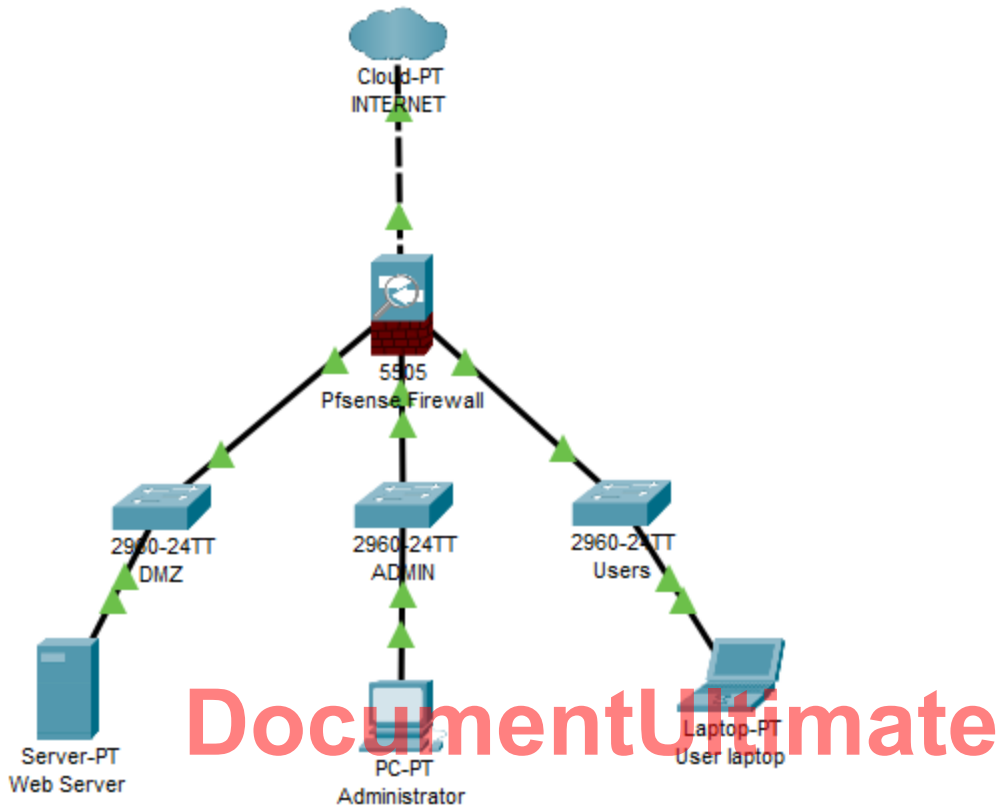
LAB 6 GUIDANCE

Contents

I. Requirement

1. Use your virtualization application to create the below network



2. In the DMZ, you have a Web server, it will serve on port 80, 443 and 22 (for SSH)

3. Use NAT on Pfsense firewall to expose the Web server to Internet. Your web server must be configured with static IP address.

4. Create some policies on Pfsense to restrict the traffic from Internet and LAN to protect your web server and data, as below description:

+ Allow traffic from Internet to access web server on port 443 only

+ Allow traffic from Users on LAN to access web server on port 443 and 80

+ Allow administrators access web server on port 443, 80, and 22

+ Deny any other port

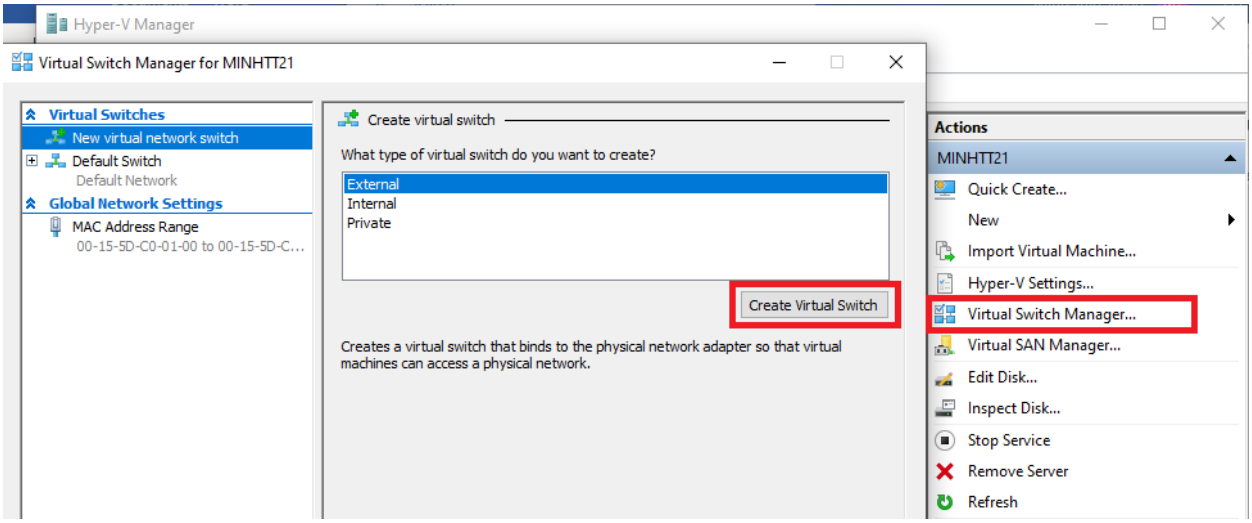
II. Preparing networks

We need 4 networks (4 switches):

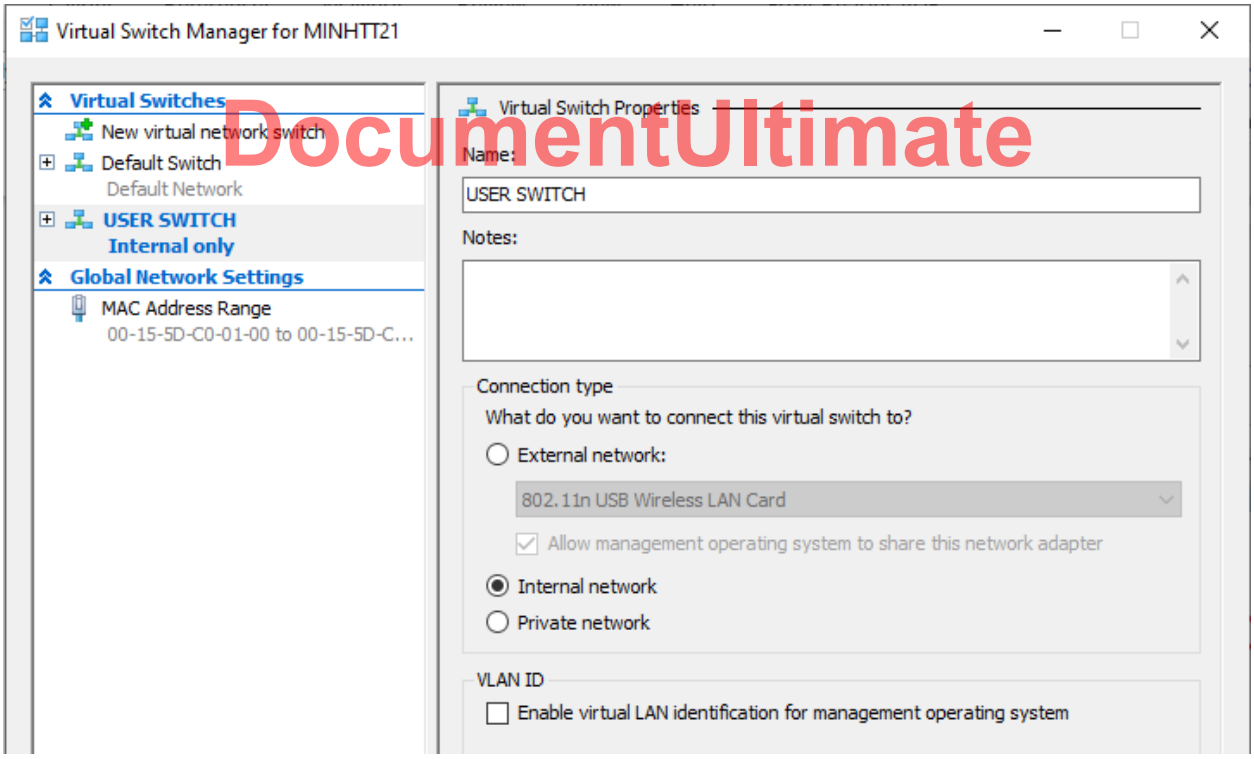
- 01 External network (or NAT network, or Default Switch): for connecting firewall to Internet
- 01 Internal network: for users' PC

- 02 Private network (host only network): for DMZ and ADMIN

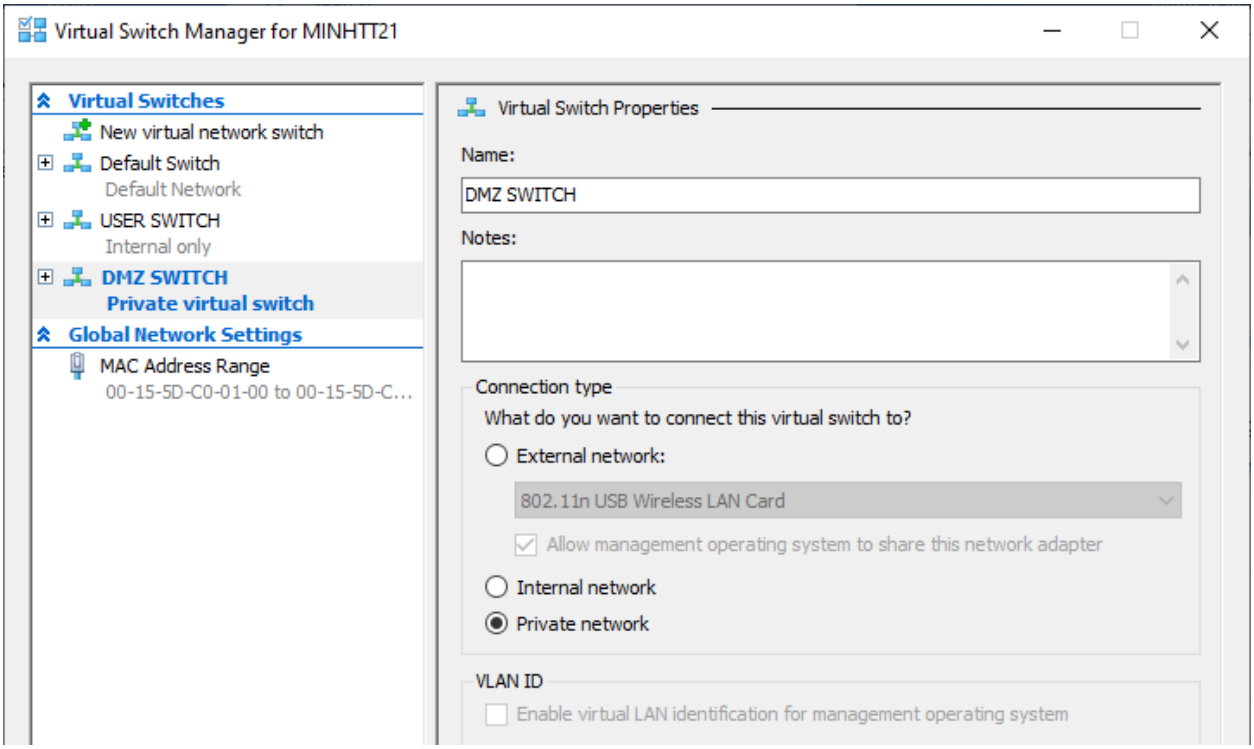
Go to Virtual Switch Manager to Create Virtual Switch



