

# Building and Configuring a Basic Multi-Subnet Network and Firewall

Roozah Khan

## **Exercise Description:**

This exercise consists of building a virtual small-business network to support Beta Corp.'s international operations. Their network consists of 1) an administrative client, 2) a corporate client, 3) a pfSense firewall, and 4) a server. The "server" required for this exercise can simply be an Ubuntu desktop VM.

In this exercise, you will configure the pfSense router/firewall such that the administrative client is able to access the server's administrative services across the network. During this exercise, you will construct firewall rules for a pfSense router/firewall as part of a strategy to protect resources.

## **Scenario:**

*Beta Corp. is small software development consulting firm. Their regular corporate users are on one subnet and their IT department traffic is on another subnet. Both are routed through a FreeBSD (pfSense) router/firewall, and then to their multi-function server. As this small firm relies on a single server to provide all necessary services, security is of great importance. It is your job to properly configure the firewall such that the firm's resources are properly protected and their critical services are functional.*

## **Credentials:**

- The credentials for the pfSense web interface are **admin:pfsense**

This lab requires 2 Kali Linux and 1 Ubuntu Linux virtual machines and 1 pfSense virtual machine. Note that you will need Internet access while you download software onto the virtual machines. Once all necessary applications are downloaded and installed, you will then switch to an internal and local network, and loss Internet connection.

## **System Pre-Configuration:**

Configure the Ubuntu and Kali virtual machines with specific software as follows:

System	Required Setting/Software	Command / Info
All Ubuntu and Kali Systems	Update System  Putty SSH Client Trace Route Pkg Open SSH Server Remmina Remote Client Remmina Plug-In Remmina Plug-In Apache Web Server VsFTPD (FTP server)	<pre>sudo apt-get update</pre>  <pre>sudo apt-get install putty -y sudo apt-get install traceroute -y sudo apt-get install openssh-server -y sudo apt-get install remmina -y sudo apt-get install remmina-plugin-vnc -y sudo apt-get install remmina-plugin-rdp -y sudo apt-get install apache2 -y sudo apt-get install vsftpd -y</pre> <p>Also: set an image of yourself to display as the content in the default document (index.html) on the server.</p>

**Shutdown the system to configure the network adapters as below**

## **Network Adapters:**

To configure the network adapters in VirtualBox, after you have completed downloading the packages above:

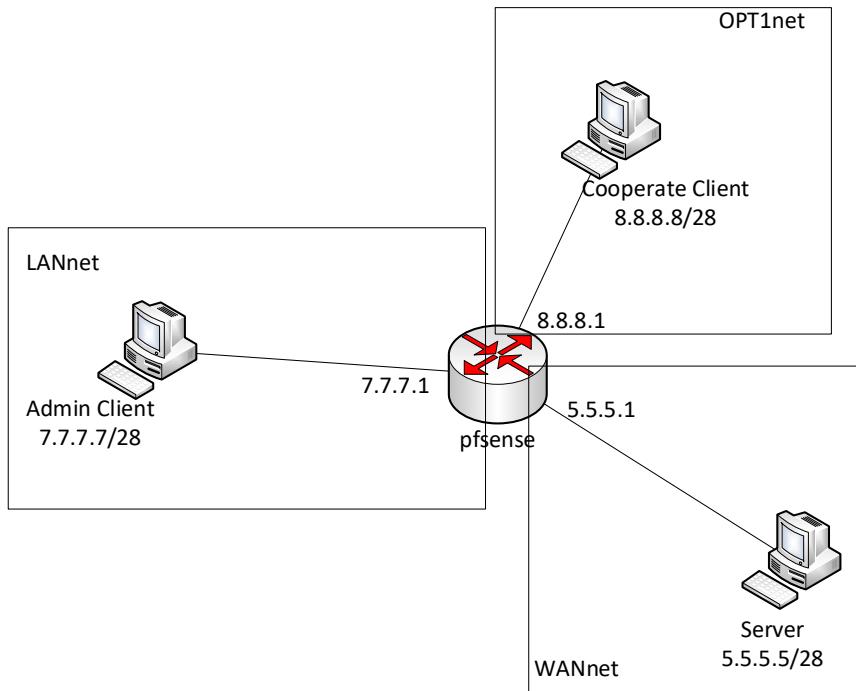
- a. Select the VM in the VirtualBox Manager
- b. Click on the *Settings* icon near the top-left of the window
- c. Click on *Network* in the left-hand menu of the Settings window
- d. Ensure the *Enable Network Adapter* check box is selected for each adapter that is used
- e. For each network adapter, select *Internal Network* from the Attached To: drop-down box
- f. Enter the appropriate name for the network from the table below into the *Name* box

