** → **Port Forward** and add the following rule.

Interface	IG_NTP
Protocol	UDP
Source	IG_NTP net
Destination / Invert	checked
Destination	IG_NTP net

Destination port range	NTP
Redirect target IP	127.0.0.1
Redirect target port	NTP
Description	Redirect outbound NTP traffic to OPNsense

Test

Now would be a good time to reboot OPNsense to make sure all settings are applied.

Test DHCP

Connect to a host in each VLAN and verify it receives an IP inside the specified DHCP range. Here is the output of the `ip -4 addr show eth0` command from a Ubuntu host connected to the VPN VLAN.

```
8: eth0: <BROADCAST,MULTICAST,UP> mtu 1500 group default qlen 1
    inet 192.168.20.106/24 brd 192.168.20.255 scope global dynamic
        valid_lft 7196sec preferred_lft 7196sec
```

Test DNS

We have to verify the following functionality of our DNS architecture:

- `VLAN20_VPN`
 - Unbound *resolves* remote and local hostname lookups
 - Redirect outbound DNS traffic to Unbound
 - Reverse lookups of private IPs
 - Don't leak lookups for the private `corp.example.com` domain
- `VL30_CLEAR`
 - Dnsmasq *forwards* remote hostname lookups to the system DNS servers like Quad9 *and* Unbound
 - Forward local hostname lookups to Unbound
 - Redirect outbound DNS traffic to Dnsmasq
 - Forward local reverse lookups of private IPs to Unbound
 - Don't leak lookups for the private `corp.example.com` domain and forward them to Unbound
- `VL40_GUEST`
 - Use external DNS resolvers

- o Allow for clients to override DNS
- o OPNsense lookups are blocked

We'll use the `dig` tool and the firewall logs under **Firewall** → **Log Files** → **Live View** for testing.

I'll also skip the Management network because it requires the same testing as the VPN network.

VLAN20_VPN: Test DNS

Connect to `VLAN20_VPN`.

VLAN20_VPN: Remote Hostname Lookups

Run `dig california.gov`:

```
; <<>> DiG 9.16.1-Ubuntu <<>> california.gov
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 41004
;; flags: qr rd ra ad; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 1232
;; QUESTION SECTION:
;california.gov.                IN      A

;; ANSWER SECTION:
california.gov.                300     IN      A      63.196.102.29

;; Query time: 36 msec
;; SERVER: 192.168.20.1#53(192.168.20.1)
;; WHEN: Tue Nov 16 22:37:34 CET 2021
;; MSG SIZE rcvd: 59
```

Here are the firewall logs showing the iterative DNS requests Unbound sends.

▶ WAN	← Nov 16 22:37:34	10.10.10.10	173.245.58.246:53
▶ WAN	← Nov 16 22:37:34	10.10.10.10	108.162.192.246:53
▶ WAN	← Nov 16 22:37:34	10.10.10.10	162.159.8.55:53
▶ WAN	← Nov 16 22:37:34	10.10.10.10	162.159.6.6:53
▶ WAN	← Nov 16 22:37:34	10.10.10.10	81.19.194.30:53 Verisign
▶ WAN	← Nov 16 22:37:34	10.10.10.10	69.36.157.30:53 .gov TLD Server
▶ WAN	← Nov 16 22:37:34	10.10.10.10	202.12.27.33:53 Root Server

VPN IPS

VLAN20_VPN: Local Hostname Lookups

Run `dig opnsense.corp.example.com`:

```

; <<>> DiG 9.16.1-Ubuntu <<>> opnsense.corp.example.com
;; global options: +cmd
;; Got answer:
;; ->HEADER<<- opcode: QUERY, status: NOERROR, id: 22291
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 3, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 1232
;; QUESTION SECTION:
;opnsense.corp.example.com. IN      A

;; ANSWER SECTION:
opnsense.corp.example.com. 3600 IN  A      192.168.1.1
opnsense.corp.example.com. 3600 IN  A      192.168.10.1
opnsense.corp.example.com. 3600 IN  A      192.168.20.1

;; Query time: 0 msec
;; SERVER: 192.168.20.1#53(192.168.20.1)
;; WHEN: Tue Nov 16 21:48:19 CET 2021
;; MSG SIZE rcvd: 105