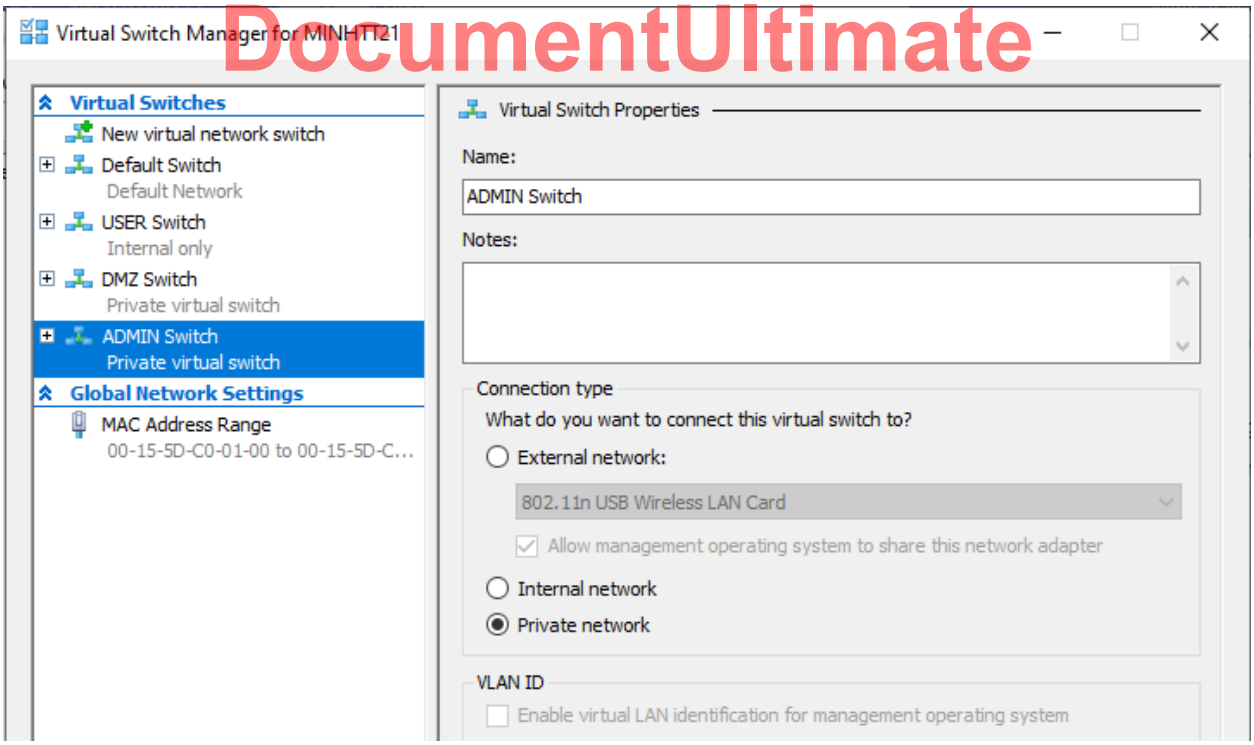
Create USER SWITCH



Create DMZ SWITCH

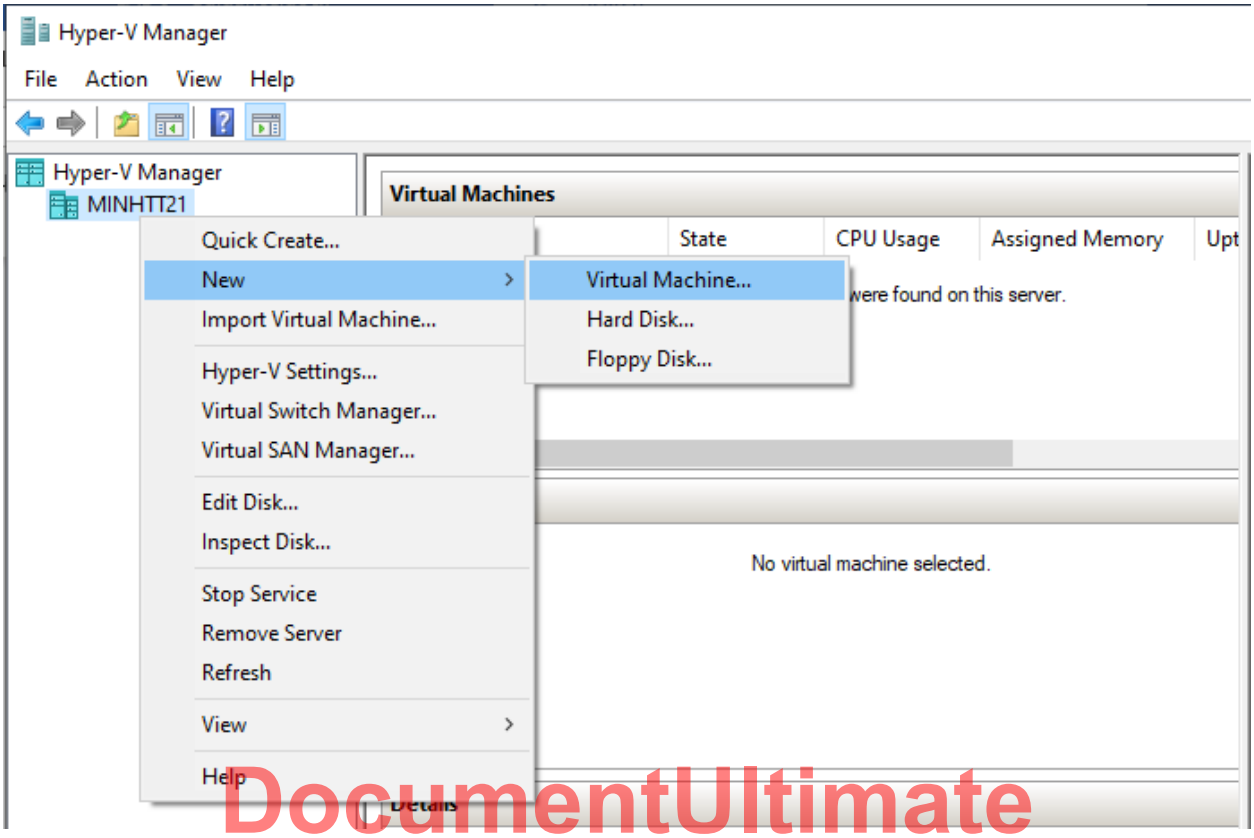


Create ADMIN Switch

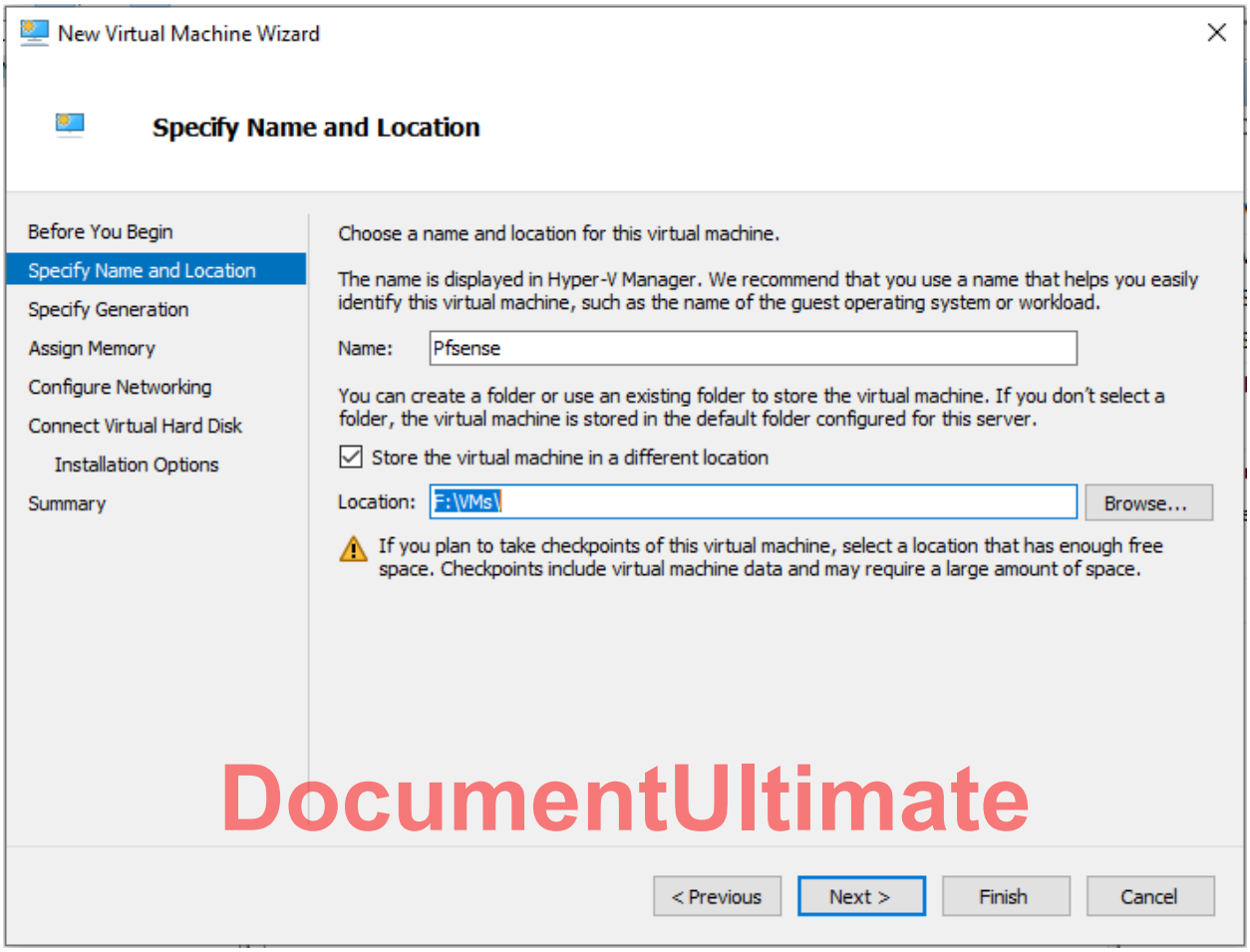


III. Create VMs

Right click at the Computer Name > New > Virtual Machine

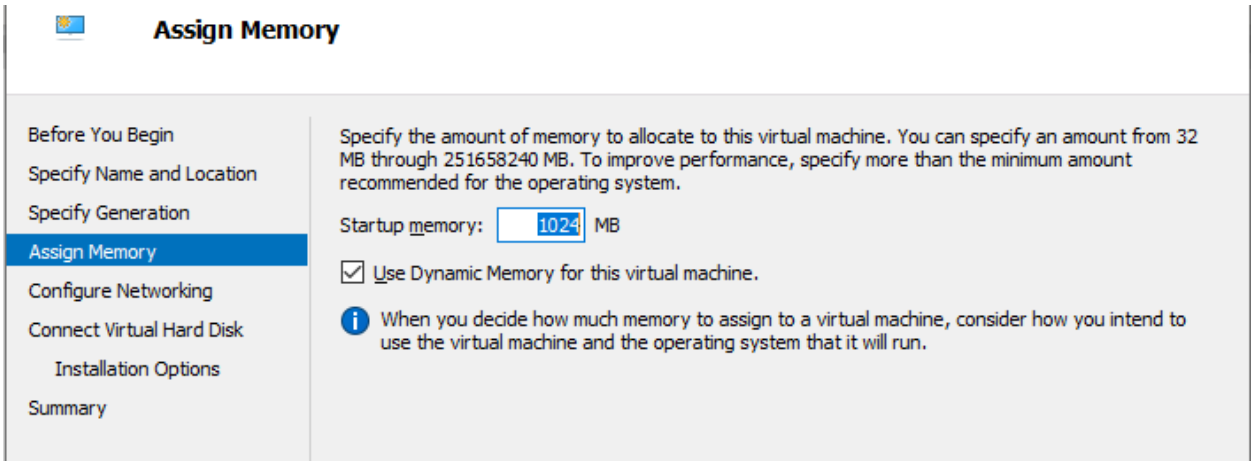


Create the VM for Pfsense firewall

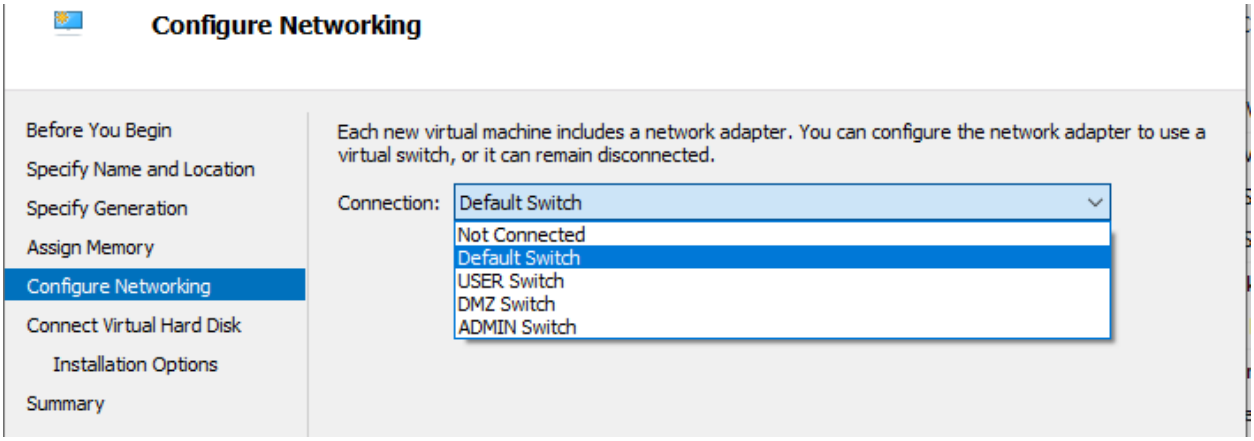


Click Next, then select **Generation 1**

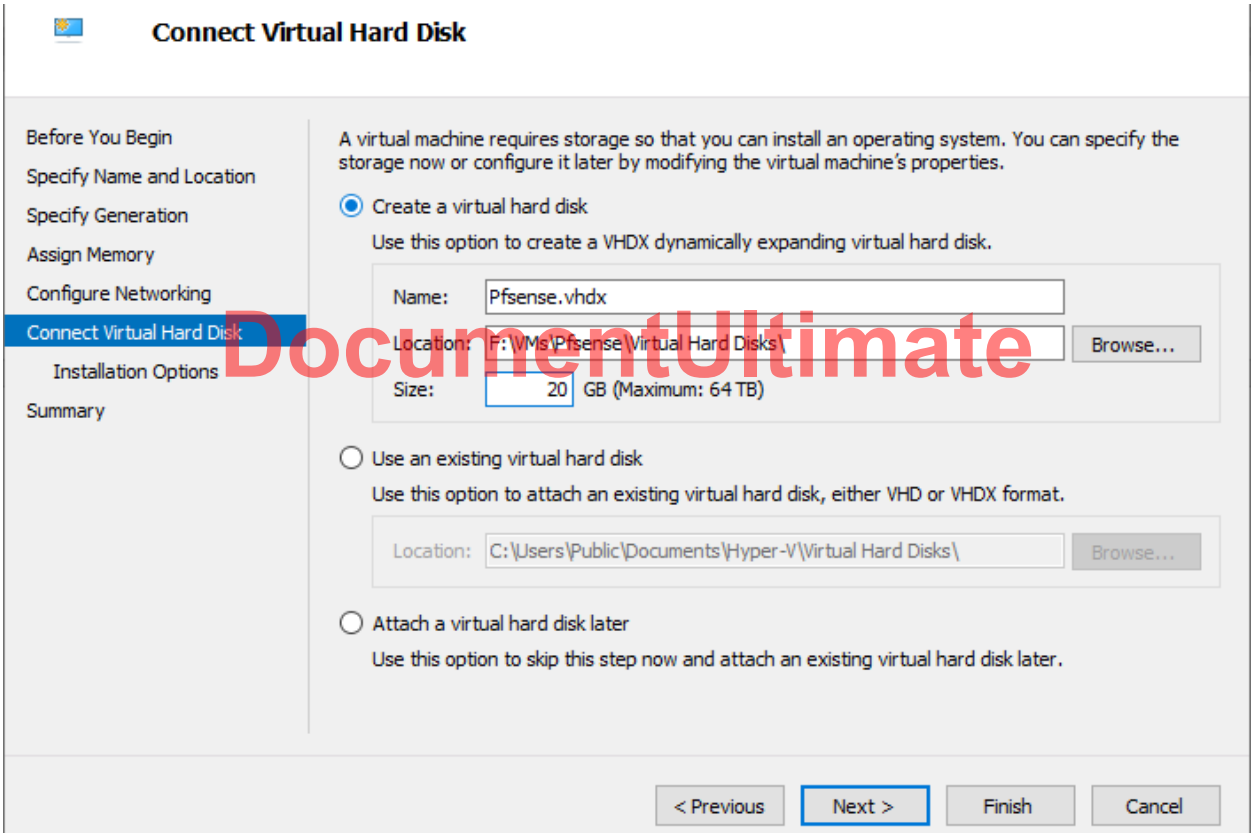
Pfsense firewall we can use minimum memory at 1024 MB (1 GB)



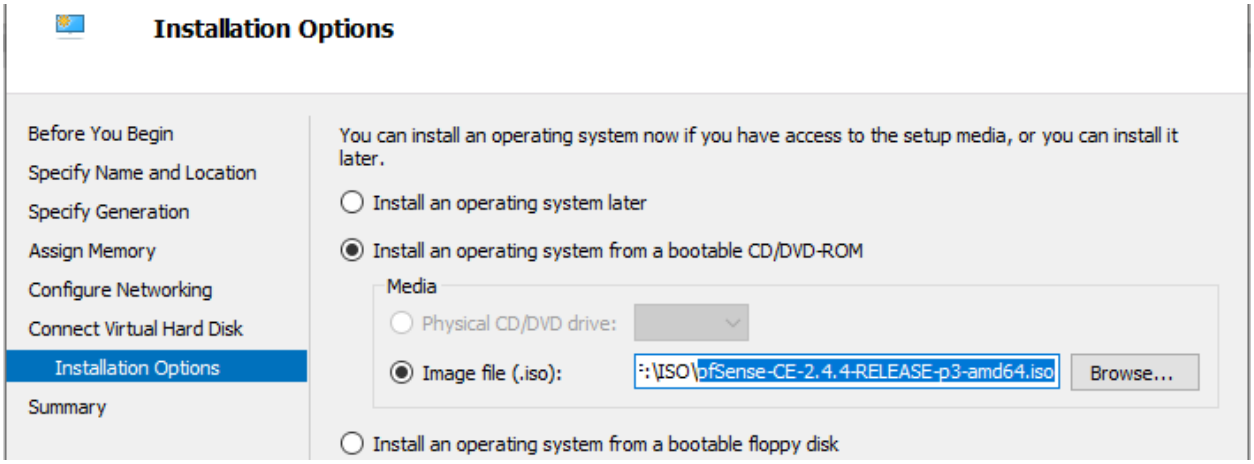
At Configure network window, you can select the Default switch



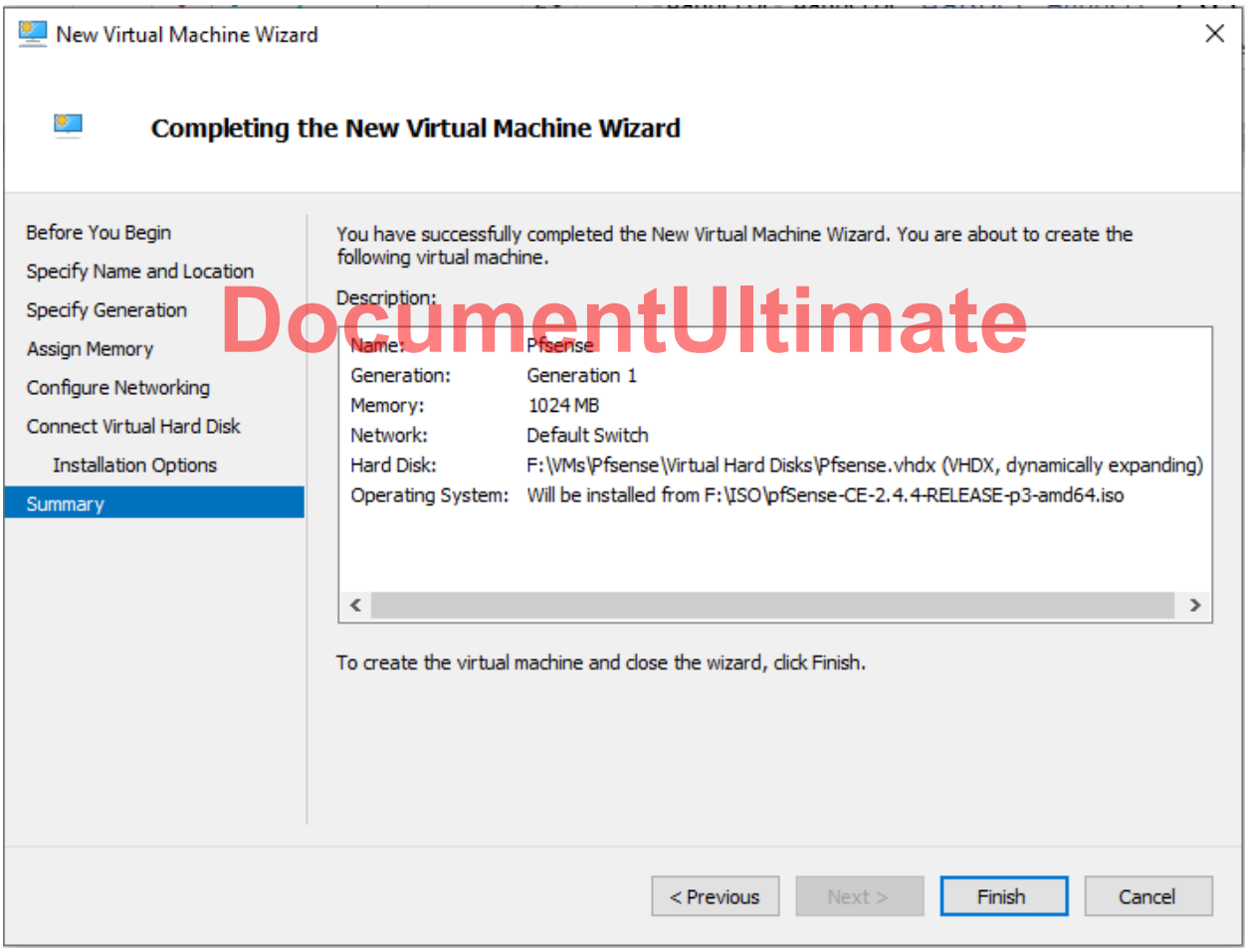
Create Virtual Hard Disk , Pfsense does not need large hard disk space, so we create a 20GB disk



