

OpenWRT WireGuard Server Setup guide using LuCi

Introduction

[WireGuard](#) is an open-source VPN solution written in C by [Jason Donenfeld](#) and [others](#), aiming to fix many of the problems that have plagued other modern server-to-server VPN offerings like IPSec/IKEv2, OpenVPN, or L2TP.

It many ways it can be seen as a replacement for OpenVPN.

It has three advantages over OpenVPN, it is much faster especially on lower-spec hardware such as Soho routers (my own R7800 goes from 85 Mb/s on OpenVPN to 300 Mb/s with WireGuard), it is easy to setup if you know how, the guides will help you with that and it has a very small code base (about 4000 lines) so that it can easily be reviewed and checked for vulnerabilities.

Some key points about WireGuard:

- Layer 3 only no bridging
- UDP only punches through firewall
- Like SSH authenticated keys
- Executes in Linux Kernel
- Static routing

This is guide is to setup WireGuard as a server.

A server is a WireGuard interface listening for incoming connections e.g. from your phone/laptop from outside.

A client is making an outbound connection to a WireGuard server.

But as WireGuard basically is a peer to peer connection it can be both "client" and "server" at the same time, and if you have this setup between two routers we are talking about a site-to-site setup

This guide is based upon OpenWRT 24.10 but also should work on 23.05 and Main builds and uses LuCi to set things up but the resulting config files are also listed.

General Remarks

The most important parts of WireGuard are the public/private keys and the Allowed IP.

The public key is distributed to the peers.

The Allowed IP serves two roles, the first is that the allowed IP is used to know which of the peers public keys (if there is more than one peer) should be used to encrypt the packets.

Therefore the Allowed IP's must be unique for each peer!

The second one is security, if WireGuard detects a source IP which is not in the Allowed IP's the packets are discarded.

The keys are 32 bytes long and can be easily represented in Base64 encoding in 44 *characters the last character is always an =*.

As WireGuard is a routed solution **all three involved subnets have to be different**. So the Servers subnet, the WG subnet and the Clients subnet all have to be different!

As you often cannot choose the subnet of the client it is best to avoid using frequently used subnet for your routers IP address of e.g. 192.168.1.1/24 or 192.168.0.1/24

To be able to connect from outside your internet facing router must have a public IP address (either IPv4 and/or IPv6).

Check if your router has a proper Public IPv4 address with (from command line):

```
` ifstatus wan | grep address `
```

A public IP address is **not** something starting with 192.168.X.X, 10.X.X.X, 172.16-31.X.X or a [CGNAT address](#) (IP addresses from 100.64.0.0 to 100.127.255.255)

Furthermore proper **testing** can only be done **from outside** e.g. with your phone or laptop on cellular data or from a friends/neighbors internet.

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Server setup

Installation

Install WireGuard:

LuCi > System > Software: click `Update Lists` to get the latest packages for your build

Install: `luci-proto-wireguard`, `wireguard-tools` and `wg-installer-client` (only necessary if you later want to install a client)

Create WireGuard Interface

Next up we are going to create the WireGuard Interface:

Network > Interfaces on the bottom click: `Add New interface`

Add new interface...

Name	<input type="text" value="wgserver"/>
Protocol	<input type="text" value="WireGuard VPN"/>

Name: give the interface a name (hyphens are not allowed and the name has to be less than 15 characters!)

Protocol: *WireGuard VPN*

Click: *Create interface* and the Interface configuration screen should appear:

Interfaces » wgserver

General Settings Advanced Settings Firewall Settings DHCP Server Peers

Status	<div>Device: wireguard-wgserver RX: 0 B (0 Pkts.) TX: 0 B (0 Pkts.)</div>
Protocol	<input type="text" value="WireGuard VPN"/>
Disable this interface	<input type="checkbox"/>
Bring up on boot	<input checked="" type="checkbox"/>
Private Key	<input type="text"/> Required. Base64-encoded private key for this interface.
Public Key	<input type="text"/> Base64-encoded public key of this interface for sharing. <input type="button" value="Generate new key pair"/>
Listen Port	<input type="text" value="random"/> Optional. UDP port used for outgoing and incoming packets.
IP Addresses	<input type="text"/> Recommended. IP addresses of the WireGuard interface.
No Host Routes	<input type="checkbox"/> Optional. Do not create host routes to peers.