```

VLAN20_VPN: Redirect Outbound DNS Traffic

Run `dig opnsense.org @8.8.8.8`:

```
; <<> DiG 9.16.1-Ubuntu <<> opnsense.org @8.8.8.8
;; global options: +cmd
;; Got answer:
;; ->HEADER<<- opcode: QUERY, status: NOERROR, id: 17970
;; flags: qr rd ra ad; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 1232
;; QUESTION SECTION:
;opnsense.org.                IN      A

;; ANSWER SECTION:
opnsense.org.                184     IN      A      178.162.131.118

;; Query time: 0 msec
;; SERVER: 8.8.8.8#53(8.8.8.8)
;; WHEN: Tue Nov 16 21:51:15 CET 2021
;; MSG SIZE rcvd: 57
```

`dig` can't tell that OPNsense hijacked the request and thus displays an incorrect `SERVER` value. If you check the firewall logs, you shouldn't see any requests to `8.8.8.8`. Instead, you should see iterative root server requests.

VLAN20_VPN: Reverse Lookups of Private IPs

Run `dig -x 192.168.20.1`:

```
; <<> DiG 9.16.1-Ubuntu <<> -x 192.168.20.1
;; global options: +cmd
;; Got answer:
;; ->HEADER<<- opcode: QUERY, status: NOERROR, id: 9264
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 1232
;; QUESTION SECTION:
;1.20.168.192.in-addr.arpa.    IN      PTR
```

```
;; ANSWER SECTION:
1.20.168.192.in-addr.arpa. 3600 IN PTR OPNsense.corp.example.com.

;; Query time: 0 msec
;; SERVER: 192.168.20.1#53(192.168.20.1)
;; WHEN: Tue Nov 16 21:56:14 CET 2021
;; MSG SIZE rcvd: 96
```

If you want, additionally reverse-lookup an IP that doesn't exist. The firewall logs mustn't contain requests to external DNS servers.

VLAN20_VPN: Verify `corp.example.com` Is Private

To test whether OPNsense is the authoritative server for `corp.example.com`, we lookup a non-existent hostname in that domain. `dig` should return an authoritative `NXDOMAIN` response with the SOA record we earlier defined earlier in the `AUTHORITY SECTION`.

Run `dig nowhere.corp.example.com`:

```
; <<>> DiG 9.16.1-Ubuntu <<>> nowhere.corp.example.com
;; global options: +cmd
;; Got answer:
;; ->HEADER<<- opcode: QUERY, status: NXDOMAIN, id: 44590
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 1232
;; QUESTION SECTION:
;nowhere.corp.example.com. IN A

;; AUTHORITY SECTION:
corp.example.com. 3600 IN SOA opnsense.corp.example.com. root.example.com.
2021110201 86400 7200 3600000 3600

;; Query time: 0 msec
;; SERVER: 192.168.20.1#53(192.168.20.1)
;; WHEN: Tue Nov 16 21:59:58 CET 2021
;; MSG SIZE rcvd: 110
```

VLAN20_VPN: DNS Leak Test

In your browser, navigate to dnsleaktest.com or mullvad.net/check. We expect the “leaked” DNS server to match our Mullvad public Mullvad IP. The second leak is from the **Outgoing Interface** we configured for Unbound:

Connection check

Using Mullvad VPN

WireGuard
ch5-wireguard.mullvad.net

193.32.127.213
Zurich, Switzerland (31173 Services Switzerland)

Leaking DNS servers

193.32.127.213
Switzerland (31173 Services Switzerland)

193.32.127.220
Switzerland (31173 Services Switzerland)

VLAN30_CLEAR: Test DNS

Connect to `VLAN30_CLEAR`.