At Installation Options windows, select the options as below

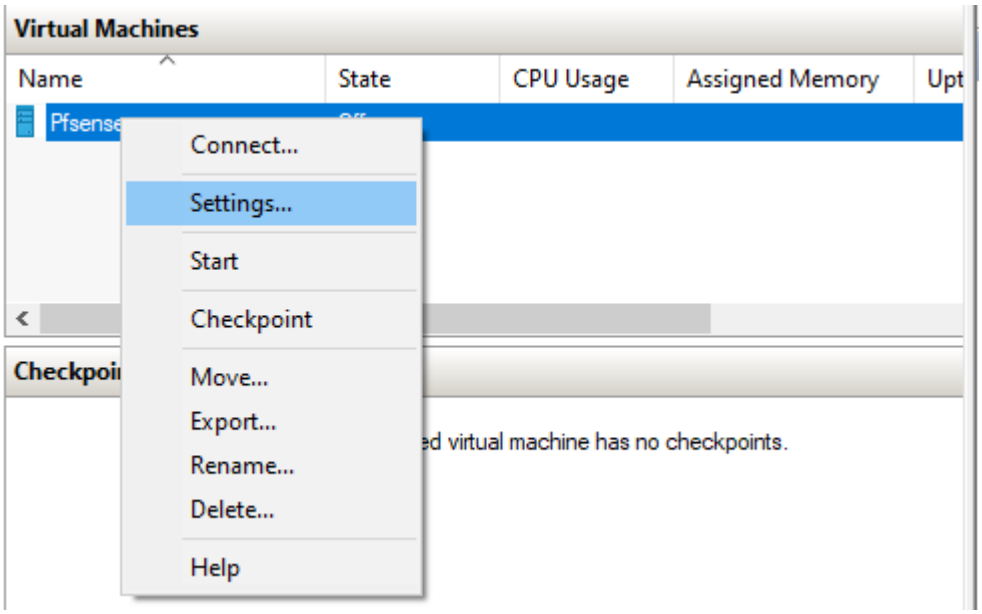


Finishing

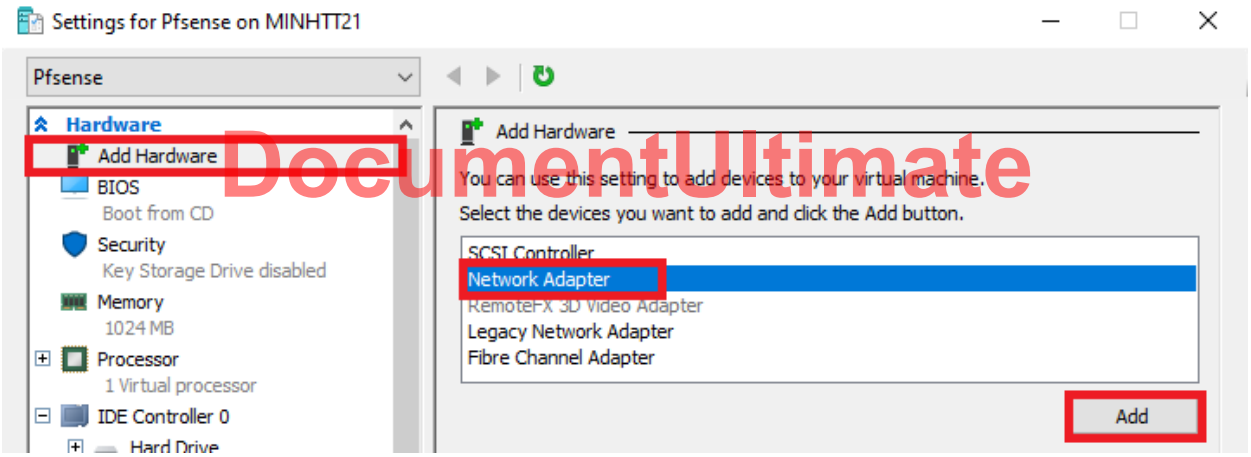


We need add more network interface (NIC) for Pfsense VM

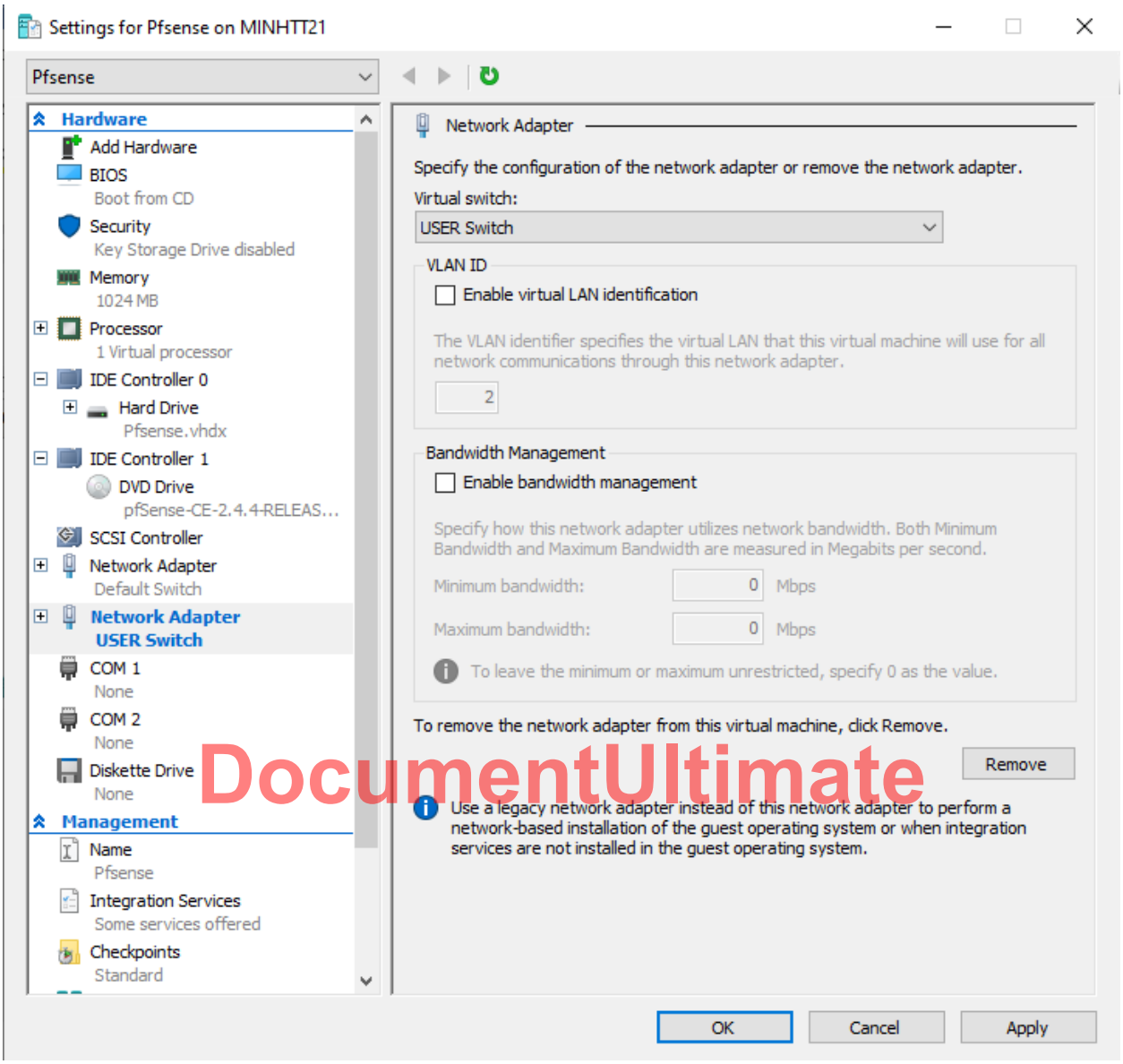
Go to Pfsense settings…



Click Add Hardware, select Network Adapter then Add button



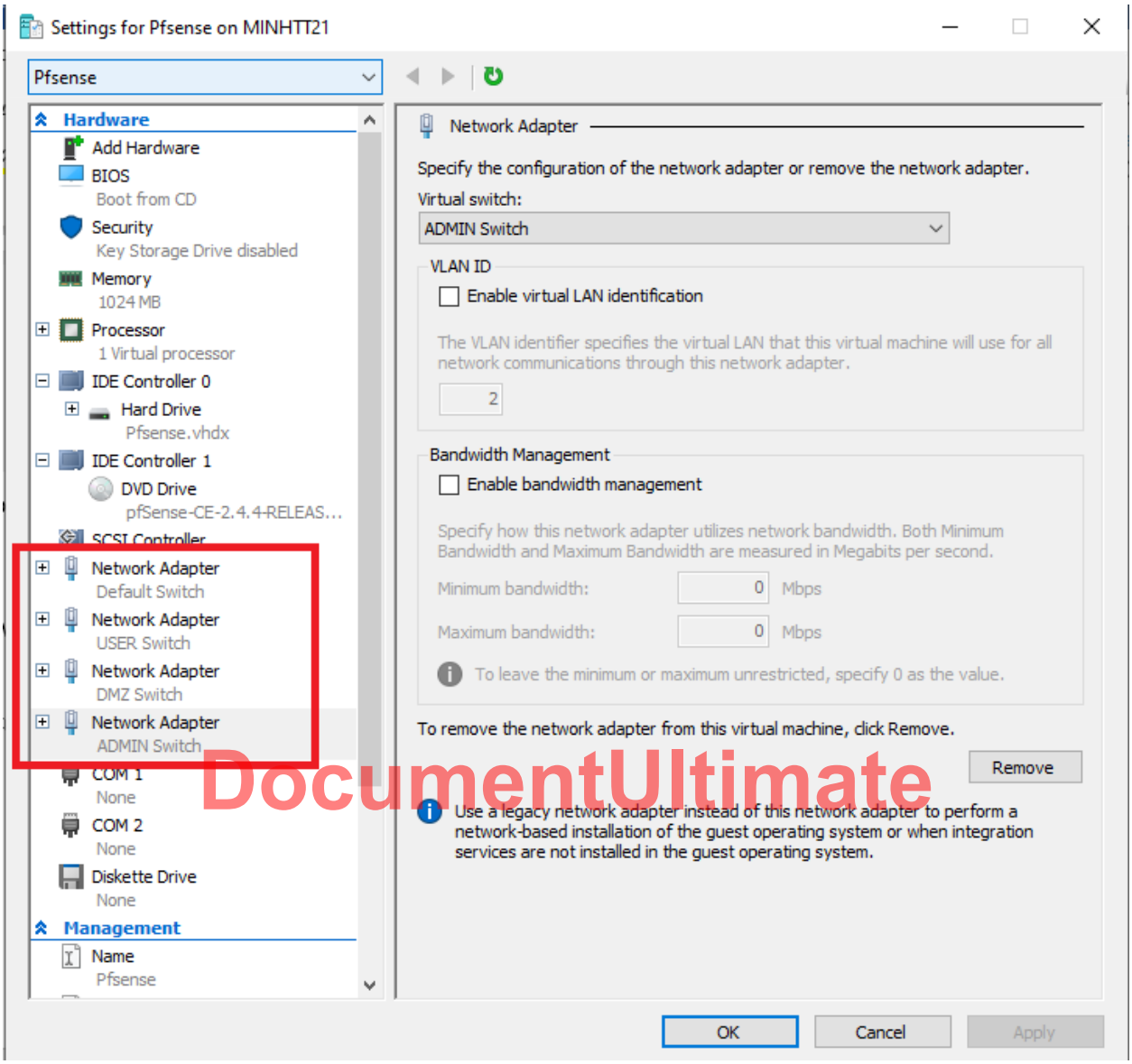
Select the USER Switch for 2nd Network



Do the same for

- DMZ Switch for 3rd Network
- ADMIN Switch for 4th Network

We got:



Create the VM for Web server

Do the same procedure of Pfsense creation, but with the below configuration

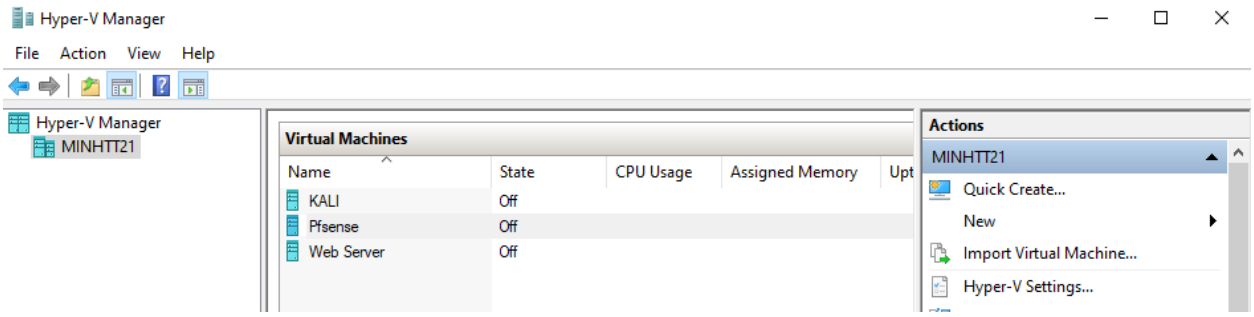
Memory for Web server: 2048 MB

Hard disk: 40 GB

Network: connect to DMZ Switch

Create the VM for ADMIN, the same as web server but this machine has a network connecting to ADMIN Switch

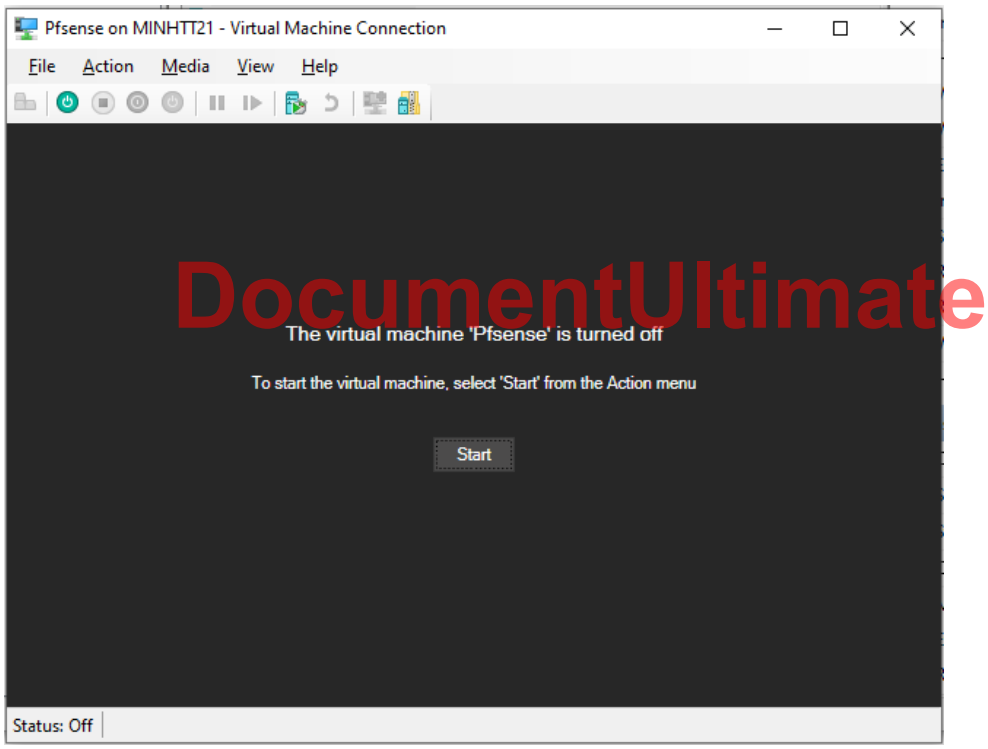
We got:



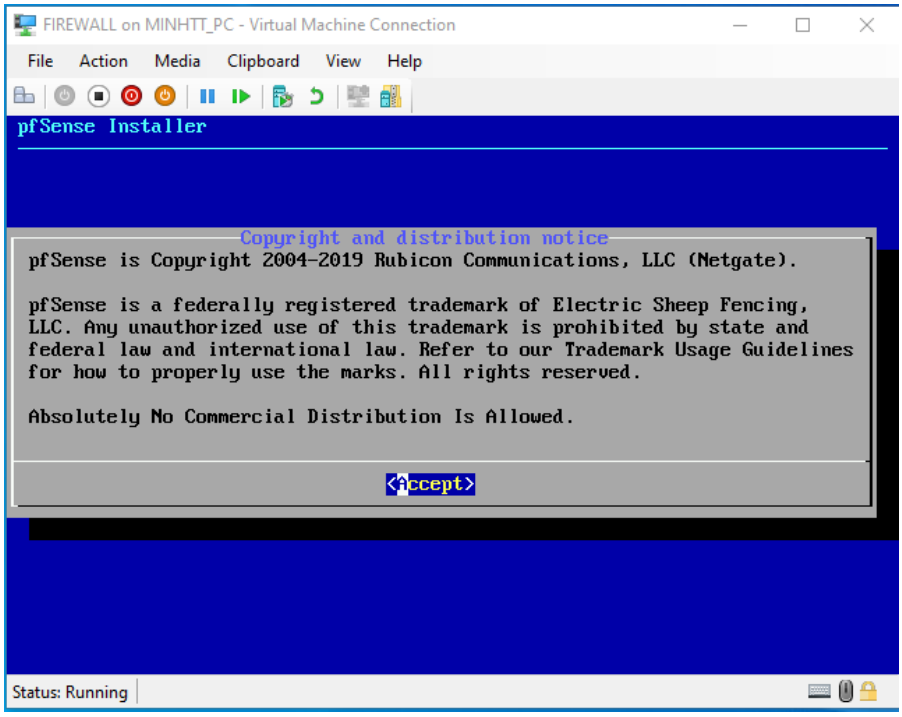
IV. Install OS

1. Install Pfsense

Connect to the Firewall monitor: Right click on Pfsense VM and select connect.

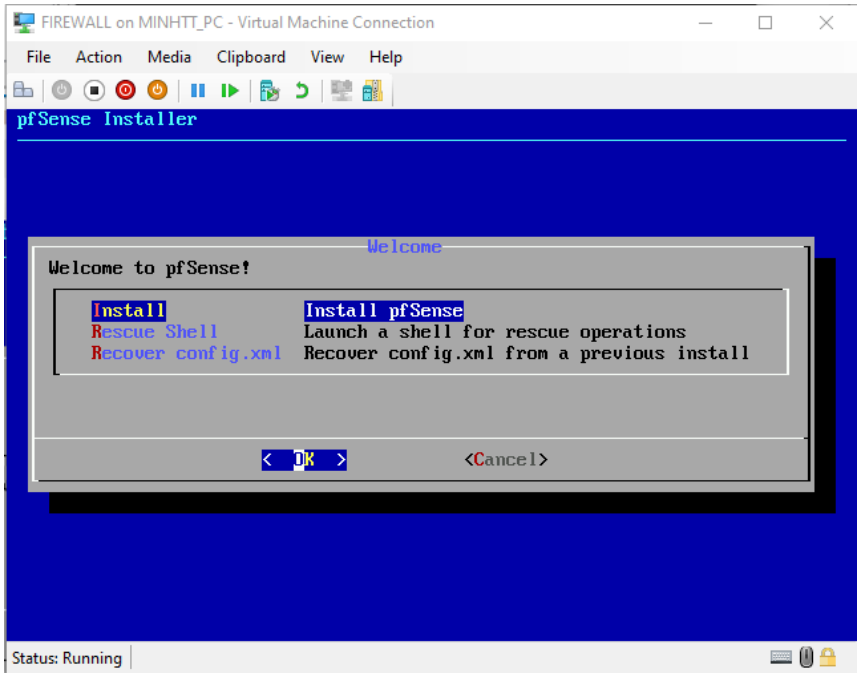


Click the Start button to Power on the Pfsense machine

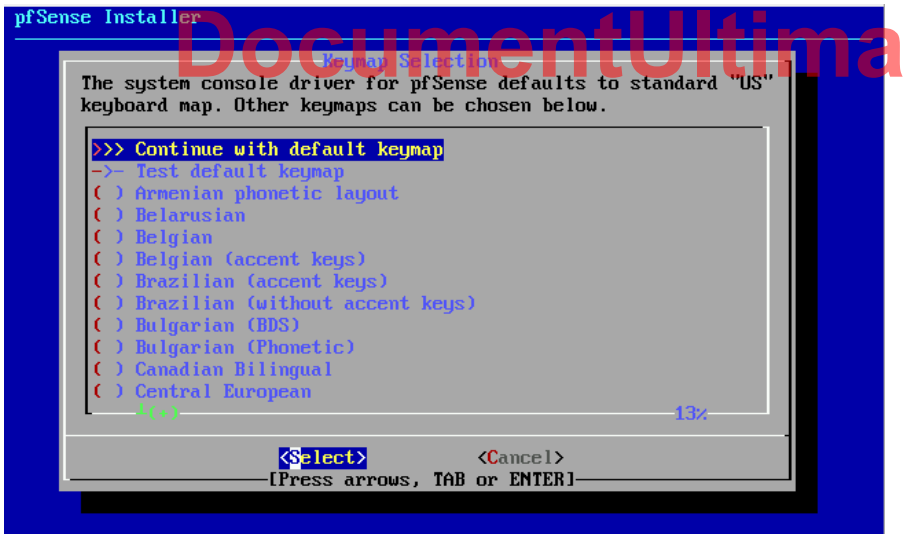


Press Enter for <Accept>

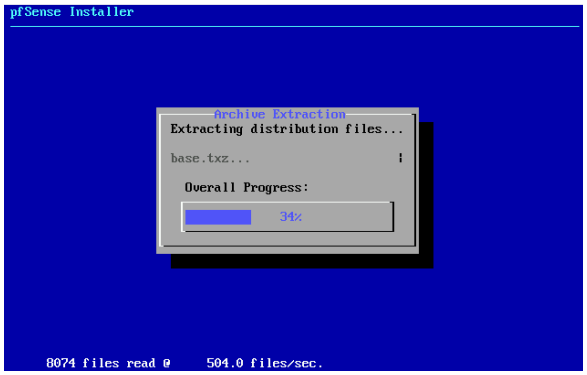
Then as below screen, press Enter for <OK> to install Pfsense on VM



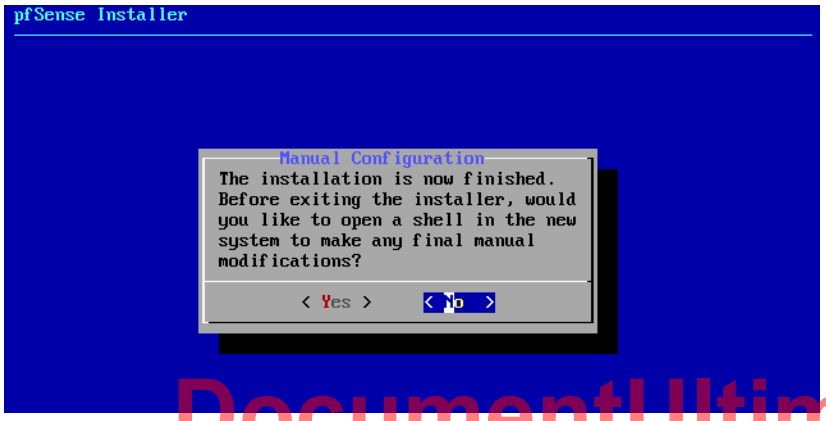
Press Enter for <Select> at “Continue with default keymap”



Press Enter for **Auto (UFS),** then Install will run

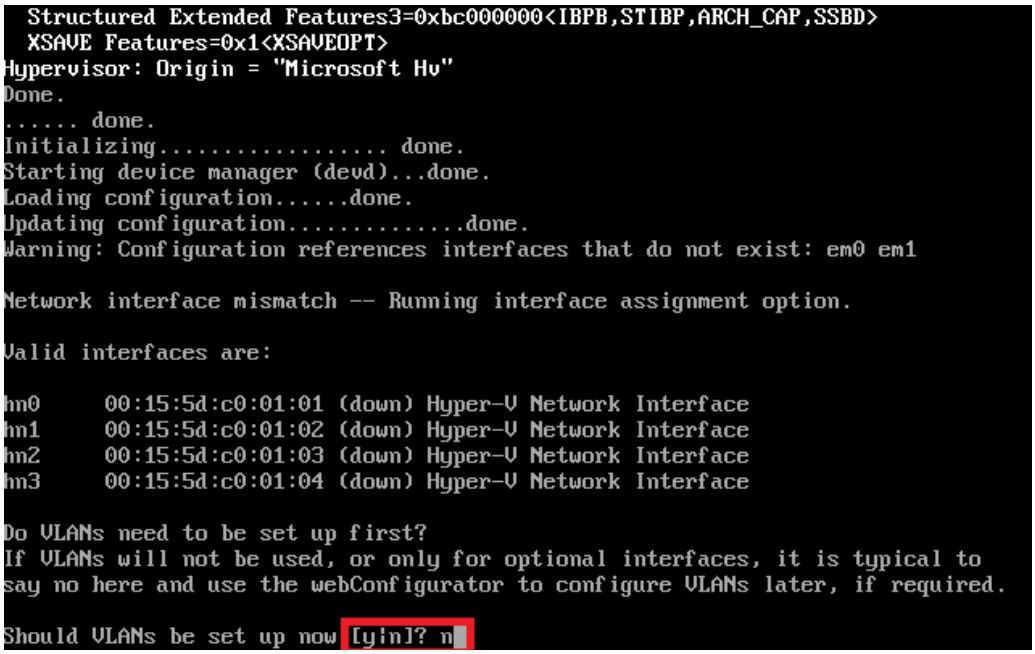


At this screen, select **NO**



At the last finishing screen, you should eject your ISO out of CDROM-Drive first, then select **Reboot**

After reboot, select NO (n) at VLAN setup requirement



Select the 1st Interface for WAN (hn0)

```
Should VLANs be set up now [y|n]? n

If the names of the interfaces are not known, auto-detection can
be used instead. To use auto-detection, please disconnect all
interfaces before pressing 'a' to begin the process.

Enter the WAN interface name or 'a' for auto-detection
(hn0 hn1 hn2 hn3 or a): hn0
```

The 2nd Interface for Users network (hn1)

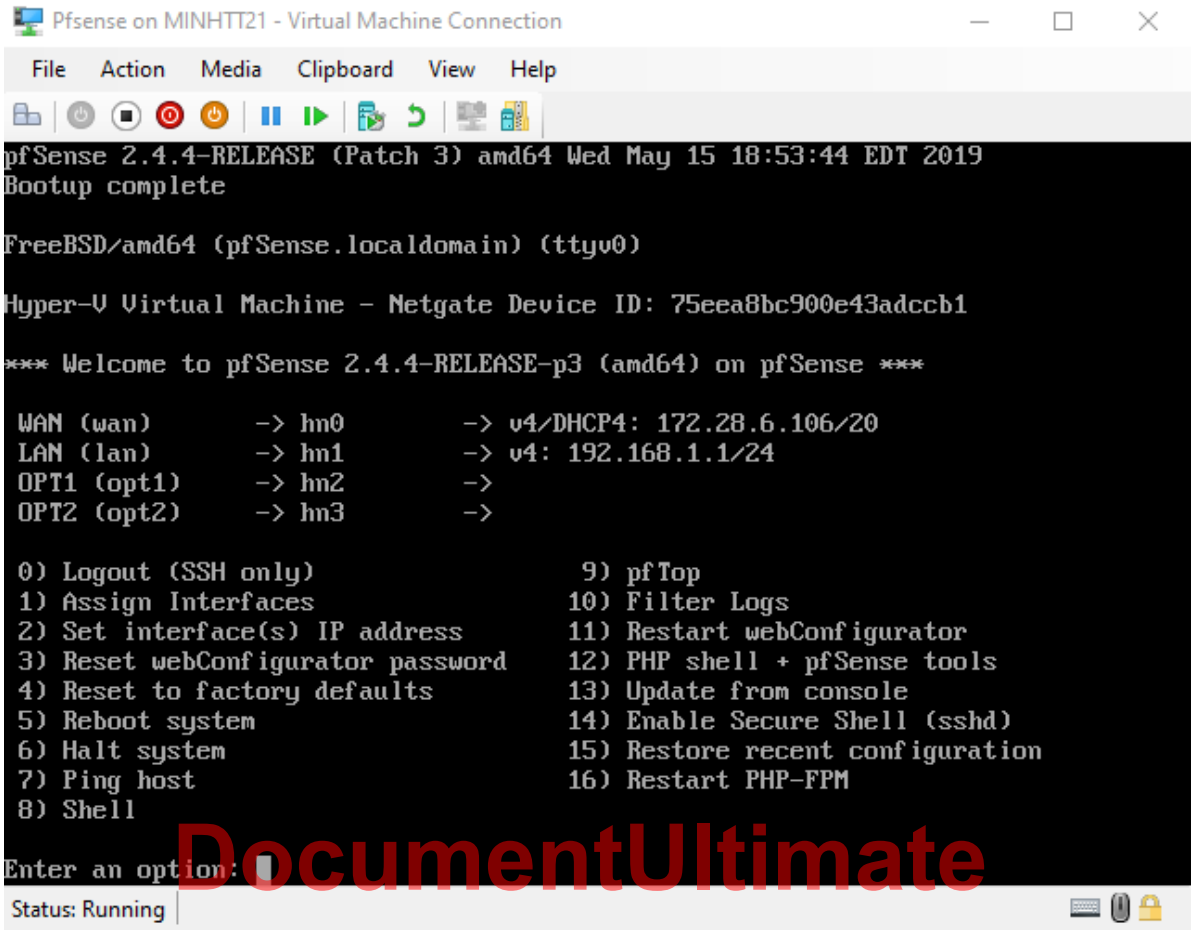
```
Enter the WAN interface name or 'a' for auto-detection
(hn0 hn1 hn2 hn3 or a): hn0

Enter the LAN interface name or 'a' for auto-detection
NOTE: this enables full Firewalling/NAT mode.
(hn1 hn2 hn3 a or nothing if finished): hn1
```

The 3rd Interface for DMZ (hn2) and the 4th Interface for Administrator network (hn3)

```
Enter the WAN interface name or 'a' for auto-detection
(hn0 hn1 hn2 hn3 or a): hn0

Enter the LAN interface name or 'a' for auto-detection
NOTE: this enables full Firewalling/NAT mode.
(hn1 hn2 hn3 a or nothing if finished): hn1

Enter the Optional 1 interface name or 'a' for auto-detection
(hn2 hn3 a or nothing if finished): hn2

Enter the Optional 2 interface name or 'a' for auto-detection
(hn3 a or nothing if finished): hn3
```


Remember that, we can change these interface assignment later!