Click: *Generate new key pair*

Listen port: *55443*, you can use any port with is not already taken.

IP Addresses: *172.22.22.1/24*, if you also want IPv6 use a [ULA address](#) e.g.: *fd8f:de49::1/64*, you can use an [ULA calculator](#) if you want

Status

Device: wgserver
Uptime: 0h 1m 41s
RX: 0 B (0 Pkts.)
TX: 0 B (0 Pkts.)
IPv4: 172.22.22.1/24
IPv6: fd8f:de49:19f1:ffff::1/64

Protocol

WireGuard VPN

Disable this interface

☐

Bring up on boot

☒

Private Key

.....*

Required. Base64-encoded private key for this interface.

Public Key

ML5BqgOUmKMklzhXGSXnmFWeTVD1gI

Base64-encoded public key of this interface for sharing.

Generate new key pair

Listen Port

55443

Optional. UDP port used for outgoing and incoming packets.

IP Addresses

172.22.22.1/24

fd8f:de49::1/64

Recommended. IP addresses of the WireGuard interface.

Save and then Save & Apply

wgserver



wgserver

Protocol: WireGuard VPN
Uptime: 0h 2m 41s
RX: 0 B (0 Pkts.)
TX: 0 B (0 Pkts.)
IPv4: 172.22.22.1/24
IPv6: fd8f:de49:19f1:ffff::1/64

Restart Stop Edit Delete

```
/etc/config/network:
config interface 'wgserver'
    option proto 'wireguard'
    option private_key 'MIShrFJZqAQ4UG/pq12Y+xgs+QP5FyAl57s3M71hw0='
    option listen_port '55443'
    list addresses '172.22.22.1/24'
    list addresses 'fd8f:de49::1/64'
```

Firewall Setup

The firewall setup consist of three things:

1. Opening up the port (55443 in this example) with a traffic rule
- 2a. Allowing traffic for the wgserver the interface
3. Allow IPv6 internet for your wgserver clients, Optional if you have implemented IPv6 and want your cleints to have IPv6 internet

1. Opening up the port (55443 in this example) with a traffic rule

Network > Firewall > Traffic Rules

Add new traffic rule

Name: *allow-55443*

Protocol: *UDP*, click drop down button and disable TCP

Source zone: *WAN*

Destination zone: *Device (input)*

Destination port: *55443* , the port the wgserver interface listens on

Action: *accept*

The traffic rule, by default, applies to IPv4 and IPv6, you can restrict the rule to IPv4 on the Advanced Tab

Firewall - Traffic Rules - Unnamed rule

General Settings

Advanced Settings

Time Restrictions

Name	allow-55443
Protocol	UDP
Source zone	wan wan: wan6: wg_proton_nl:
Source address	-- add IP --
Source port	any
Destination zone	Device(input)
Destination address	-- add IP --
Destination port	55443
Action	accept

Save the rule and the result looks like this:

allow-55443	Incoming <i>IPv4</i> and <i>IPv6</i> , protocol <i>UDP</i>		
	From <i>wan</i>	Accept input	<input checked="" type="checkbox"/>
	To <i>this device</i> , port <i>55443</i>		<div>EditCloneDelete</div>

```
/etc/config/firewall:
config rule
    option name 'allow-55443'
    list proto 'udp'
    option src 'wan'
    option dest_port '55443'
    option target 'ACCEPT'
```

