VPN Setup – The Easy Way



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Overview

Introduction

This pdf booklet will go through the steps to set up a Virtual Private Network (VPN) from scratch. A VPN allows you to surf the web safely and securely from your personal devices when connected to an unsecured network such as the WiFi of a hotel or coffee shop.

Throughout this booklet we will be typing in commands into two separate machines - the VPN server and the Certificate Authority (CA). The VPN server hides your personal devices IP as you access the internet. If you visit www.google.com from your personal device, your request first goes through the VPN server and then the actual Google webpage. Information coming back to your device (so that the webpage is displayed on your device) also goes through the VPN server before reaching your device. The CA acts as a gatekeeper to your VPN server so only authorized users can access it (to prevent malicious attacks on your VPN server).

Commands typed into the machine running our VPN server will have a yellow background:

\$ VPN server commands look like this

Commands typed into the machine running our CA will have a blue background:

\$ CA commands look like this

Output and file text will have a green background:

\$ Output and file text look like this

Prerequisites

You need the 2 resources below in order to completely install VPN:

- 1 machine running Ubuntu 18.04 as the VPN server
- 1 machine running Ubuntu 18.04 as the CA

Both machines require you to have sudo access. If you do not have these machines set up, follow the instructions in "0. Setting Up Your Servers with Digital Ocean", else skip to Section 1. There are 10 sections in total.

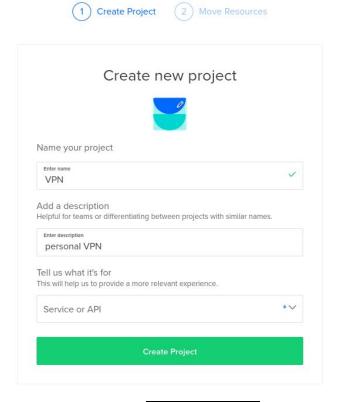
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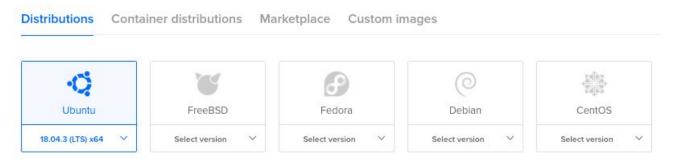
Step 0. Setting Up Your Servers with Digital Ocean

After following these steps, you should be able to SSH into your servers.

- 1. Create your Digital Ocean account
- 2. Click on + New Project
- 3. Fill up the form and click on "Create Project"

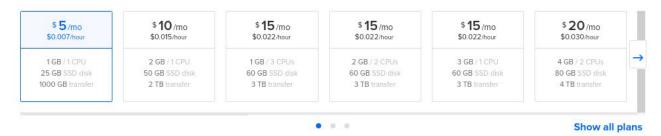


- 4. When prompted to move resources, click Skip for now
- 5. Click on Get Started with a Droplet
- 6. Choose Ubuntu as your droplet

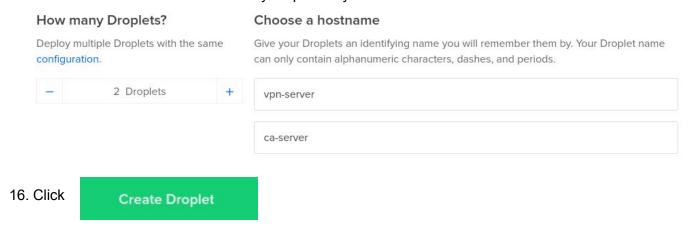


7. Choose the Standard plan

8. Make sure it is the cheapest plan



- 9. Do not add block storage and choose a datacenter region
- 10. Do not add a VPC network
- 14. Follow instructions in the pop-up window
- 15. Create two droplets. This example names the droplets vpn-server, ca-server for the VPN server and Certificate Authority respectively.