After answer yes (y) at asking for processing, we get

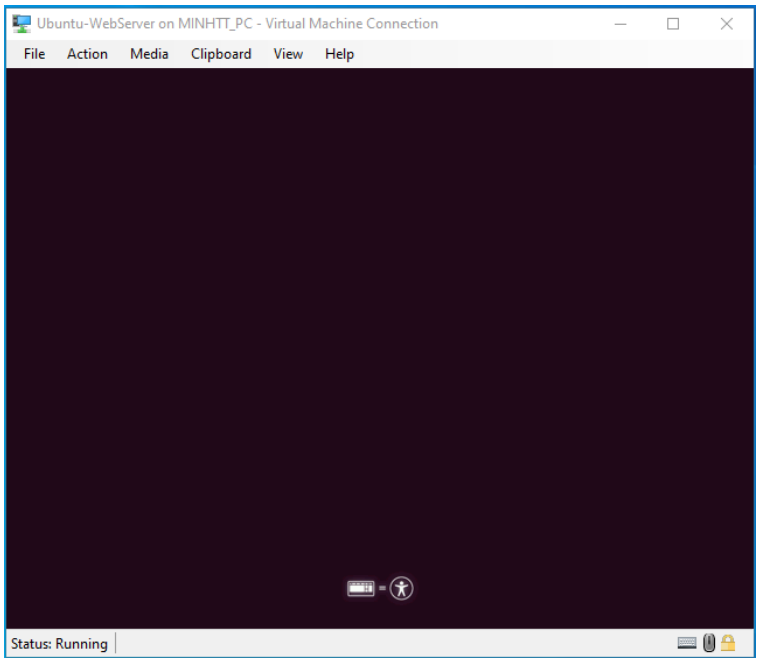


2. **Install Web server**

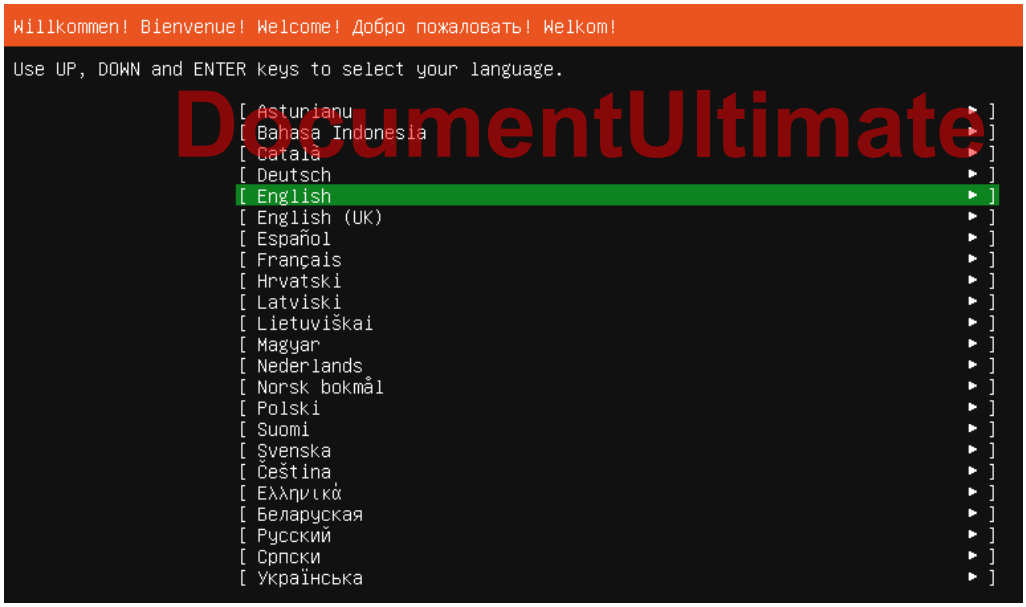
   We can use any kind of OS to create a web server in the DMZ.

   At this guidance, we will use the Ubuntu 20.04.

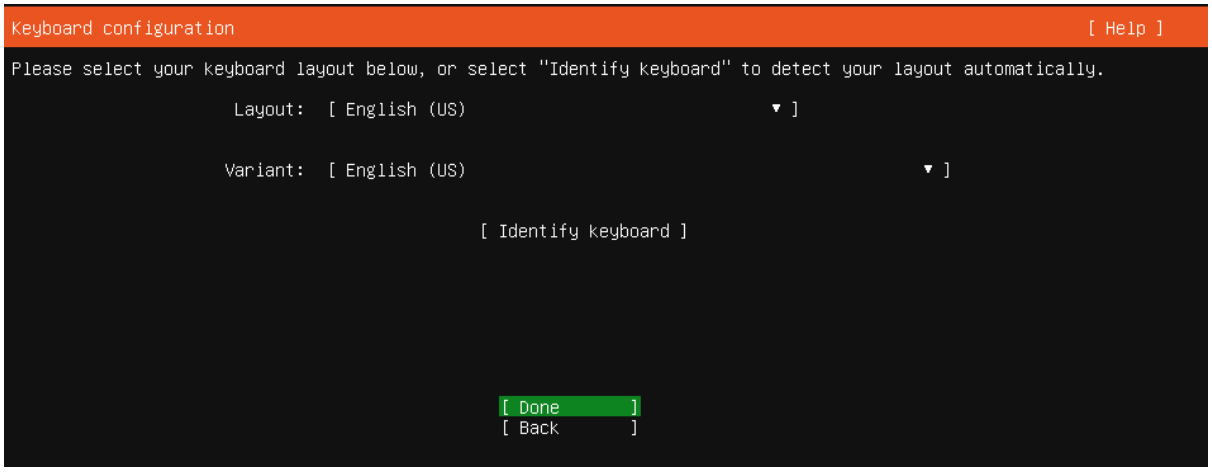
   Start your machine



At the language selection, we should use the English, then press Enter

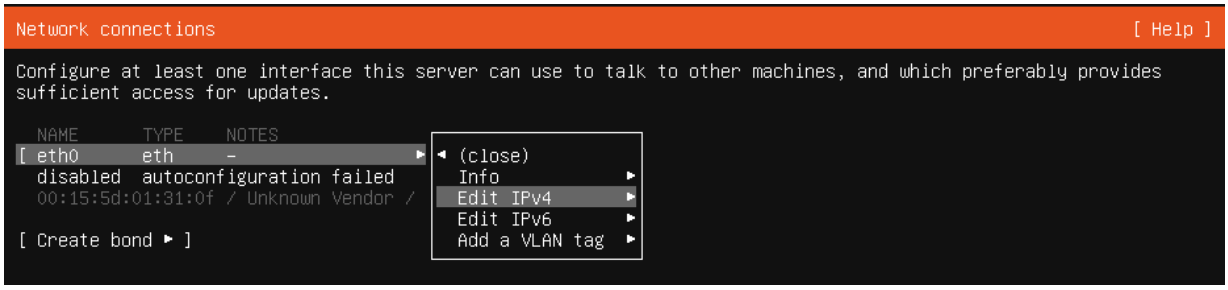


At the keyboard configuration, also use English (US) key type and Done

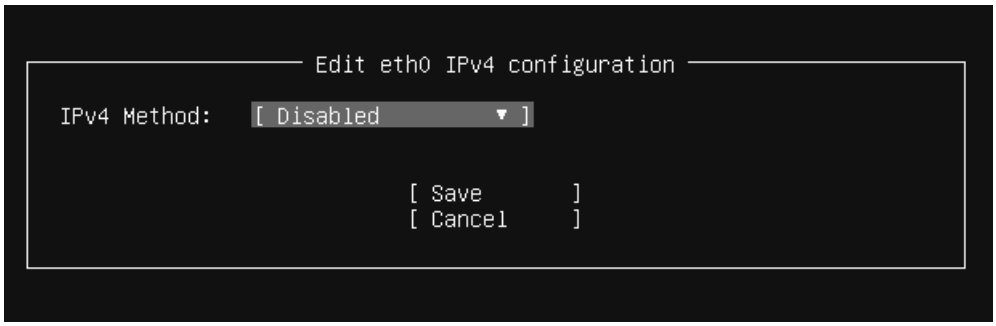


At the Network Configuration, use the up/down arrow keys to move the pointer to your network interface as below

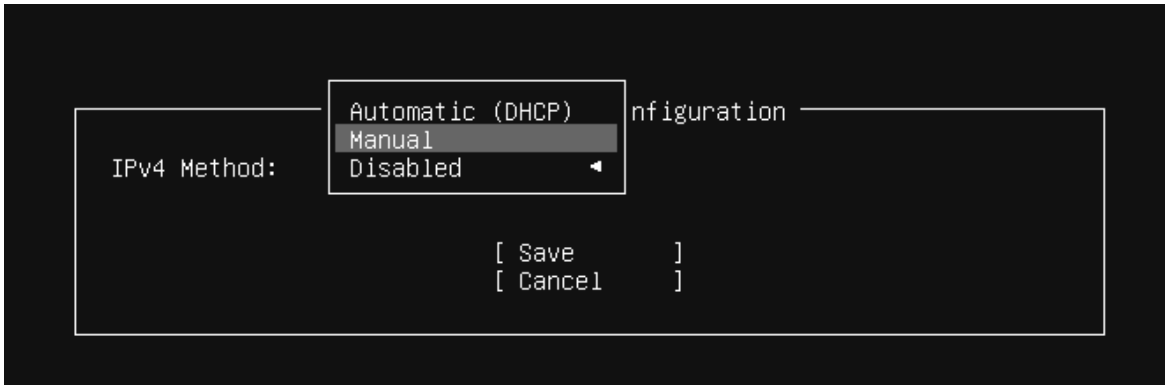
Press Enter, select **Edit IPv4**



Press Enter at Edit IPv4, we have the edit screen



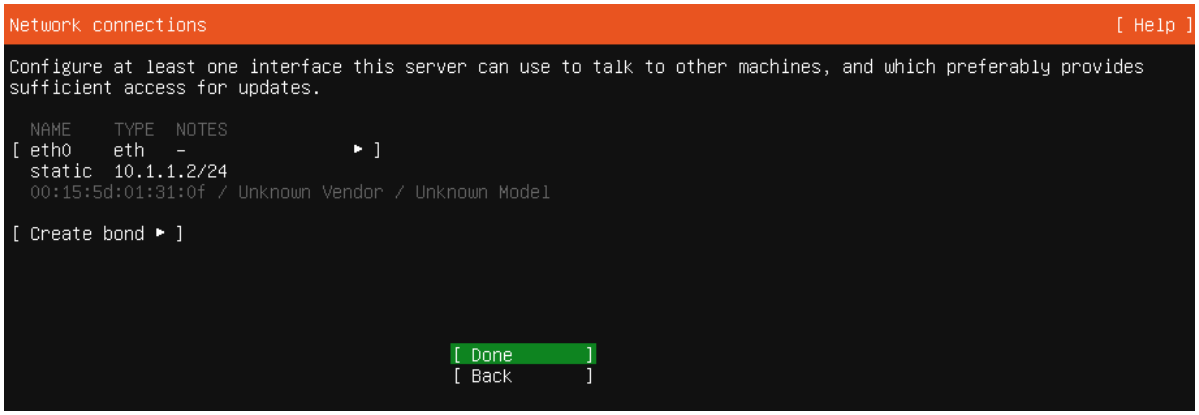
At IPv4 Method, press Enter then select the **Manual**



We will set static IP for this web server

Move the pointer to Save and press Enter.

We get the below screen



Move the pointer to Done then press Enter

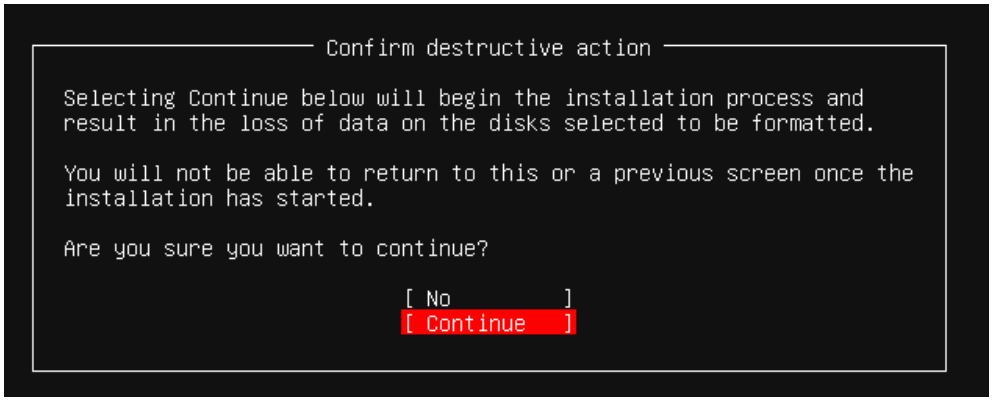
Continue press Enter at the Configure Proxy and Configure Ubuntu Archive Mirror screen.
We use the default setting at these screen.
At the Guided Storage Configuration, we also use the default setting as below

```
Guided storage configuration

Configure a guided storage layout, or create a custom one:

(X)  Use an entire disk

     [ 3600224806d35e23bd67c210eab1b5864 local disk 40.000G ▼ ]

     [X]  Set up this disk as an LVM group

          [ ]  Encrypt the LVM group with LUKS

                       Passphrase:

                 Confirm passphrase:

( )  Custom storage layout
```

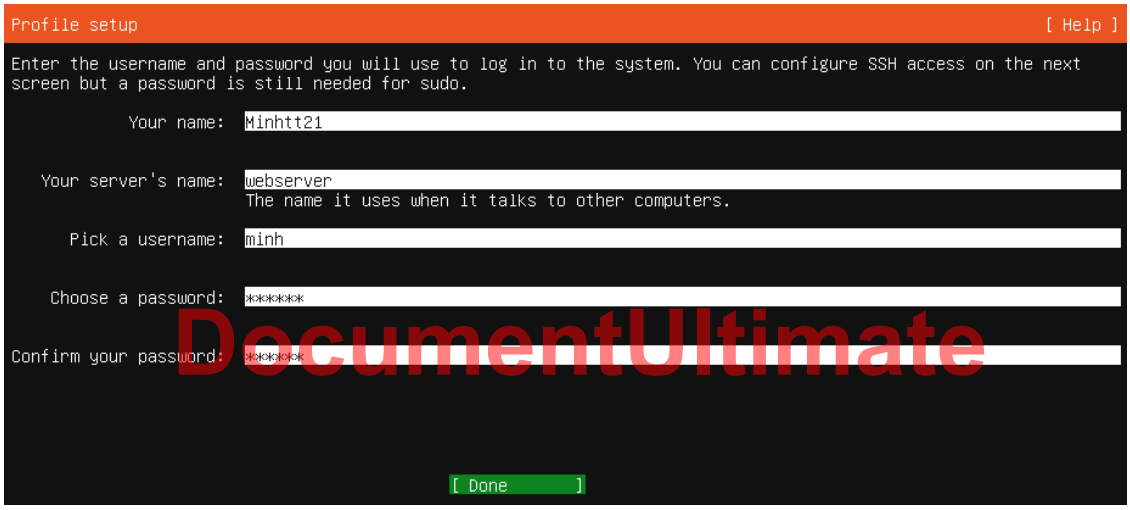
Move your pointer to Done and press Enter
Next screen, review your partitions and just Done

```
Storage configuration

FILE SYSTEM SUMMARY

  MOUNT POINT     SIZE    TYPE      DEVICE TYPE
[ /              20.000G  new ext4  new LVM logical volume      ► ]
[ /boot           1.000G  new ext4  new partition of local disk ► ]


AVAILABLE DEVICES

  DEVICE                                      TYPE                 SIZE
[ ubuntu-vg (new)                             LVM volume group    38.996G  ► ]
  free space                                                        18.996G

[ Create software RAID (md) ► ]
[ Create volume group (LVM) ► ]


USED DEVICES

  DEVICE                                      TYPE                 SIZE
[ ubuntu-vg (new)                             LVM volume group    38.996G  ► ]
  ubuntu-lv    new, to be formatted as ext4, mounted at /        20.000G  ►

[ 3600224806d35e23bd67c210eab1b5864           local disk          40.000G  ► ]
  partition 1  new, bios_grub                                      1.000M  ►
  partition 2  new, to be formatted as ext4, mounted at /boot      1.000G  ►
  partition 3  new, PV of LVM volume group ubuntu-vg              38.997G  ►


                         [ Done       ]
                         [ Reset      ]
                         [ Back       ]
```

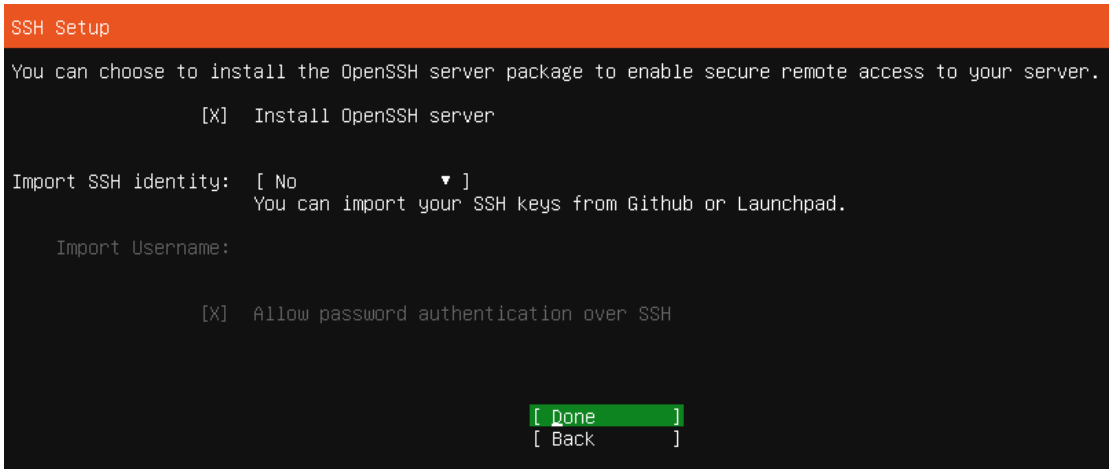
At confirmation screen, move the pointer to Continue and press Enter