VM	Network Adapter Name	Internal Network Name
Admin Client	Adapter 1	LANnet
Corporate Client	Adapter 2	OPT1net
pfSense Firewall	Adapter 1	WANnet
	Adapter 2	LANnet
	Adapter 3	OPT1net

Server	Adapter 1	WANnet
--------	-----------	--------

### **Instructions for configuration:**

The following is the architecture of the network we are about to build.



#### Admin Client

*Configure the Client's Network Settings:*

- 1 Manually set the Client's IP address, and netmask in the “interfaces” file using the following command:  
**sudo nano /etc/network/interfaces**

- 2 Your file should look like this:

```

auto lo
iface lo inet loopback

auto eth0
iface eth0 inet static
    address 7.7.7.7/28
    post-up route add default gw 7.7.7.1

```

- 3 Provide your completed client interfaces file as [Screenshot 1](#). (Note: all screenshots must be zoomed in to clearly include the asked content. )

```
GNU nano 6.0          /etc/network/interfaces
# This file describes the network interfaces available on your
# and how to activate them. For more information, see interface(7)

source /etc/network/interfaces.d/*

# The loopback network interface
auto lo
iface lo inet loopback

auto eth0
iface eth0 inet static
    address 7.7.7.7/28
    post-up route add default gw 7.7.7.1
```

The screenshot displays the Admin client VM's IP address and netmask in the interfaces file.

- 4 Restart the system! (to restart the networking processes)

- 5 Use the ifconfig command to verify that your network settings are correct

**ifconfig**

(you should see the 2 network interfaces with the IPs you set above)

- 6 Use the following command to view the routing table:

**route -n**

- 7 Provide your client routing table (output from command above) as [Screenshot 2](#).

```
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
      inet 7.7.7.7 netmask 255.255.255.240 broadcast 7.7.7.15
      inet6 fe80::a00:27ff:fe95:bd54 prefixlen 64 scopeid 0x20<link>
        ether 08:00:27:95:bd:54 txqueuelen 1000 (Ethernet)
          RX packets 0 bytes 0 (0.0 B)
          RX errors 0 dropped 0 overruns 0 frame 0
          TX packets 12 bytes 936 (936.0 B)
          TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
      inet 127.0.0.1 netmask 255.0.0.0
      inet6 ::1 prefixlen 128 scopeid 0x10<host>
        loop txqueuelen 1000 (Local Loopback)
          RX packets 0 bytes 0 (0.0 B)
          RX errors 0 dropped 0 overruns 0 frame 0
          TX packets 0 bytes 0 (0.0 B)
          TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

```
└──(kali㉿kali)-[~]
$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         7.7.7.1        0.0.0.0         UG    0      0        0 eth0
7.7.7.0         0.0.0.0        255.255.255.240 U     0      0        0 eth0
```

This screenshot shows the output of the routing table and ipconfig of the Admin client.

- 8 Modify the Client's "hosts" file

***sudo nano /etc/hosts***

Append the following line to this file and save it

#### **5.5.5.5    web-server**

- 9 Provide your updated hosts file as **Screenshot 3**.