VLAN30_CLEAR: Remote Hostname Lookups

Run `dig opnsense.org`:

```
; <<>> DiG 9.16.1-Ubuntu <<>> opnsense.org
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 65053
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1
```

```

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:: udp: 1232
;; QUESTION SECTION:
;opnsense.org.                IN      A

;; ANSWER SECTION:
opnsense.org.                596     IN      A      178.162.131.118

;; Query time: 5 msec
;; SERVER: 192.168.30.1#53(192.168.30.1)
;; WHEN: Tue Nov 16 16:45:08 CET 2021
;; MSG SIZE rcvd: 57

```

Check the firewall logs. Enable logging for the port forward rule if you want it to show up.

▶ WAN	←	Nov 17 01:01:45	10.10.10.10:20292 VPN IP	52.214.115.96:53 Unbound
▶ WAN	←	Nov 17 01:01:45	149.112.112.112:10960 ISP IP	149.112.112.112:53 Quad9
▶ WAN	←	Nov 17 01:01:45	9.9.9.9:10960 ISP IP	9.9.9.9:53 Quad9
▶ Loopback	→	Nov 17 01:01:45	127.0.0.1:10960	127.0.0.1:53 Unbound
▶ Loopback	←	Nov 17 01:01:45	127.0.0.1:10960	127.0.0.1:53 Unbound
▶ VLAN30_CLEAR	→	Nov 17 01:01:45	192.168.30.100:52845 VNET30_CLEAR	127.0.0.1:5335 Dnsmasq
⇌ VLAN30_CLEAR	→	Nov 17 01:01:45	192.168.30.100:52845 VNET30_CLEAR	192.168.30.1:53 Redirect

You can see that Dnsmasq forwards to the DNS servers defined under **System** → **Settings** → **General** and Unbound.

VLAN30_CLEAR: Local Hostname Lookups

Run `dig opnsense.corp.example.com`:

```

; <<>> DiG 9.16.1-Ubuntu <<>> opnsense.corp.example.com
;; global options: +cmd

```

```
;; Got answer:
;; ->HEADER<<- opcode: QUERY, status: NOERROR, id: 61385
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 4096
;; QUESTION SECTION:
;opnsense.corp.example.com. IN      A

;; ANSWER SECTION:
opnsense.corp.example.com. 1 IN      A      192.168.1.1

;; Query time: 0 msec
;; SERVER: 192.168.30.1#53(192.168.30.1)
;; WHEN: Wed Nov 17 00:45:49 CET 2021
;; MSG SIZE rcvd: 73
```

VLAN30_CLEAR: Redirect Outbound DNS Traffic

Run `dig opnsense.org @8.8.8.8`:

```
; <<>> DiG 9.16.1-Ubuntu <<>> opnsense.org @8.8.8.8
;; global options: +cmd
;; Got answer:
;; ->HEADER<<- opcode: QUERY, status: NOERROR, id: 34638
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 1232
;; QUESTION SECTION:
;opnsense.org. IN      A

;; ANSWER SECTION:
opnsense.org. 430 IN      A      178.162.131.118

;; Query time: 3 msec
;; SERVER: 8.8.8.8#53(8.8.8.8)
;; WHEN: Tue Nov 16 00:12:15 CET 2021
;; MSG SIZE rcvd: 57
```

We confirm it works by looking at the firewall logs again:

▶ WAN	←	Nov 17 00:12:15	10.10.10.1:55128 VPN IP	52.57.114.204:53 Unbound
▶ WAN	←	Nov 17 00:12:15	192.168.30.10:61031 ISP IP	149.112.112.112:53 Quad9
▶ WAN	←	Nov 17 00:12:15	192.168.30.10:61031 ISP IP	9.9.9.9:53 Quad9
▶ Loopback	→	Nov 17 00:12:15	127.0.0.1:61031	127.0.0.1:53 Unbound
▶ Loopback	←	Nov 17 00:12:15	127.0.0.1:61031	127.0.0.1:53 Unbound
▶ VLAN30_CLEAR	→	Nov 17 00:12:15	192.168.30.100:55242	127.0.0.1:5335 Dnsmasq
⇌ VLAN30_CLEAR	→	Nov 17 00:12:15	192.168.30.100:55242	8.8.8.8:53 Redirect

VLAN30_CLEAR: Forward Reverse Lookups of Private IPs to Unbound

Run `dig -x 192.168.20.1`:

```
; <<>> DiG 9.16.1-Ubuntu <<>> -x 192.168.20.1
;; global options: +cmd
;; Got answer:
;; ->HEADER<<- opcode: QUERY, status: NOERROR, id: 20607
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 1232
;; QUESTION SECTION:
;1.20.168.192.in-addr.arpa.      IN      PTR

;; ANSWER SECTION:
1.20.168.192.in-addr.arpa. 3600 IN      PTR      OPNsense.home.schnerring.net.

;; Query time: 1 msec
;; SERVER: 192.168.30.1#53(192.168.30.1)
;; WHEN: Wed Nov 17 00:09:05 CET 2021
;; MSG SIZE rcvd: 96
```

The firewall logs confirm it works.

▶ Loopback	→	Nov 17 00:09:05	192.168.20.1:24301	192.168.20.1:53
▶ Loopback	←	Nov 17 00:09:05	192.168.20.1:24301	192.168.20.1:53
⇌ VLAN30_CLEAR	→	Nov 17 00:09:05	192.168.30.100:61172	192.168.30.1:53

VLAN30_CLEAR: Verify `corp.example.com` Is Private

Run `dig nowhere.corp.example.com`:

```
; <<>> DiG 9.16.1-Ubuntu <<>> nowhere.corp.example.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NXDOMAIN, id: 7481
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 1232
;; QUESTION SECTION:
;nowhere.corp.example.com. IN      A

;; AUTHORITY SECTION:
corp.example.com.    3600    IN      SOA     opnsense.corp.example.com. root.example.com.
2021110201 86400 7200 3600000 3600

;; Query time: 0 msec
;; SERVER: 192.168.30.1#53(192.168.30.1)
;; WHEN: Tue Nov 16 20:44:35 CET 2021
;; MSG SIZE rcvd: 112
```

This time, requests will only be forwarded to Unbound, but not external DNS resolvers.

▶ Loopback	→	Nov 17 01:21:33	192.168.20.1:61416	192.168.20.1:53 Unbound (Domain Override)
▶ Loopback	←	Nov 17 01:21:33	192.168.20.1:61416	192.168.20.1:53 Unbound (Domain Override)
▶ VLAN30_CLEAR	→	Nov 17 01:21:33	192.168.30.100:63290	127.0.0.1:5335 Dnsmasq
⇌ VLAN30_CLEAR	→	Nov 17 01:21:33	192.168.30.100:63290	192.168.30.1:53 Redirect

VLAN30_CLEAR: DNS Leak Test

As we saw earlier, we expect the Quad9 *and* the Mullvad public IPs to leak. Here is the result of an extended test from dnsleaktest.com:

IP	ISP	Hostname	ISP
193.32.127.213	Mullvad	None	31173 Services AB
193.32.127.220		None	31173 Services AB
212.25.22.38	Quad9	None	Iway AG
74.80.88.242		None	WoodyNet

VLAN40_GUEST: Test DNS

Connect to `VLAN40_GUEST`.

Verify that `dig opnsense.org @192.168.40.1` times out.

The Cloudflare DNS servers you configured in the DHCP settings of the Guest VLAN should show up when running the leak test:

IP	Hostname	ISP
162.158.148.104	None	Cloudflare