Step 1. Build CA with EasyRSA

1. Log in to your CA

(You can log in via SSH)

2. Download and Install EasyRSA

```
$ cd && wget
https://github.com/OpenVPN/easy-rsa/releases/download/v3.0.4/EasyRS
A-nix-3.0.4.tgz
$ tar -xvf EasyRSA-3.0.4.tgz
$ cd ~/EasyRSA-3.0.4/
$ cp vars.example vars
```

3. Change commented lines in ~/EasyRSA-3.0.4/vars in your favorite text editor to the ones below

(remember to replace each field in double quotes with a sensible value)

```
set_var EASYRSA_REQ_COUNTRY
set_var EASYRSA_REQ_PROVINCE
set_var EASYRSA_REQ_CITY
set_var EASYRSA_REQ_ORG
set_var EASYRSA_REQ_EMAIL
set_var EASYRSA_REQ_EMAIL
set_var EASYRSA_REQ_OU
"Personal"
"your_country"
"your_state/province"
"your_city"
"Personal Certificate LTD"
"your_email@your_domain.com"
"your_email@your_domain.com"
```

- 4. Save and close the file
- 5. Initialize public key infrastructure

```
$ ./easyrsa init-pki
```

6. Create public certificate ca.crt and private key ca.key. (press "Enter" if you are prompted to enter extra information mid-command)

(The nopass option removes the need for a password prompt each time you sign your certificates. Pressing "Enter" removes the need for having an optional common name.)

- \$./easyrsa build-ca nopass
- 7. Check output

```
Output
...
Enter PEM pass phrase:
```

```
Verifying - Enter PEM pass phrase:
----
...
Common Name (eg: your user, host, or server name) [Easy-RSA CA]:

CA creation complete and you may now import and sign cert requests.
Your new CA certificate file for publishing is at:
/home/causer/EasyRSA-3.0.4/pki/ca.crt
```

Step 2. Install OpenVPN and EasyRSA on VPN server

- 1. Open a terminal window with a shell to your VPN server
- 2. Install OpenVPN on your VPN server

(OpenVPN is a free open-source implementation of a VPN service)

```
$ sudo apt update
$ sudo apt install openvpn
```

3. Install EasyRSA on your VPN server

```
$ cd && wget -P ~/
https://github.com/OpenVPN/easy-rsa/releases/download/v3.0.4/EasyRS
A-3.0.4.tgz
$ tar -xvf EasyRSA-3.0.4.tgz
```

4. Navigate to EasyRSA directory and run easyrsa script on your VPN server

```
$ cd EasyRSA-3.0.4/
$ ./easyrsa init-pki
```

Step 3. Create Diffie-Hellman and HMAC Keys

1. Navigate to the EasyRSA directory on your VPN server.

```
$ cd EasyRSA-3.0.4/
```

2. Generate a Diffie-Hellman key.

```
$ ./easyrsa gen-dh
```

3. Check output (it might take some time to generate the cryptographic key)

Output

```
DH parameters of size 2048 created at /home/serveruser/EasyRSA-3.0.4/pki/dh.pem
```

4. Copy the generated file to the /etc/openvpn directory

```
$ sudo cp ~/EasyRSA-3.0.4/pki/dh.pem /etc/openvpn/
```

5. Generate an HMAC signature and move to the /etc/openvpn directory

```
$ openvpn --genkey --secret ta.key
sudo cp ~/EasyRSA-3.0.4/ta.key /etc/openvpn/
```

Step 4. Create Server Certificate and Private Key

1. Generate new private key for server and a certificate request file

```
$ cd ~/EasyRSA-3.0.4/
$ ./easyrsa gen-req server1 nopass
```

2. Check output

```
Output
----
Common Name (eg: your user, host, or server name) [server1]:

Keypair and certificate request completed. Your files are:
req: /home/serveruser/EasyRSA-3.0.4/pki/reqs/server1.req
key: /home/serveruser/EasyRSA-3.0.4/pki/private/server1.key
```

3. Copy the private key to the /etc/openvpn directory

```
$ sudo cp ~/EasyRSA-3.0.4/pki/private/server1.key /etc/openvpn/
```

4. Transfer the certificate request file to your CA

```
$ scp ~/EasyRSA-3.0.4/pki/reqs/server1.req
your_ca_user@your_ca_ip:/tmp
```

5. Login to your CA and import the certificate request file

```
$ cd ~/EasyRSA-3.0.4
$ ./easyrsa import-req /tmp/server1.req server1
```

6. Sign the request file

```
$ cd ~/EasyRSA-3.0.4
$ ./easyrsa sign-req server1
```

7. Transfer signed certificate back to your VPN server

```
$ scp pki/issued/server1.crt your_server_user@your_server_ip:/tmp
$ scp pki/ca.crt your_server_user@your_server_ip:/tmp
```

8. Login to your VPN server, and copy the server1.crt and ca.crt files into the /etc/openvpn/ directory:

\$ sudo cp /tmp/{server1,ca}.crt /etc/openvpn/

Step 5. Configure the OpenVPN Service

With the generated certificate and key pair, we will proceed with the configurations.