```
File Actions Edit View Help
GNU nano 6.0
/etc/hosts *
127.0.0.1      localhost
127.0.1.1      kali
5.5.5.5        web-server
# The following lines are desirable for IPv6 capable hosts
::1      localhost ip6-localhost ip6-loopback
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
```

This screenshot shows the modified "hosts" file.

## Corporate Client

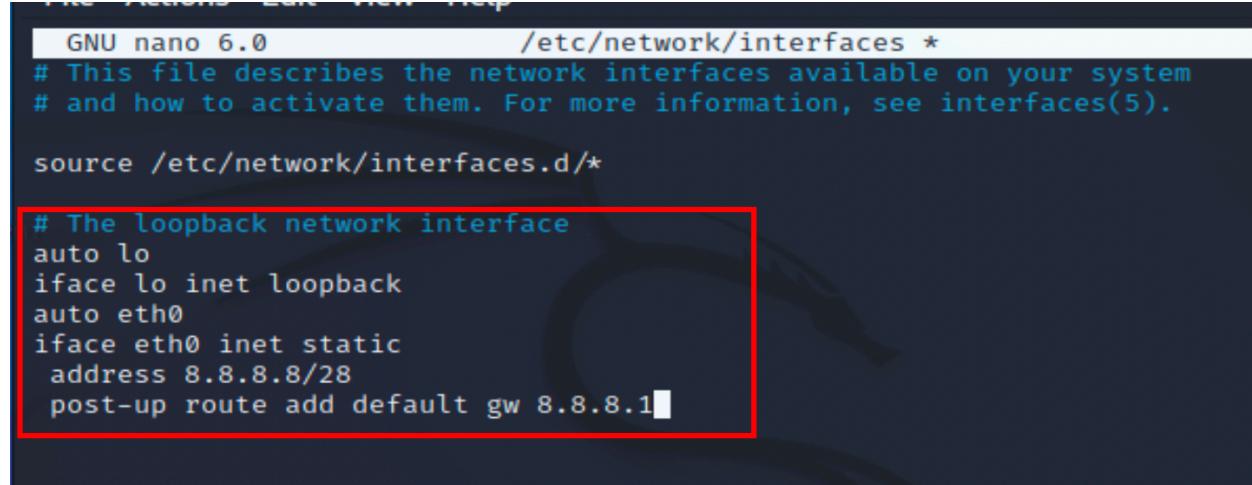
*Configure the Client's Network Settings:*

- 10 Manually set the Client's IP address, and netmask in the "interfaces" file using the following command:  
**sudo nano /etc/network/interfaces**

- 11 Your file should look like this:

```
auto lo
iface lo inet loopback

auto eth0
iface eth0 inet static
    address 8.8.8.8/28
    post-up route add default gw 8.8.8.1
```



```
GNU nano 6.0          /etc/network/interfaces *
# This file describes the network interfaces available on your system
# and how to activate them. For more information, see interfaces(5).

source /etc/network/interfaces.d/*

# The loopback network interface
auto lo
iface lo inet loopback
auto eth0
iface eth0 inet static
    address 8.8.8.8/28
    post-up route add default gw 8.8.8.1
```

This screenshot shows the corporate client's IP address and netmask.

- 12 Restart the system! (to restart the networking processes)

- 13 Use the ifconfig command to verify that your network settings are correct

**ifconfig**

(you should see the 2 network interfaces with the IPs you set above)

Use the following command to view the routing table:

**route -n**

```

└─(kali㉿kali)-[~]
$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 8.8.8.8 netmask 255.255.255.240 broadcast 8.8.8.15
        inet6 fe80::a00:27ff:fe03:b1e8 prefixlen 64 scopeid 0x20<link>
            ether 08:00:27:03:b1:e8 txqueuelen 1000 (Ethernet)
            RX packets 0 bytes 0 (0.0 B)
            RX errors 0 dropped 0 overruns 0 frame 0
            TX packets 12 bytes 936 (936.0 B)
            TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
        inet6 ::1 prefixlen 128 scopeid 0x10<host>
            loop txqueuelen 1000 (Local Loopback)
            RX packets 0 bytes 0 (0.0 B)
            RX errors 0 dropped 0 overruns 0 frame 0
            TX packets 0 bytes 0 (0.0 B)
            TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