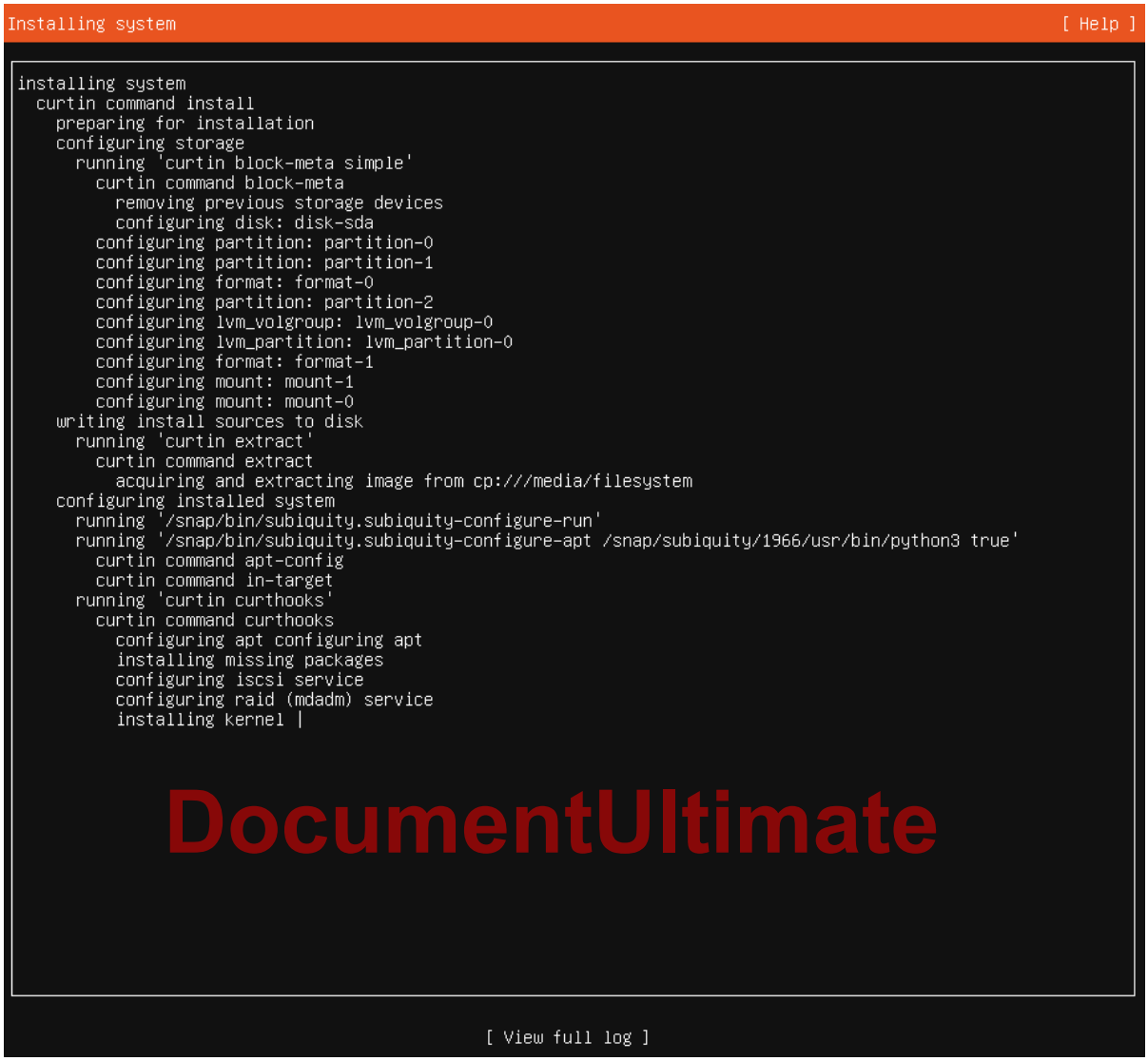
Setting your name, username and password then Done



At SSH setup screen, move the pointer to Install SSH Server option, use Space key to select (tick) this option. Then Done.



System will be installed. Just wait until it finishes.



Complete and reboot

```
Installation complete!                                                    [ Help ]

                                   Finished install!
          removing previous storage devices
          configuring disk: disk-sda
        configuring partition: partition-0
        configuring partition: partition-1
        configuring format: format-0
        configuring partition: partition-2
        configuring lvm_volgroup: lvm_volgroup-0
        configuring lvm_partition: lvm_partition-0
        configuring format: format-1
        configuring mount: mount-1
        configuring mount: mount-0
    writing install sources to disk
      running 'curtin extract'
        curtin command extract
          acquiring and extracting image from cp:///media/filesystem
    configuring installed system
      running '/snap/bin/subiquity.subiquity-configure-run'
      running '/snap/bin/subiquity.subiquity-configure-apt /snap/subiquity/1966/usr/bin/python3 true'
        curtin command apt-config
        curtin command in-target
      running 'curtin curthooks'
        curtin command curthooks
          configuring apt configuring apt
          installing missing packages
          configuring iscsi service
          configuring raid (mdadm) service
          installing kernel
          setting up swap
          apply networking config
          writing etc/fstab
          configuring multipath
          updating packages on target system
          configuring pollinate user-agent on target
          updating initramfs configuration
          configuring target system bootloader
          installing grub to target devices
    finalizing installation
      running 'curtin hook'
        curtin command hook
    executing late commands
final system configuration
  configuring cloud-init
  installing openssh-server
  restoring apt configuration
downloading and installing security updates

                                   [ View full log ]
                                   [ Reboot        ]
```


Login after reboot

```
Ubuntu 20.04.1 LTS webserver tty1

webserver login: minh
Password: _
```

```
Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

minh@webserver:~$
minh@webserver:~$
minh@webserver:~$ _
```

Check IP address of web server

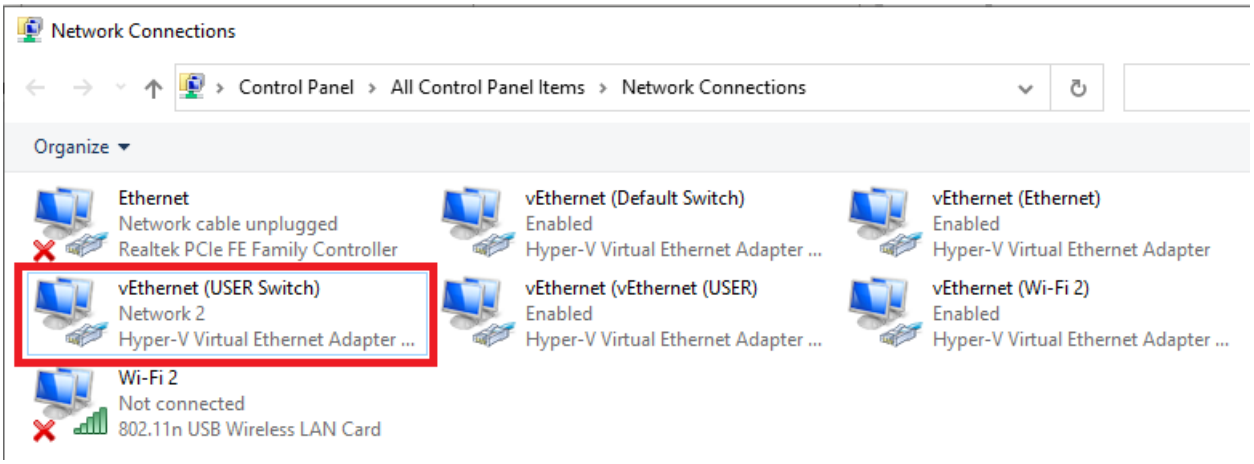
```
minh@webserver:~$
minh@webserver:~$
minh@webserver:~$ ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000
    link/ether 00:15:5d:01:31:0f brd ff:ff:ff:ff:ff:ff
    inet 10.1.1.2/24 brd 10.1.1.255 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::215:5dff:fe01:310f/64 scope link
       valid_lft forever preferred_lft forever
minh@webserver:~$
```

Test ping to gateway of DMZ

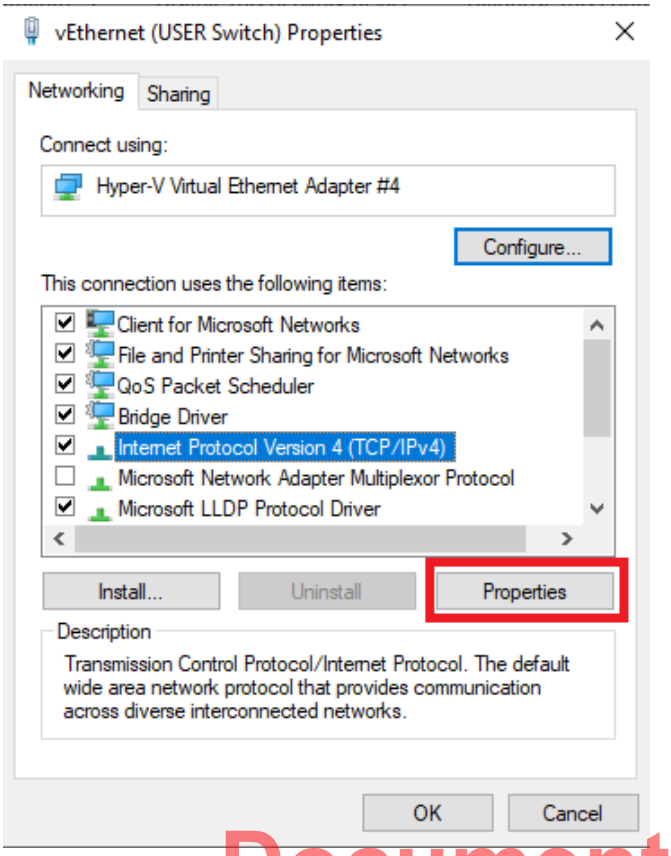
3. **Install Kali Linux for Administrator's PC**

V. Configure the Pfsense firewall

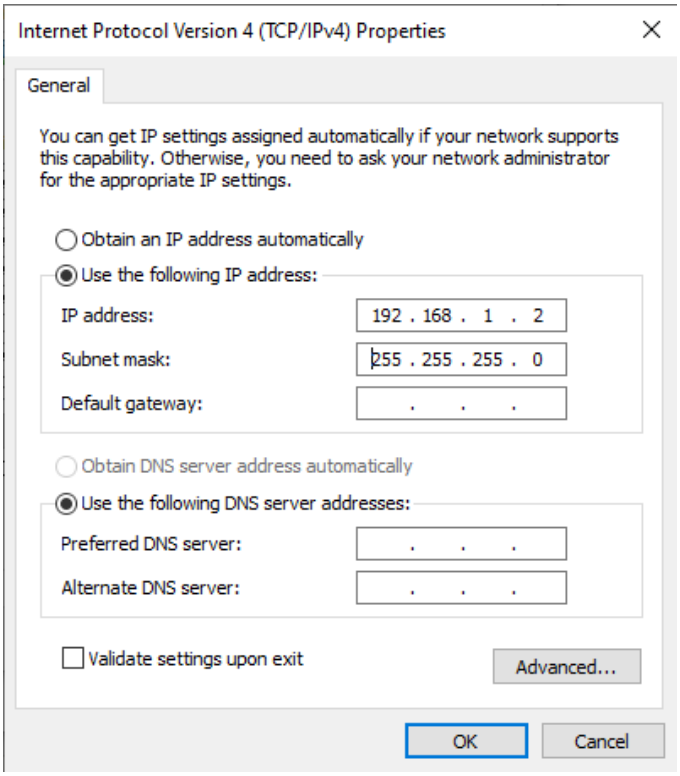
1. Setting the virtual interface on your REAL computer (laptop) that connecting to USER Switch



Right click an select Properties



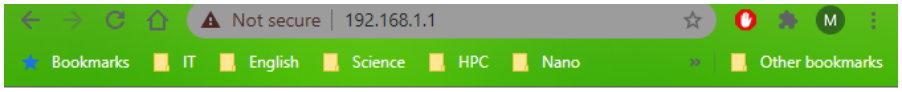
Set the static IP in the same subnet of LAN Network on Pfsense. You can change the LAN IP address later.

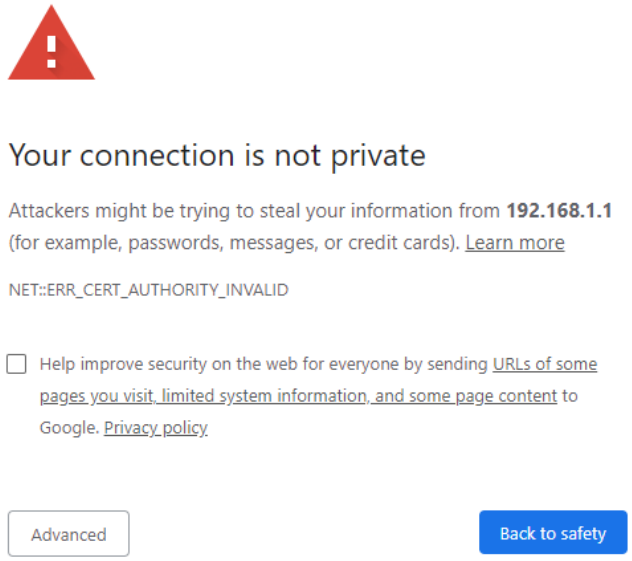


Make sure you can reach the the LAN interface by the ping command on your real computer (laptop).