2a. Allowing traffic for the wgserver's the interface

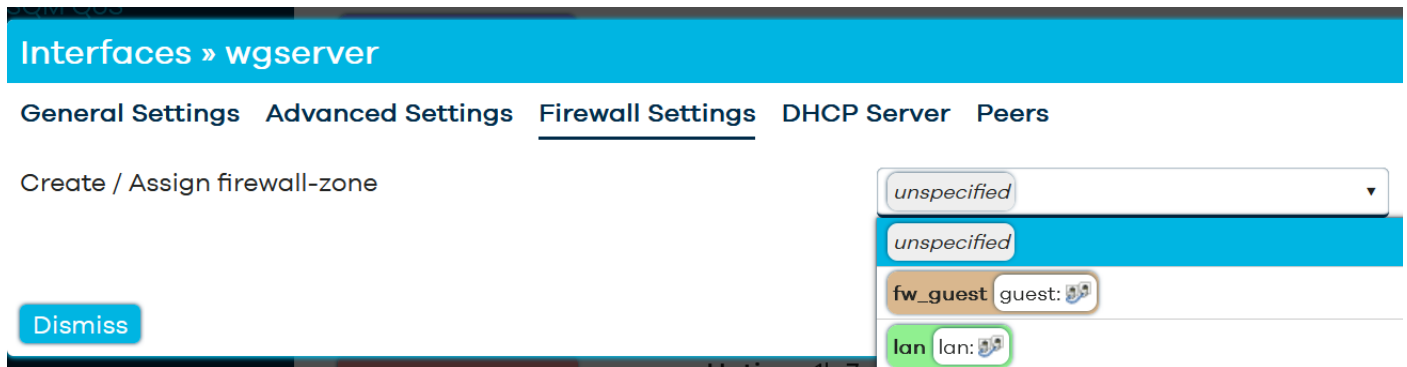
The easiest method is to edit the wg server interface.

Network > Interfaces and click the *edit* button on the *wgserver interface*

Go to **Firewall settings**:

Click on the drop down button and click on *lan*, this will add the wgserver interface to the lan zone

Save and Save & Apply



```
/etc/config/firewall:
config zone
    option name 'lan'
    option input 'ACCEPT'
    option output 'ACCEPT'
    option forward 'ACCEPT'
    list network 'lan'
    list network 'wgserver'
```

2b. Alternative setup

This can be used if you want a more finer grained control.

Instead of adding the wgserver interface to the LAN zone, create a separate firewall zone:

Go to **Network > Firewall** and

Click **Add**

Name: *wgserver* (or a name to your liking)

Input: *accept* (unless you do not want your wgserver clients to have access to your router)

Output: *accept* (always set accept)

Intra zone Forward: *accept* (unless you do not want your wgserver clients to be able to communicate with each other)

Covered networks: *wgserver* (this is the wgserver interface)

allow forward to destination zones:

lan zone (to allow to connect to your lan clients)

wan zone (optional to give your wg server clients internet access via your router)

allow forward from source zones:

lan zone (optional only to allow bidirectional traffic e.g. in case you have a site-to-site setup, ote that your wg server clients also have to allow this traffic)

Firewall - Zone Settings

General Settings Advanced Settings Conntrack Settings

This section defines common properties of "this new zone". The *input* and *output* options set the default policies for traffic entering and describes the policy for forwarded traffic between different networks within the zone. *Covered networks* specifies which available netw

Name	<input type="text" value="wgserver"/>
Input	<input type="text" value="accept"/>
Output	<input type="text" value="accept"/>
Intra zone forward	<input type="text" value="accept"/>
Masquerading	<input type="checkbox"/> Enable network address and port translation IPv4 (NAT4) or typically enabled on the <i>wan</i> zone.
MSS clamping	<input type="checkbox"/>
Covered networks	<input type="text" value="wgserver:"/>

The options below control the forwarding policies between this zone (this new zone) and other zones. *Destination zones* cover forwarded *zones* match forwarded traffic from other zones **targeted at this new zone**. The forwarding rule is *unidirectional*, e.g. a forward from lan from wan to lan as well.