└─(kali㉿kali)-[~]
$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref  Use Iface
0.0.0.0         8.8.8.1        0.0.0.0         UG    0      0      0 eth0
8.8.8.0         0.0.0.0        255.255.255.240 U     0      0      0 eth0

```

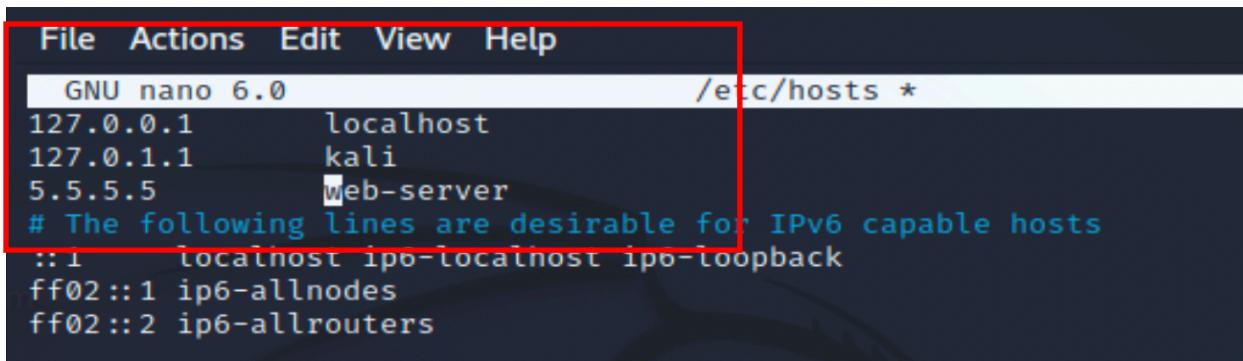
This screenshot shows the corporate client's routing table and ipconfig.

- 14 Modify the Client's "hosts" file

**sudo nano /etc/hosts**

Append the following line to this file and save it

#### 5.5.5 web-server



```

File Actions Edit View Help
GNU nano 6.0          /etc/hosts *
127.0.0.1      localhost
127.0.1.1      kali
5.5.5.5        web-server
# The following lines are desirable for IPv6 capable hosts
::1      localhost ip6-localhost ip6-loopback
ff02::1  ip6-allnodes
ff02::2  ip6-allrouters

```

This screenshot shows the corporate client's modified "hosts" file.

## Server

*Configuring the Server's Network Settings:*

- 1 Bring up the “network” menu in settings, find out the IPv4 setting page, and set the “IPv4 method” from “Automatic” to “Manual”.
- 2 Manually set the following:

**Address: 5.5.5.5**

**Netmask: 28**

**Gateway: 5.5.5.1**

The screenshot shows two network configuration interfaces. The top interface is titled "New Profile" and has tabs for "Identity", "IPv4" (which is selected), "IPv6", and "Security". It includes sections for "IPv4 Method" (with "Manual" selected) and "Addresses" (listing an address 5.5.5.5 with netmask 28 and gateway 5.5.5.1). The bottom interface is titled "Wired" and also has tabs for "Details", "Identity", "IPv4" (selected), "IPv6", and "Security". It has similar sections for "IPv4 Method" (with "Manual" selected) and "Addresses" (listing an address 5.5.5.5 with netmask 255.255.255.240 and gateway 5.5.5.1). A red box highlights the "Addresses" table in the bottom interface.

Address	Netmask	Gateway
5.5.5.5	28	5.5.5.1

Address	Netmask	Gateway
5.5.5.5	255.255.255.240	5.5.5.1

This screenshot shows the server's IPv4 interface.

- 3 Provide your completed server interfaces file as [Screenshot 4](#).

- 4 Restart the system! (to restart the networking processes)

- 5 Use the ifconfig command to verify that your network settings are correct

**ifconfig**

- 6 Note: In this instance we have specified a default gateway because it is static. You can see it in the routing table. Use the following command to view the routing table and note the additional gateway entry that wasn't present in the client's routing table:

**route -n**

- 7 Provide your server routing table with the gateway marked (you can either circle it or highlight it in the output) as Screenshot 5.

```
roozah@roozah-VirtualBox:~$ ifconfig
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
        inet 5.5.5.5 netmask 255.255.255.240 broadcast 5.5.5.15
        inet6 fe80::d9e9:10dc:5600:ea6b prefixlen 64 scopeid 0x20<link>
          ether 08:00:27:e7:f2:15 txqueuelen 1000 (Ethernet)
            RX packets 15307 bytes 17771098 (17.7 MB)
            RX errors 0 dropped 0 overruns 0 frame 0
            TX packets 6403 bytes 1188066 (1.1 MB)
            TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
        inet 127.0.0.1 netmask 255.0.0.0
        inet6 ::1 prefixlen 128 scopeid 0x10<host>
          loop txqueuelen 1000 (Local Loopback)
            RX packets 3343 bytes 291384 (291.3 KB)
            RX errors 0 dropped 0 overruns 0 frame 0
            TX packets 3343 bytes 291384 (291.3 KB)
            TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

```
roozah@roozah-VirtualBox:~$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         5.5.5.1        0.0.0.0         UG    20100   0        0 enp0s3
5.5.5.0         0.0.0.0        255.255.255.240 U      100    0        0 enp0s3
169.254.0.0     0.0.0.0        255.255.0.0     U      1000   0        0 enp0s3
```

This screenshot shows the routing table of the server with the gateway.