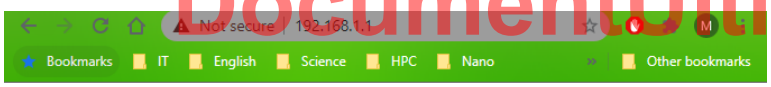

```
C:\Users\minht>ping 192.168.1.1

Pinging 192.168.1.1 with 32 bytes of data:
Reply from 192.168.1.1: bytes=32 time<1ms TTL=64
Reply from 192.168.1.1: bytes=32 time<1ms TTL=64
Reply from 192.168.1.1: bytes=32 time<1ms TTL=64
Reply from 192.168.1.1: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

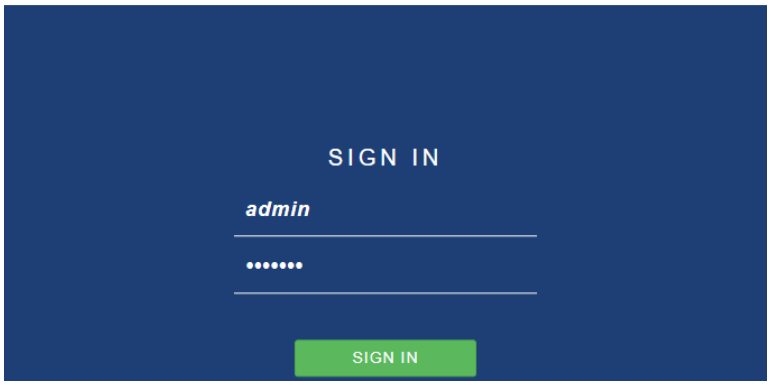
2. Use your browser to open the Pfsense web console (use the LAN IP 192.168.1.1 for the URL)



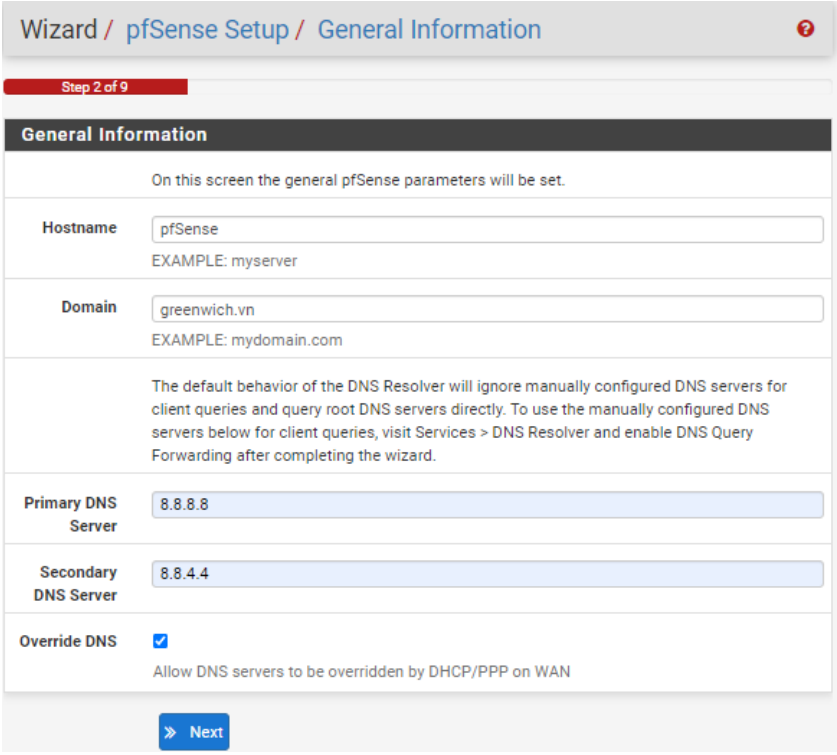


Because we have no certificate for the HTTPS on this page, so don't worry, just click **Advanced** and then **Proceed**.



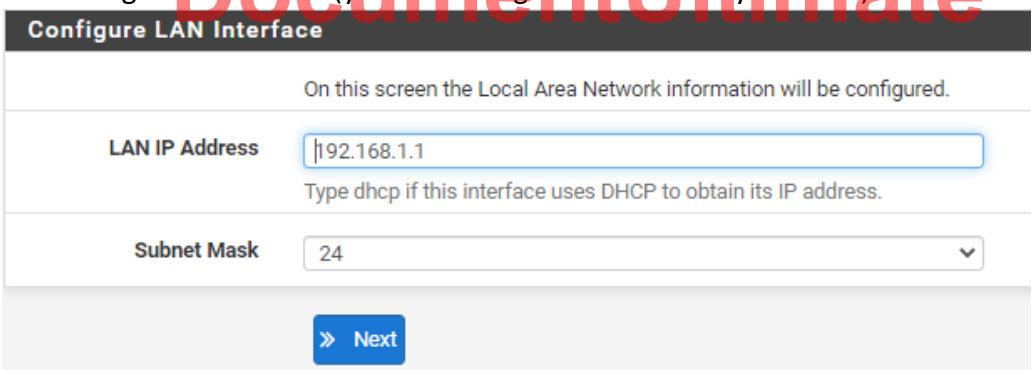


3. Login your Pfsense with admin/pfsense for username/password
   You can follow the Wizard to configure your firewall
   Or you just ignore the wizard and go to the menu bar on the top to configure the Pfsense.
   Below is the wizard steps
   Next and then fill some information

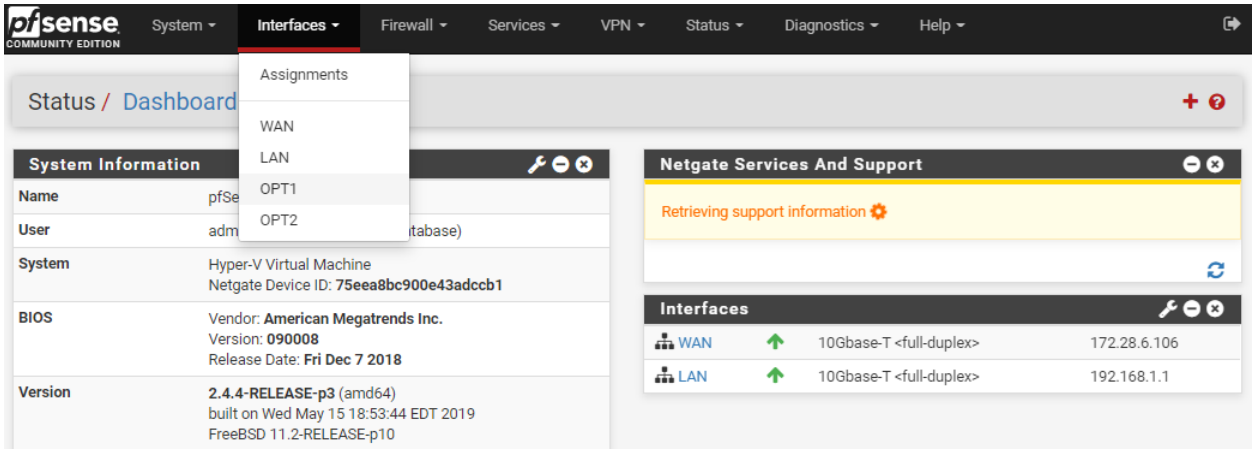


Next at the WAN configuration (use the default setting)

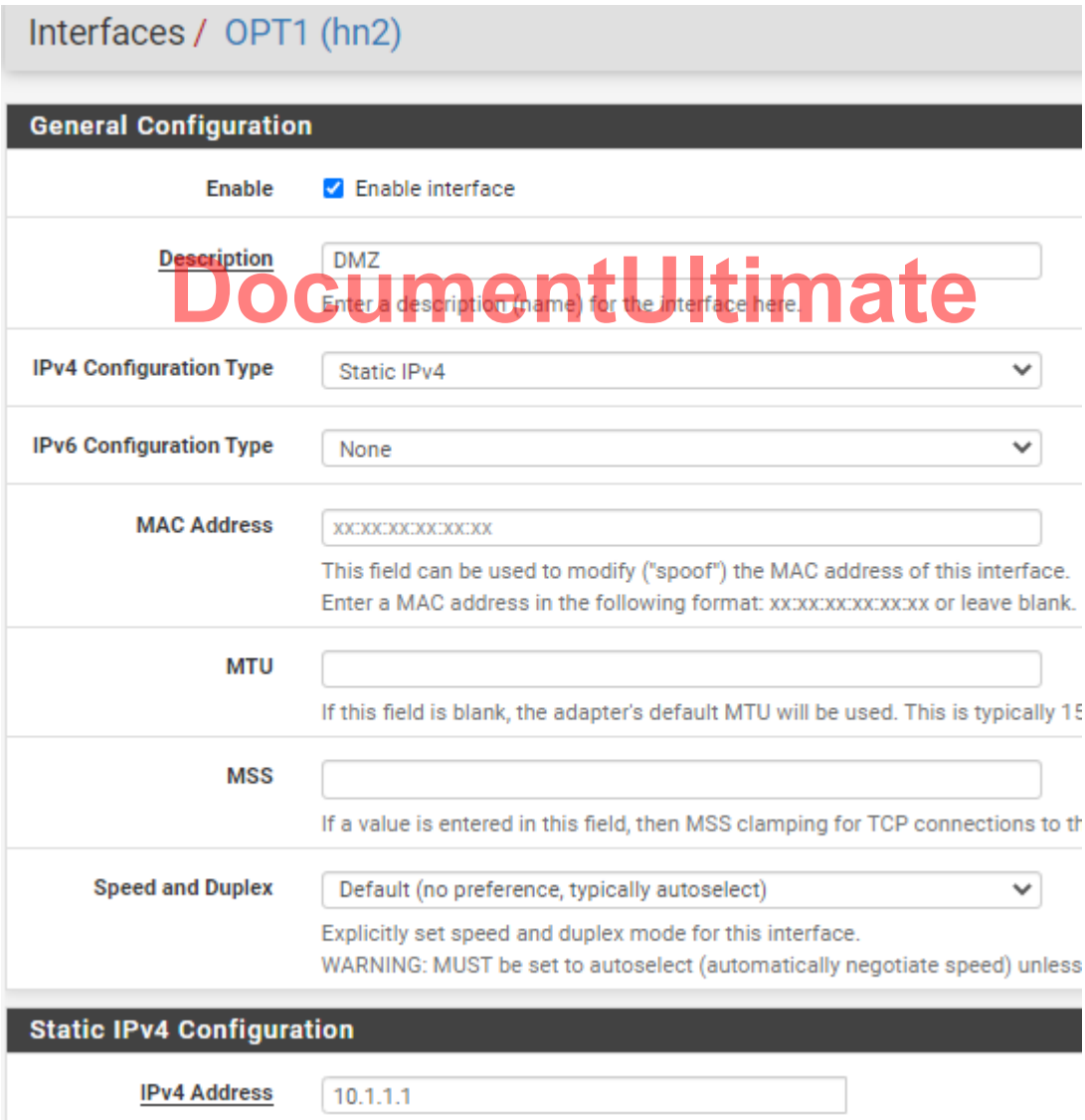
The configuration of LAN (you can change the subnet as your wish)



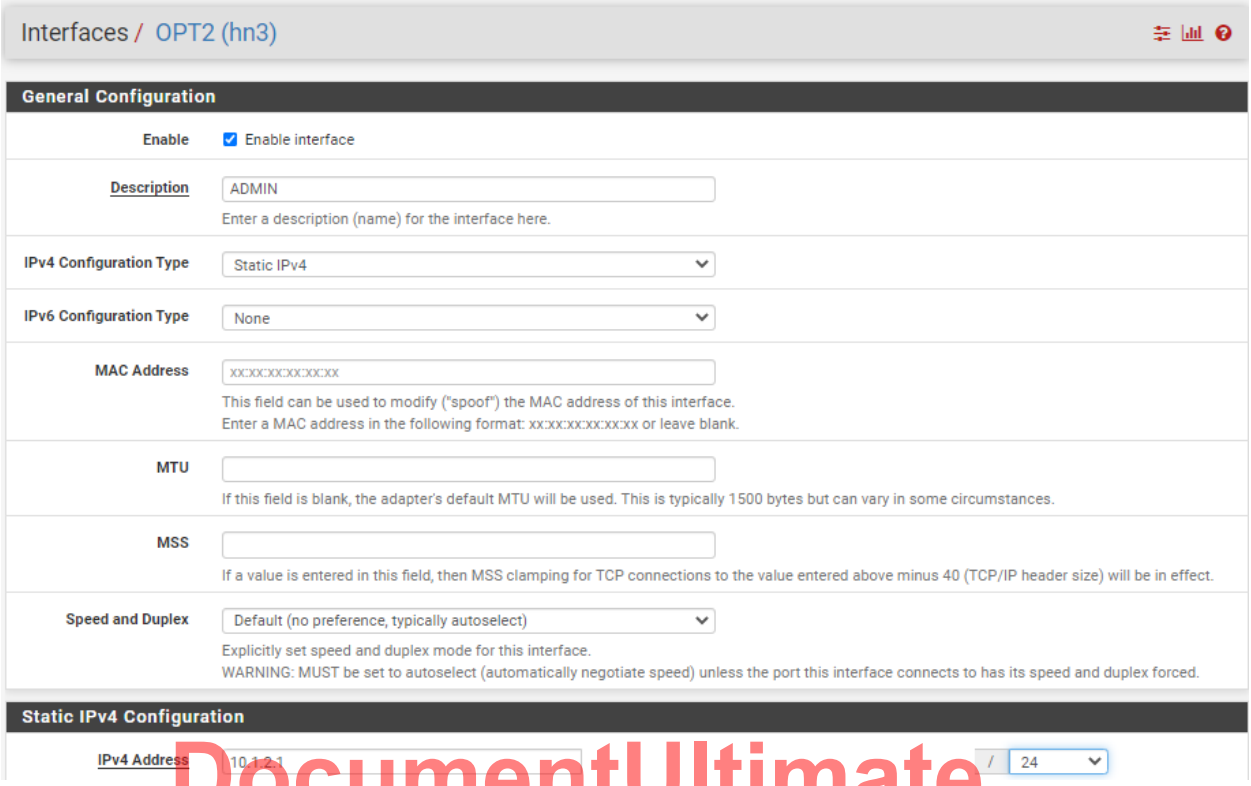
4. Rename the interface for easy remember them



The OPT1 will be DMZ (below image, I have cropped the important information about the subnet mask of DMZ interface, it should be /24, see the next image for the same)



The OPT2 will be ADMIN



DO NOT forget to tick at Enable Interface, Save and Apply Changes buttons

5. NAT configuration

   Here we will use the overlapping NAT

   NAT will be used for Web server, mapping the private IP of web server (10.1.1.2) to the WAN's IP and mapping the HTTPS port (on web server) to outside HTTPS port.

   Go to Firewall > NAT, then click Add button

Edit Redirect Entry

Disabled	☐ Disable this rule
No RDR (NOT)	☐ Disable redirection for traffic matching this rule This option is rarely needed. Don't use this without thorough knowledge of the implications.
Interface	WAN Choose which interface this rule applies to. In most cases "WAN" is specified.
Protocol	TCP Choose which protocol this rule should match. In most cases "TCP" is specified.
Source	Display Advanced
Destination	☐ Invert match. WAN address (Type) / Address/mask
Destination port range	HTTPS (From port) Custom — HTTPS (To port) Custom Specify the port or port range for the destination of the packet for this mapping. The 'to' field may be left empty if only mapping a single port.
Redirect target IP	10.1.1.2 Enter the internal IP address of the server on which to map the ports. e.g.: 192.168.1.12
Redirect target port	HTTPS (Port) Custom Specify the port on the machine with the IP address entered above. In case of a port range, specify the beginning port of the range (the end port will be calculated automatically). This is usually identical to the "From port" above.
Description	NAT for Web server A description may be entered here for administrative reference (not parsed).

Then click Save button

Firewall / NAT / Port Forward

The NAT configuration has been changed.
The changes must be applied for them to take effect.

Apply Changes

Port Forward 1:1 Outbound NPt

Rules

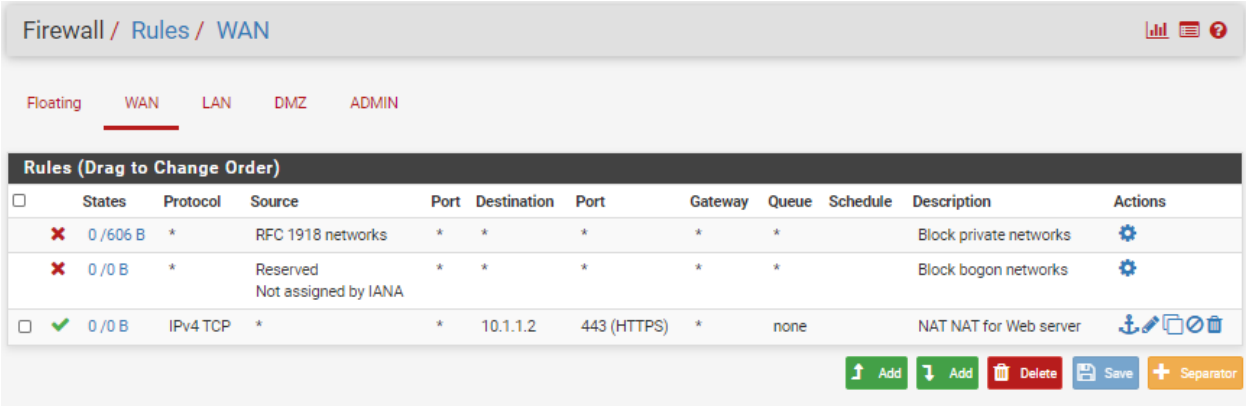
	Interface	Protocol	Source Address	Source Ports	Dest. Address	Dest. Ports	NAT IP	NAT Ports	Description	Actions
☐ ✔ ⤮	WAN	TCP	*	*	WAN address	443 (HTTPS)	10.1.1.2	443 (HTTPS)	NAT for Web server	

Add Add Delete Save Separator

Legend
▶ Pass
⤮ Linked rule

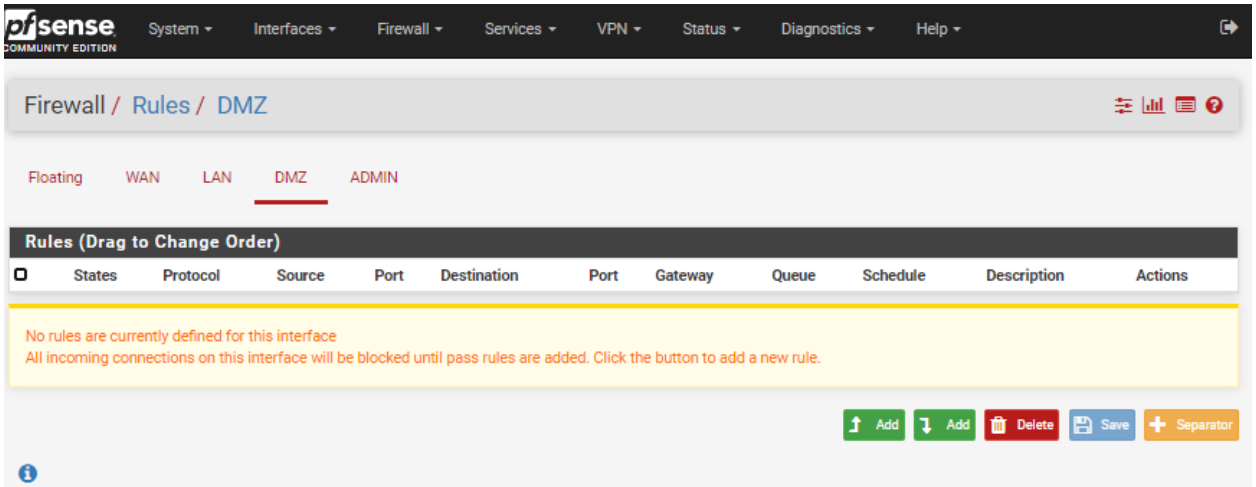
And Do Not forget to click Apply Changes button

Go to the Firewall > Rules, we can see :

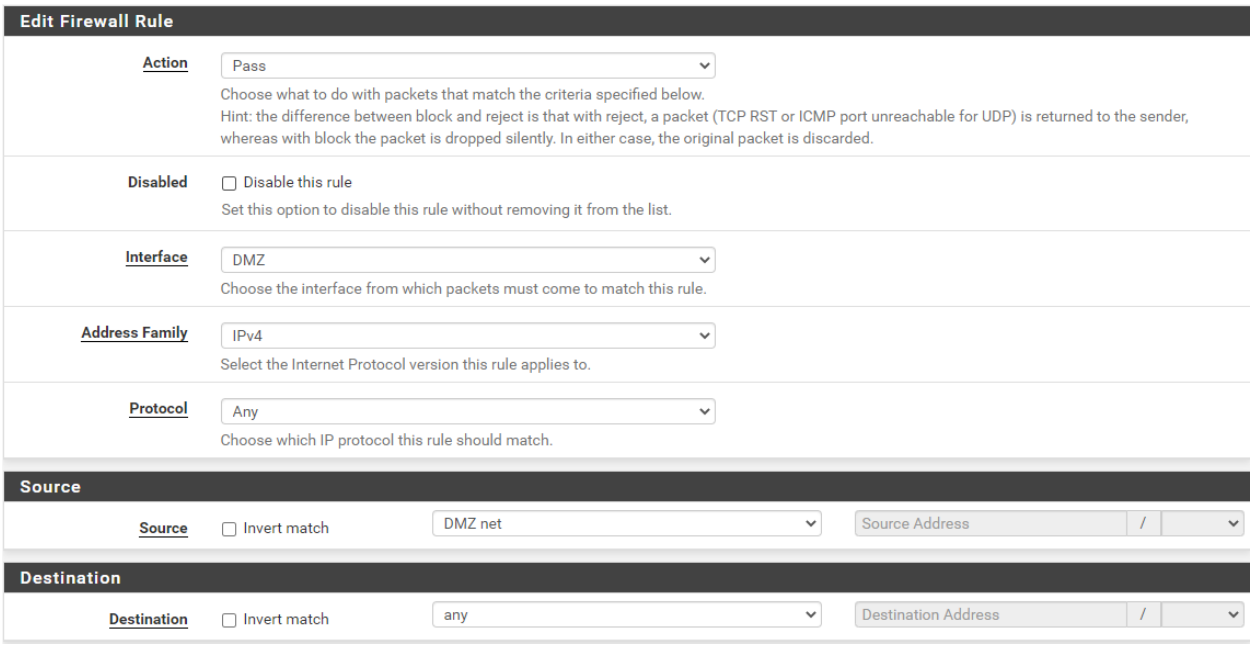


The NAT rules was created for Web server.
The NAT for web server means: accept any TCP/IPv4 session from any IP (outside) to Web server on port 443 (HTTPS)

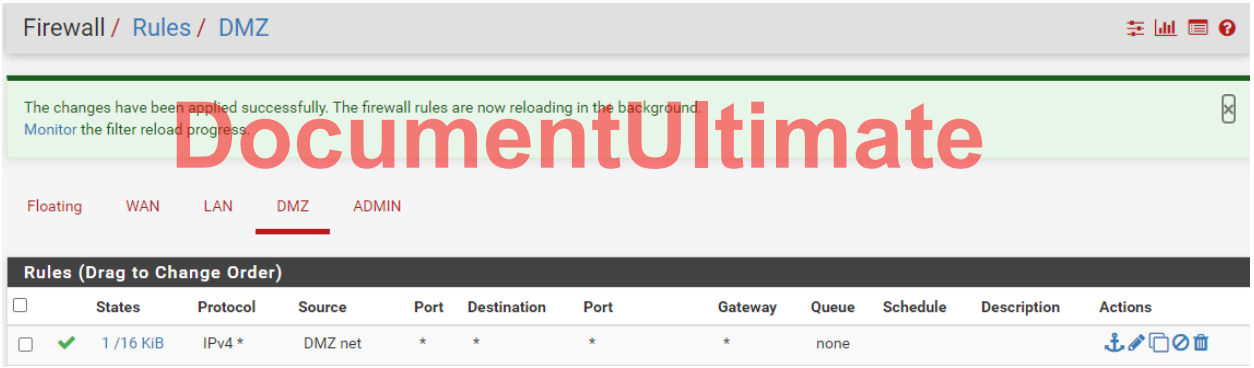
6. Configure the Rules (firewall policies)
   Now, at the menu Firewall > Rules we can create any policy we want to protect our network on any interface.
   REMEMBER: firewall will manage session of any connection, this mean that firewall will check for the first packet of any initiation session then remember the policy of this session in memory until the session finishes.
   As the LAB requirements, we can create some rules on the DMZ network as below
   Go to the DMZ, then click Add (with down arrow, you can change the order of rules by dragging them)



Now the first rule, we allow any computer in the DMZ network can reach outside network (or reach the Internet). This means that any session that initiates by any computer in DMZ will pass the firewall check. This rule is optional so that your servers can download any update or patch packet from software supplier.



Save the rule and we have:



Do not forget click apply changes

Create the rule: *Allow any Administrator PC (source) connect to Web server (Destination, a host with IP 10.1.1.2) on SSH port (22)*

Edit Firewall Rule

Action Pass

Choose what to do with packets that match the criteria specified below.
Hint: the difference between block and reject is that with reject, a packet (TCP RST or ICMP port unreachable for UDP) is returned to the sender, whereas with block the packet is dropped silently. In either case, the original packet is discarded.

Disabled ☐ Disable this rule

Set this option to disable this rule without removing it from the list.

Interface DMZ

Choose the interface from which packets must come to match this rule.

Address Family IPv4

Select the Internet Protocol version this rule applies to.

Protocol TCP

Choose which IP protocol this rule should match.

Source

Source ☐ Invert match ADMIN net Source Address /

Display Advanced

The **Source Port Range** for a connection is typically random and almost never equal to the destination port. In most cases this setting must remain at its default value, **any**.

Destination

Destination ☐ Invert match Single host or alias 10.1.1.2 /

Destination Port Range SSH (22) From Custom SSH (22) To Custom

Specify the destination port or port range for this rule. The "To" field may be left empty if only filtering a single port.

And the rules table as below

Firewall / Rules / DMZ

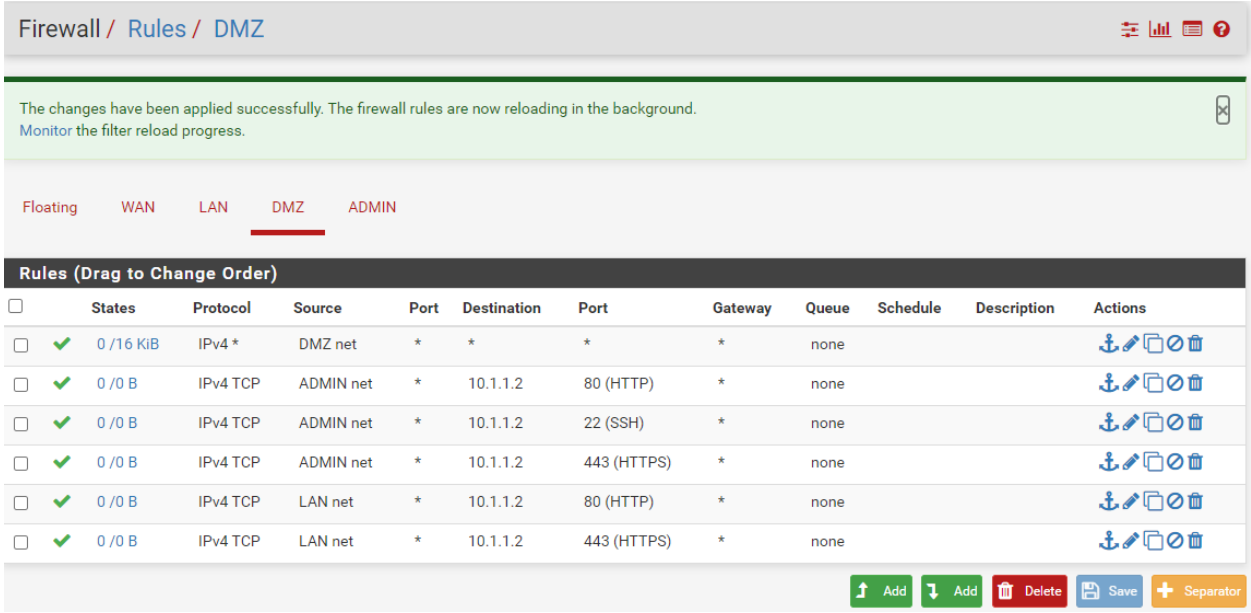
The changes have been applied successfully. The firewall rules are now reloading in the background.
Monitor the filter reload progress.

Floating WAN LAN DMZ ADMIN

Rules (Drag to Change Order)

	States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
✔	1 /16 KiB	IPv4 *	DMZ net	*	*	*	*	none			
✔	0 /0 B	IPv4 TCP	ADMIN net	*	10.1.1.2	22 (SSH)	*	none			

It is similar for other rules.



VI. Install and configure web server

1. Install Apache2

Reference: https://www.digitalocean.com/community/tutorials/how-to-install-the-apache-web-server-on-ubuntu-20-04

Run the command:

$ sudo apt install apache2