Allow forward to *destination zones*:

Allow forward from *source zones*:

/etc/config/firewall:

config zone

```
option name 'wgserver'
option input 'ACCEPT'      #use REJECT if you do not want access to the router
option output 'ACCEPT'
option forward 'ACCEPT'
list network 'wgserver'
```

config forwarding

```
# to give WG clients access to your LAN clients
# if you want more fine grained control remove this and make a traffic rule see below
option dest 'lan'
option src 'wgserver'
```

config forwarding

```
# to give your LAN client access to WG clients needed for site-to-site setup
option dest 'wgserver'
option src 'lan'
```

config forwarding

```
# to give your WG client access to the internet via the router
option src 'wgserver'
option dest 'wan'
```

#Extra traffic rule for access to individual LAN clients if there is no general forwarding:

config rule

```
option name 'access-from-wg'
option src 'wgserver'
list dest_ip '192.168.5.199'
option target 'ACCEPT'
list proto 'all'
option dest '*'
```

3. Allow IPv6 internet for wgserver clients

If IPv6 is implemented and you want wgserver clients to have internet access via IPv6 then Masquerading should be enabled for the WireGuard subnet out of the WAN.

Network > Firewall > Wan zone : **click edit**

goto *Advanced Settings*:

IPv6 Masquerading: *Enable*

Restrict Masquerading to given source subnets: *fd8f:de49::0/64* (WireGuard IPv6 subnet)

Save and Save & Apply

Firewall - Zone Settings

General Settings **Advanced Settings** **Conntrack Settings**

The options below control the forwarding policies between this zone (wan) and other zones. *Destination zones* cover forward forwarded traffic from other zones **targeted at wan**. The forwarding rule is *unidirectional*, e.g. a forward from lan to wan doe

Covered devices	<div>unspecified</div> <div>Use this option to classify zone traffic by raw, nc</div>
Covered subnets	<div></div> <div>Use this option to classify zone traffic by source</div>
IPv6 Masquerading	<div><input checked="" type="checkbox"/></div> <div>Enable network address and port translation IPv</div>
Restrict to address family	<div>IPv4 and IPv6</div>
Restrict Masquerading to given source subnets	<div>fd8f:de49::0/64</div> <div>0.0.0.0/0</div>

```
/etc/config/firewall:
config zone
    option name 'wan'
    <>
    option masq6 '1'
    list masq_src 'fd8f:de49::0/64'
```

Furthermore there is no standard default route for IPv6 as "source" routing is used so source routing should be disabled.

Network > Interfaces > WAN6: **click edit**

goto *Advanced Settings*:

Disable Source Routing by removing the tick:

IPv6 source routing	<div><input type="checkbox"/></div> <div>Automatically handle multiple uplink interfaces using source-based policy routing.</div>
---------------------	---

Save and Save & Apply

```
/etc/config/network:
config interface 'wan6'
    option device 'wan'
    <>
    option sourcefilter '0'
```


4. Allow seamless access to LAN clients

Your LAN clients might not accept traffic from your WG clients because traffic comes from another subnet and LAN clients might have their own firewall which blocks non local traffic.

The best way to solve this is to tweak the firewall of local clients to accept traffic from the WG subnet.

For Windows:

[How to Add IP Address in Windows Firewall](#)

Step 1) On the Start menu, Click 'Windows Firewall with Advanced Security'.

Step 2) Click the 'Advanced settings' option in the sidebar.

Step 3) On the left side, click the option 'Inbound Rules'.

Step 4) On the right, under the section 'Actions', click on the option 'New Rule'. Windows Firewall shows you the New Inbound Rule Wizard.

Step 5) A new window will open and Select the 'custom' option and click Next.

Step 6) In the left-hand side again, go to the option 'Scope'.

Step 7) Add the IP address and click on the 'Ok' button.

But if that is not feasible you can masquerade the WireGuard traffic which comes out of the router.


Simplest method is to use [option 2b](#) for setting up the firewall and Enable Masquerading on the LAN interface.