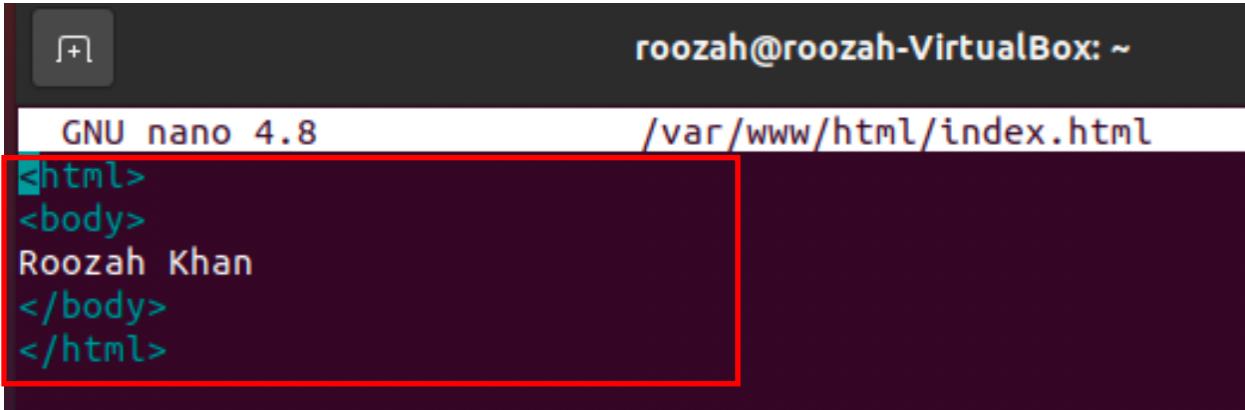
- 8 Place your full name as the default page of the web-server. The default page is located in **/var/www/html/index.html**

- 9 Remove all the contents in the index.html, and put the following content:

```
<html>
  <body>
    Your first name and last name
  </body>
</html>
```

You can use any editor to edit the html file, for example, nano as you have just used to modify /etc/network/interfaces.

10 Provide the html source code for your modified index.html file as [Screenshot 6](#).

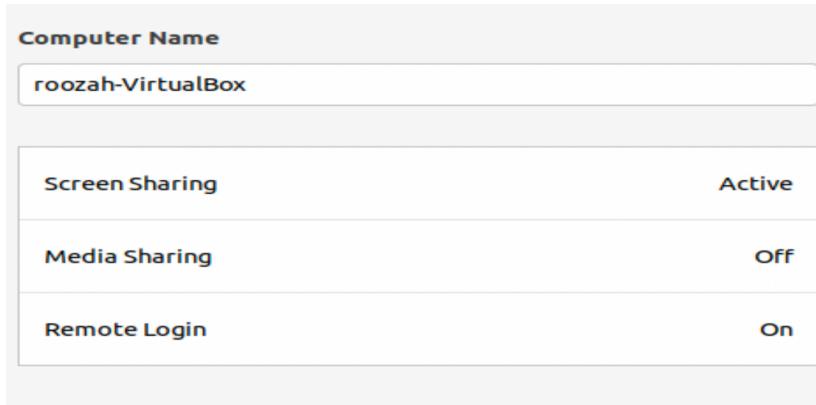


The screenshot shows a terminal window with the command 'nano index.html' running. The file contains the following HTML code:

```
<html>
<body>
Roozah Khan
</body>
</html>
```

This screenshot shows the modified html file with my name.

- 11 While on the server, you will need to enable DESKTOP SHARING so you'll be able to initiate a Remmina VNC session later in the lab. To do this:
- Bring up the “sharing” menu from setting.
  - Toggle the “sharing” button on the top.
  - Enable “Screen Sharing”, it should display as “active” after you enable it.