1. Copy the sample configuration into the configuration directory and then extract it.

```
$ sudo cp
/usr/share/doc/openvpn/examples/sample-config-files/server.conf.gz
/etc/openvpn/
$ sudo gzip -d /etc/openvpn/server.conf.gz
```

2. Open the configuration file in the editor of choice.

```
$ sudo nano /etc/openvpn/server1.conf
```

- 3. Update the configuration file server1.conf as follows.
 - Update the line containing port # to be port 443
 - Update the line containing ;proto tcp to proto tcp by removing the ; at the beginning of the line and change proto udp to ;proto udp
 - Update the line containing dh filename to be dh dh.pem to match the filename of the file you created in the previous section
 - Update the line containing push "redirect-gateway def1 bypass-dhcp" to be uncommented by removing the; at the beginning of this line
 - Update the lines containing push "dhcp-option DNS 208.67.222.222" and push "dhcp-option DNS 208.67.220.220" to be uncommented by removing the; at the beginning of both these lines
 - Make sure the line containing tls-auth ta.key 0 is not commented by removing the; if it exists
 - Make sure the line containing cipher AES-256-CBC is not commented by removing the; if it exists
 - Directly under this line add a line containing auth SHA256
 - Update the lines containing user nobody and group nogroup to be uncommented by removing the; at the beginning of both these lines
 - Update the line containing explicit-exit-notify 1 to be explicit-exit-notify 0

4. Open the system network configuration file.

```
$ sudo nano /etc/sysctl.conf
```

- 5. Update the system configuration file.
 - Update the line containing net.ipv4.ip_forward=1 to be uncommented by removing the # at the beginning of this line.
- 6. Run the following command in the terminal and save the output.

```
$ ip -o -4 route show to default | awk '{print $5}'
```

7. Open the firewall rules file.

```
$ sudo nano /etc/utw/before.rules
```

8. Update before.rules by adding the following bolded lines as shown. Replace the eth0 with the previously saved output from 6.

```
# ufw-before-input
# ufw-before-output
# ufw-before-forward
#

# START OPENVPN RULES
# NAT table rules
*nat
:POSTROUTING ACCEPT [0:0]
# Allow traffic from OpenVPN client to eth0 (change to the interface you discovered!)
-A POSTROUTING -s 10.8.0.0/8 -o eth0 -j MASQUERADE
COMMIT
# END OPENVPN RULES
# Don't delete these required lines, otherwise there will be errors
```

9. Update /etc/default/ufw as follows.

```
$ sudo nano /etc/default/ufw
```

- Update the line containing DEFAULT_FORWARD_POLICY="DROP" to be DEFAULT_FORWARD_POLICY="ACCEPT"
- 10. Execute the following commands to allow TCP connections through port 443

```
$ sudo ufw allow OpenSSH
$ sudo ufw allow 443/tcp
```

11. Finally, reload ufw with the following commands.

\$ sudo ufw disable
\$ sudo ufw enable

Step 6. Start and Enable the OpenVPN Service

With the server configured, we can start the OpenVPN service.

1. Start the VPN server.

```
$ sudo systemctl start openvpn@server1
```

2. The server should be up and running. To check its status, run the following command.

```
$ sudo systemctl status openvpn@server1
```

If the server is running correctly, you can expect a similar message as follows.

```
openvpn@server1.service - OpenVPN connection to server
 Loaded: loaded (/lib/systemd/system/openvpn@.service; indirect;
vendor preset: enabled)
 Active: active (running) since Sun 2020-06-21 01:13:47 UTC; 22h
ago
    Docs: man:openvpn(8)
https://community.openvpn.net/openvpn/wiki/Openvpn24ManPage
          https://community.openvpn.net/openvpn/wiki/HOWTO
Main PID: 2401 (openvpn)
 Status: "Initialization Sequence Completed"
  Tasks: 1 (limit: 1152)
 CGroup:
/system.slice/system-openvpn.slice/openvpn@server.service
          └──2401 /usr/sbin/openvpn --daemon ovpn-server --status
/run/openvpn/server.status 10 --cd /etc/openvpn --script-security
2 --config /etc/openvpn/server.conf --writepid
/run/openvpn/server.pid
```

3. To set the OpenVPN server to be activated at boot, run the following command.

```
$ sudo systemctl enable openvpn@server1
```

Step 7. Create Client Configuration Infrastructure

Now that we are all set with the server, there are only a few steps to do. First,we will set up the client configurations.