However this Masquerades all traffic so better is to only Masquerade WG traffic with the following firewall NAT rule:

Network > Firewall > NAT rules:

Firewall - NAT Rules - SNAT-WGserver

[General Settings](#) [Advanced Settings](#) [Time Restrictions](#)

Name	SNAT-WGserver	/etc/
Restrict to address family	automatic	▼
Protocol	Any	▼
Outbound zone	lan lan: 	▼
Source address	172.22.22.0/24	▼
	Match forwarded traffic from this IP or range.	
Destination address	any	▼
	Match forwarded traffic directed at the given IP address.	
Action	MASQUERADE - Automatically rewrite to outbound interface IP ▼	

config/firewall:

config nat

```
option name 'SNAT-WGserver'
option src 'lan'
option src_ip '172.22.22.0/24' # the WG subnet, note the .0 at the end
option target 'MASQUERADE'
list proto 'all'
option enabled '1'
```

With Masquerading WG traffic you loose logging and access control but in a typical SoHo setup, where you trust your users, that is not a big deal.

Peer Setup

Next setup the peers for the WireGuard server.

Peers are the clients which connects from outside to the wgserver.

There are WireGuard clients for almost operating systems.

We are going to setup one Peer but you can of course add as many as you want, note that you can reuse this one peer for multiple clients but you can only connect one at a time!

Go to **Network > Interfaces > wgserver > Peers**

Interfaces » wgserver

General Settings Advanced Settings Firewall Settings DHCP Server Peers

Further information about WireGuard interfaces and peers at wireguard.com.

Disabled	Description	Allowed IPs	Endpoint Host
No peers defined yet.			

Add peerImport configuration as peer...

Click: *Add Peer*

Description: give a name for your Peer

Click *Generate new key pair*, the keys for the peer will be filled in.

Allowed IPs: *172.22.22.2/32*, the wgserver has this address *172.22.22.1/24*, all peers should have an address in this subnet so for this peer use *172.22.22.2/32*, note the /32 mask. Subsequent peers will use *.3/32* etc.

For IPv6 you add: *fd8f:de49::2/128*, note the /128 mask

Route Allowed IPs: *Enable*, Always enable this

Endpoint host: Leave blank

Endpoint port: *554433*, this is the listening port of the wgserver (only used to make your config).

Persistent keep alive: *25*, most clients are behind NAT so to keep the connection open use persistent keep alive (only used to make your config).

[Interfaces » wgserver » Edit peer](#)

Disabled

☐ Enable / Disable peer. Restart wireguard interface

Description

My Phone

Optional. Description of peer.

Public Key

1/eg09g0LT72ogh2sUC9ySNbbb4yhOo+c

Required. Public key of the WireGuard peer.

Private Key



Optional. Private key of the WireGuard peer. The
a connection but allows generating a peer conf
can be removed after the configuration has been

Generate new key pair

Preshared Key

Optional. Base64-encoded preshared key. Adds symmetric-key cryptography for post-quantum

Generate preshared key

Allowed IPs

172.22.22.2/32fd8f:de49::2/128

[+ Add new content](#)

Optional. IP addresses and prefixes that this peer tunnel. Usually the peer's tunnel IP addresses as through the tunnel.

Route Allowed IPs

☒

Optional. Create routes for Allowed IPs for this p

Endpoint Host

vpn.example.com

Optional. Host of peer. Names are resolved prior

Endpoint Port

55443

Optional. Port of peer.

Persistent Keep Alive

25

Optional. Seconds between keep alive message
Recommended value if this device is behind a N

Configuration Export

 [Generate configuration...](#)

Generates a configuration suitable for import o

Save

Open the peer again by clicking on **Edit**.