```
minh@webserver:~$ sudo apt install apache2
[sudo] password for minh:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  apache2-bin apache2-data apache2-utils libapr1 libaprutil1 libaprutil1-dbd-sqlite3 libaprutil1-ldap libjansson4 liblua5.2-0 ssl-cert
Suggested packages:
  apache2-doc apache2-suexec-pristine | apache2-suexec-custom www-browser openssl-blacklist
The following NEW packages will be installed:
  apache2 apache2-bin apache2-data apache2-utils libapr1 libaprutil1 libaprutil1-dbd-sqlite3 libaprutil1-ldap libjansson4 liblua5.2-0 ssl-cert
0 upgraded, 11 newly installed, 0 to remove and 0 not upgraded.
Need to get 1,864 kB of archives.
After this operation, 8,080 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://archive.ubuntu.com/ubuntu focal/main amd64 libapr1 amd64 1.6.5-1ubuntu1 [91.4 kB]
Get:2 http://archive.ubuntu.com/ubuntu focal/main amd64 libaprutil1 amd64 1.6.1-4ubuntu2 [84.7 kB]
Get:3 http://archive.ubuntu.com/ubuntu focal/main amd64 libaprutil1-dbd-sqlite3 amd64 1.6.1-4ubuntu2 [10.5 kB]
Get:4 http://archive.ubuntu.com/ubuntu focal/main amd64 libaprutil1-ldap amd64 1.6.1-4ubuntu2 [8,736 B]
Get:5 http://archive.ubuntu.com/ubuntu focal/main amd64 libjansson4 amd64 2.12-1build1 [28.9 kB]
Get:6 http://archive.ubuntu.com/ubuntu focal/main amd64 liblua5.2-0 amd64 5.2.4-1.1build3 [106 kB]
Get:7 http://archive.ubuntu.com/ubuntu focal/main amd64 apache2-bin amd64 2.4.41-4ubuntu3 [1,179 kB]
74% [7 apache2-bin 1,146 kB/1,179 kB 97%]                                                                    1,962 B/s 3min 17s
Get:8 http://archive.ubuntu.com/ubuntu focal/main amd64 apache2-data all 2.4.41-4ubuntu3 [159 kB]
Get:9 http://archive.ubuntu.com/ubuntu focal/main amd64 apache2-utils amd64 2.4.41-4ubuntu3 [83.3 kB]
Get:10 http://archive.ubuntu.com/ubuntu focal/main amd64 apache2 amd64 2.4.41-4ubuntu3 [95.5 kB]
Get:11 http://archive.ubuntu.com/ubuntu focal/main amd64 ssl-cert all 1.0.39 [17.0 kB]
Fetched 1,864 kB in 13s (147 kB/s)
Preconfiguring packages ...
Selecting previously unselected package libapr1:amd64.
(Reading database ... 70848 files and directories currently installed.)
Preparing to unpack .../00-libapr1_1.6.5-1ubuntu1_amd64.deb ...
Unpacking libapr1:amd64 (1.6.5-1ubuntu1) ...
Selecting previously unselected package libaprutil1:amd64.
Preparing to unpack .../01-libaprutil1_1.6.1-4ubuntu2_amd64.deb ...
Unpacking libaprutil1:amd64 (1.6.1-4ubuntu2) ...
^[SSelecting previously unselected package libaprutil1-dbd-sqlite3:amd64.
Preparing to unpack .../02-libaprutil1-dbd-sqlite3_1.6.1-4ubuntu2_amd64.deb ...
Unpacking libaprutil1-dbd-sqlite3:amd64 (1.6.1-4ubuntu2) ...
Selecting previously unselected package libaprutil1-ldap:amd64.
Preparing to unpack .../03-libaprutil1-ldap_1.6.1-4ubuntu2_amd64.deb ...
Unpacking libaprutil1-ldap:amd64 (1.6.1-4ubuntu2) ...

Progress: [ 16%] [##################.....................................................................................]
```

Check Ubuntu firewall for this app (Optional: if the Ubuntu firewall is active)

```
$ sudo ufw app list
```

```
minh@webserver:~$ sudo ufw app list
Available applications:
  Apache
  Apache Full
  Apache Secure
  OpenSSH
minh@webserver:~$
```

Allow Apache service on Ubuntu firewall

```
$ sudo ufw allow 'Apache'
```

```
minh@webserver:~$ sudo ufw allow 'Apache'
Rules updated
Rules updated (v6)
minh@webserver:~$
```

You can verify the change by typing:

```
$ sudo ufw status
```

2. **Configure web server**

Check with the systemd init system to make sure the service is running by typing:

```
$ sudo systemctl status apache2
```



```
minh@webserver:~$ sudo systemctl status apache2
● apache2.service - The Apache HTTP Server
     Loaded: loaded (/lib/systemd/system/apache2.service; enabled; vendor preset: enabled)
     Active: active (running) since Thu 2020-11-26 03:08:28 UTC; 14min ago
       Docs: https://httpd.apache.org/docs/2.4/
   Main PID: 1664 (apache2)
      Tasks: 55 (limit: 2205)
     Memory: 5.1M
     CGroup: /system.slice/apache2.service
             ├─1664 /usr/sbin/apache2 -k start
             ├─1666 /usr/sbin/apache2 -k start
             └─1667 /usr/sbin/apache2 -k start

Nov 26 03:08:28 webserver systemd[1]: Starting The Apache HTTP Server...
Nov 26 03:08:28 webserver apachectl[1663]: AH00558: apache2: Could not reliably determine the server's fully qualified domain name, using 127.0
Nov 26 03:08:28 webserver systemd[1]: Started The Apache HTTP Server.
lines 1-15/15 (END)
```

Or

```
$ netstat -nca | grep :80
```

```
minh@webserver:~$ netstat -nca | grep :80
tcp6       0      0 ::80                    :::*                    LISTEN
tcp6       0      0 ::80                    :::*                    LISTEN
tcp6       0      0 ::80                    :::*                    LISTEN
tcp6       0      0 ::80                    :::*                    LISTEN
tcp6       0      0 ::80                    :::*                    LISTEN
tcp6       0      0 ::80                    :::*                    LISTEN
```

VII. Test your firewall rules

1. **Test connection session from WAN to DMZ**

You can use your real machine (laptop) or Kali Linux VM

Setting the correct IP address of the virtual interface that connect to Default Switch of Hyper-V

Use the nmap to scan port to make sure that you can see the 443 port only.

2. **Test connection session from USER network to DMZ**
   Similar to the 1st test above
3. **Test connection session from ADMIN network to DMZ**
   Similar to the 1st test above
   Test SSH, you can use the Kali Linux to SSH to Web Server. Before this, you should enable the SSH service on web server first.

4. **Try to change the order of rules or try with some incorrect configuration**
5. **Conclusion**