1. We need to create a directory storing the client-related files and two sub-directories for keys and generated configuration files.

```
$ mkdir -p ~/client-configs/{keys, files}
$ chmod -R 700 ~/client-configs
$ cp ~/EasyRSA-3.0.4/ta.key ~/client-configs/keys/
$ sudo cp /etc/openvpn/ca.crt ~/client-configs/keys/
```

2. Start with the provided starter configuration by copying the file.

```
$ cp
/usr/share/doc/openvpn/examples/sample-config-files/client.conf
~/client-configs/
```

- 3. Update the ~/client-configs/client.conf with the following instructions.
 - update the line containing remote my-server-1 1194 to be of the form remote YOUR_SERVER_IP 443 to update the port and use the public IP address of the VPN Server
 - Change the protocol from proto udp by adding a; at the start of this line and remove the; from the line containing proto tcp
 - Comment out the lines containing ca ca.crt, cert client.crt, key client.key by adding a # before these lines
 - Make sure the line containing cipher AES-256-CBC is not commented by removing the; if it exists
 - Directly under this line add a line containing auth SHA256
 - Add the line key-direction 1 in the file as well
- 4. Create a new file ~/client-configs/generate_config.sh in a text editor and write the following script.

```
#!/bin/bash
# First argument: Client identifier
```

5. Save the file and run the following command to grant execution permission.

```
$ chmod 700 ~/client-configs/generate_config.sh
```

Step 8. Create Client Certificate and Private Key Configuration

1. Navigate to the EasyRSA directory on your VPN server and generate a new private key and a certificate request file for the client

```
$ cd ~/EasyRSA-3.0.4/
$ ./easyrsa gen-req client1 nopass
```

2. Copy the private key to the correct directory

```
cp ~/EasyRSA-3.0.4/pki/private/client1.key
~/openvpn-clients/files/
```

3. Transfer certificate request to your CA machine

```
$ scp ~/EasyRSA-3.0.4/pki/reqs/client1.req
your_ca_user@your_ca_ip:/tmp
```

4. Login to your CA machine, switch to the EasyRSA directory and import the certificate request file

```
$ cd ~/EasyRSA-3.0.4
$ ./easyrsa import-req /tmp/client1.req client1
```

5. Sign the request

```
./easyrsa sign-req client client1
```

6. Transfer the signed request back to your VPN server

```
$ scp ~/EasyRSA-3.0.4/pki/issued/client1.crt
your_server_user@your_server_ip:/tmp
```

7. Login to your VPN server and complete configuration

```
$ cp /tmp/client1.crt ~/openvpn-clients/files
$ cd ~/openvpn-clients
$ ./gen_config.sh client1
```

8. Transfer the config file to your local machine via scp (there are other ways to transfer the file but scp is used for linux machines)

\$ scp ~/client-configs/files/client1.ovpn
your_user@your_local_ip:~

Step 9. Connect Clients

Linux - Ubuntu

1. Install OpenVPN on Ubuntu and Debian

```
$ sudo apt update
$ sudo apt install openvpn
```

2. Run OpenVPN

```
$ sudo openvpn --config client1.ovpn
```

macOS

- 1. Install the free open-source graphical user interface <u>Tunnelblick</u> for OpenVPN on macOS
- 2. Double click on the .ovpn file and let the profile install
- 3. Connect to the intended client through the app to start the VPN connection.

Windows

- 1. Download and install the latest build of OpenVPN application the OpenVPN's Downloads page.
- 2. Copy the .ovpn file to the OpenVPN config folder (\Users\<Name>\OpenVPN\Config or \Program Files\OpenVPN\config).
- 3. Launch the OpenVPN application.
- 4. Right click on the OpenVPN system tray icon and the name of OpenVPN configuration file you copied will be listed on the menu. Click Connect.

Android & iOS

A VPN application developed by OpenVPN is available for both Android and iOS. Install the application and import the client .ovp file.

- Android OpenVPN Connect
- iOS OpenVPN Connect