## pfSense Firewall

### *Configuring pfSense Firewall's Network Settings*

- In pfSense, choose option “1. Assign Interfaces”, skip VLAN setup, and use the following device settings
  - WAN : em0 (this will be the server interface)
  - LAN : em1 (this will be the admin interface)
  - OPT1: em2 (this will be the corporate interface)

- 2 When the pfSense menu is shown, chose “2. Set Interface(s) IP addresses”. Choose No for DHCP, and manually assign a static IP address (and the appropriate netmask) to each interface.

WAN = 5.5.5.1/28

LAN = 7.7.7.1/28

OPT1=8.8.8.1/28

- When setting the WAN IP only – At the gateway prompt you can set it to 5.5.5.5
- For all interfaces - You can select “yes” for the prompt concerning HTTP as the webConfigurator protocol, and “no” for anything related to DHCP)

- 3 Provide an image showing your successful completion of the pfSense configuration (the menu screen showing all of the configured interfaces) as [Screenshot 7](#).

The screenshot shows the pfSense 2.6.0-RELEASE terminal menu. It displays the following information:

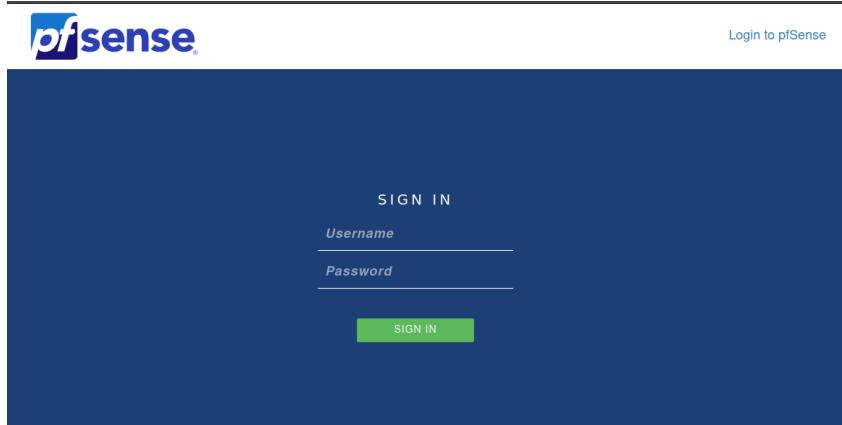
- Reloading filter...
- Reloading routing configuration...
- The IPv4 OPT1 address has been set to 8.8.8.1/28
- Press <ENTER> to continue.
- VirtualBox Virtual Machine - Netgate Device ID: 78b6dea76f3fad4a4923
- \*\*\* Welcome to pfSense 2.6.0-RELEASE (amd64) on pfSense \*\*\*
- Configured interfaces:
  - WAN (wan) → em0 → v4: 5.5.5.1/28
  - LAN (lan) → em1 → v4: 7.7.7.1/28
  - OPT1 (opt1) → em2 → v4: 8.8.8.1/28
- System options (numbered 0-16):
  - 0) Logout (SSH only)
  - 1) Assign Interfaces
  - 2) Set interface(s) IP address
  - 3) Reset webConfigurator password
  - 4) Reset to factory defaults
  - 5) Reboot system
  - 6) Halt system
  - 7) Ping host
  - 8) Shell
  - 9) pfTop
  - 10) Filter Logs
  - 11) Restart webConfigurator
  - 12) PHP shell + pfSense tools
  - 13) Update from console
  - 14) Enable Secure Shell (sshd)
  - 15) Restore recent configuration
  - 16) Restart PHP-FPM
- Enter an option: [ ]

This screenshot shows the Pfsense configuration interface of WAN, LAN, and OPT1.

- 4 From the client, open Firefox, log on to the pfSense web interface by entering the IP address for the LAN connection

<http://7.7.7.1>

if you have all the steps configured correctly, you should now see the login interface of pfSense, as the following:



the default login is admin/pfsense. Once logged in, it'll ask you to do some initial configuration, you can proceed without changing anything.

- 5 Provide an image showing the “dashboard” page of the pfSense configuration page as **Screenshot 8**.

This screenshot shows the dashboard page of the PfSense using <http://7.7.7.1> on Admin client.