Click: *Generate configurations*

Connection Endpoint: this is the WAN IP address or DDNS address your wgserver listens on

Allowed IPs: standard `0.0.0.0/0, ::/0`, which means all traffic from your wg client will use the tunnel

DNS server: standard your routers IP address, not all clients can deal with this (rebind protection, using the wgserver interface (172.22.22.1) might help) but you router might also not listen on the wgserver interface so to be sure that you have got DNS resolution use `1.1.1.1`

Addresses: do not change

Interfaces » wgserver » Edit peer » Generate configuration

The generated configuration can be imported into a WireGuard client application to set up a connection toward

Connection endpoint

my.ddns.nl

The public hostname or IP address of this system that usually is a static public IP address, a static hostname

Allowed IPs

0.0.0.0/0

::/0

-- Please choose --

IP addresses that are allowed inside the tunnel. The packets with source IP addresses matching this list matching destination IP.

DNS Servers

192.168.5.1

1.1.1.1

+

DNS servers for the remote clients using this tunnel wireguard clients require this to be set.

Addresses

172.22.22.2/32

fd8f:de49::2/128

-- Please choose --

IP addresses for the peer to use inside the tunnel. Sc



```
[Interface]
PrivateKey = iGrogUvTflvHv1y8cZxHVJYzeosjccZSfGiyX64FUko=
Address = 172.22.22.2/32, fd8f:de49::2/128
ListenPort = 55443
DNS = 192.168.5.1, 1.1.1.1

[Peer]
PublicKey = ML5BqgOUmKMk1zhXGSXnmFWeTVD1gDn15SEB8f/T5zo=
# PresharedKey not used
AllowedIPs = 0.0.0.0/0, ::/0
Endpoint = my.ddns.nl:55443
PersistentKeepAlive = 25
```

```
/etc/config/network:
config wireguard_wgserver
    option description 'My Phone'
    option public_key '1/eg09g0LT72ogh2sUC9ySNbbb4yh0o+q7kmDaAv1gM='
    option private_key 'iGrogUvTflvHv1y8cZxHVJYzeosjccZSfGiyX64FUko='
    list allowed_ips '172.22.22.2/32'
    list allowed_ips 'fd8f:de49::2/128'
    option route_allowed_ips '1'
    option endpoint_port '55443'
    option persistent_keepalive '25'
```

Setup WireGuard on your Client

Setup WireGuard on your client (phone/laptop etc) by downloading the WireGuard app via google play store , apple store Microsoft store or download from the [WireGuard website](#).

For OpenWRT see: <https://github.com/egc112/OpenWRT-egc-add-on/tree/main/notes>

For DDWRT see: <https://forum.dd-wrt.com/phpBB2/viewtopic.php?t=327397>

You can import the settings with the QR code or copy the text and paste in a file, name it *peer-172.22.22.2.conf* which can be used to import in your wg client

Finish by Saving and Applying everything and do a reboot!

Now see if you can connect from outside e.g. with your phone or laptop on cellular.

Note that your LAN clients will not always allow traffic from a foreign subnet, in that case you have to tweak the firewall of said lan clients to allow traffic from 172.22.22.0/24 (the wg servers subnet), or masquerade this traffic

Site-to-site setup

Although WireGuard is a peer to peer connection we still make a distinction between a server, listening for incoming connections and a client which initiates a connection to a server via an endpoint.

A site-to-site setup is the ultimate peer to peer setup in which the WireGuard interfaces are used to make a connection between two routers for bidirectional traffic.

Prerequisites:

All involved subnets need to be unique, so both routers must be on a different subnets and the wg subnet also must be different!

To start just setup one side as a server (Site A) and the other side as a client (Site B), check that you have a working connection.

WireGuard subnet: *172.22.22.0/24*

On the server side (site A, subnet *192.168.5.0/24*):

Network > Interfaces> wgserver interface: edit > Peers > edit Peer of side B

Peer setup of side B:

Allowed IPs: Add whole subnet of site B: *192.168.9.0/24*

On the client side (site B, subnet *192.168.9.0/24*):

Network > Firewall

WAN zone: **remove** *wgclient interface* from the WAN zone

LAN zone: **add** *wgclient interface* to the LAN zone

Network > Interfaces> wgclient interface: edit > Peers > edit Peer of side A

Peer setup of side A:

- Allowed IPs:
1. **Remove** *0.0.0.0/0 and ::0/0*
 2. **Add** the whole subnet of side A: *192.168.5.0/24*
 3. **Add** the whole subnet of WireGuard: *172.22.22.0/24*

DNSMasq resolution between networks

It is perfectly possible to use DNSMasq for DNS between both routers resolution.

Prerequisites: the domain names must be different

For a proper setup if both sides are OpenWRT routers four things are important

The first is to make sure that the DNS server can actually process queries from the other side.

DNSmasq has to listen on all interfaces so also on the WG interface, by default this is the case but if you changed that then you have to add the WG interface as listen interface.

The second is that DNSMasq has to answer non local request coming from the other side.

For this disable Local Service only (DNSMasq: `-local-service`):

Luci DNS-DHCP > Filter > Local service only : untick/disable, \

or in `/etc/config/dhcp` > `config dnsmasq`

`option localservice '0'`

The third is that DNSMasq is now also using a DNS server with a local RFC1918 address.

DNSmasq has rebind protection which shield you from using local addresses as that can be used to spoof DNS so disable Rebind Protection:

Luci DNS-DHCP > Filter > Rebind protection untick/disable

```
/etc/config/dhcp > config dnsmasq
    option rebind_protection '0'
```

instead of disabling Rebind protection you can also whitelist the domain of the other side

Luci DNS-DHCP > Filter > Domain Whitelist "set name of domain of other side"

```
/etc/config/dhcp > config dnsmasq
    list rebind_domain 'set name of domain of other side'
```

The fourth is that you have to instruct DNSMasq which server it has to use to resolve the domain of the other side, this assumes you have set a different domain name for each side e.g. *lan5* (router is 192.168.5.1) and *lan9* (router is 192.168.9.1)

On router *lan5* add: server=/lan9/192.168.9.1

```
/etc/config/dhcp > config dnsmasq:
    list server '/lan9/192.168.9.1'
```

On *lan9* : server=/lan5/192.168.5.1

```
/etc/config/dhcp > config dnsmasq:
    list server '/home1/192.168.1.1'
```

Asking for Help

You can ask for help at the [OpenWRT forum](#).

If you do it helps if we can have a look at your configs, so please connect to your OpenWRT device [using ssh](#) and copy the output of the following commands and post it on the forum using the "Preformatted text </>" button



Remember to redact keys, passwords, MAC addresses and any public IP addresses you may have:

- `ubus call system board`
- `cat /etc/config/network`
- `cat /etc/config/wireless`
- `cat /etc/config/firewall`
- `wg show`

References

<https://openwrt.org/docs/guide-user/services/vpn/wireguard/start>

<https://wiki.dd-wrt.com/wiki/index.php/Wireguard>

<https://www.wireguard.com/quickstart/>

<https://www.wireguard.com/>

<https://github.com/pirate/wireguard-docs>

<https://www.wireguard.com/papers/wireguard.pdf>

<https://wiki.archlinux.org/index.php/WireGuard>

<https://stackoverflow.com/questions/65178004/what-does-ip-4-rule-add-table-main-suppress-prefixlength-0-meaning>

ipv6:

<https://angristan.xyz/2019/01/how-to-setup-vpn-server-wireguard-nat-ipv6/>

<https://try.popho.be/wg.html>

suppress prefix length and wg quick

<https://ro-che.info/articles/2021-02-27-linux-routing>

<https://stackoverflow.com/questions/65178004/what-does-ip-4-rule-add-table-main-suppress-prefixlength-0-meaning>

Packet flow:

<https://www.procustodibus.com/blog/2021/01/wireguard-endpoints-and-ip-addresses/>

WireGuard server in the cloud

Setup Oracle free OpenVPN cloud server

<https://www.youtube.com/watch?v=E-CLtExRzX8>

<https://mateo.cogeanu.com/2020/wireguard-vpn-pihole-on-free-oracle-cloud/>

Amazon Web services (AWS)

<https://www.youtube.com/watch?v=m-i2JBtG4FE>