

pfSense Firewall Virtualization & Network Monitoring Lab

VirtualBox Implementation with NAT, Bridged & Host-Only Adapters

This report documents the creation and configuration of a pfSense virtual firewall running inside Oracle VirtualBox, including VM provisioning, virtual networking, pfSense console configuration, Web GUI access, and connectivity testing using ping, traceroute, and tcpdump.

1. Virtual Machine Creation & ISO Selection

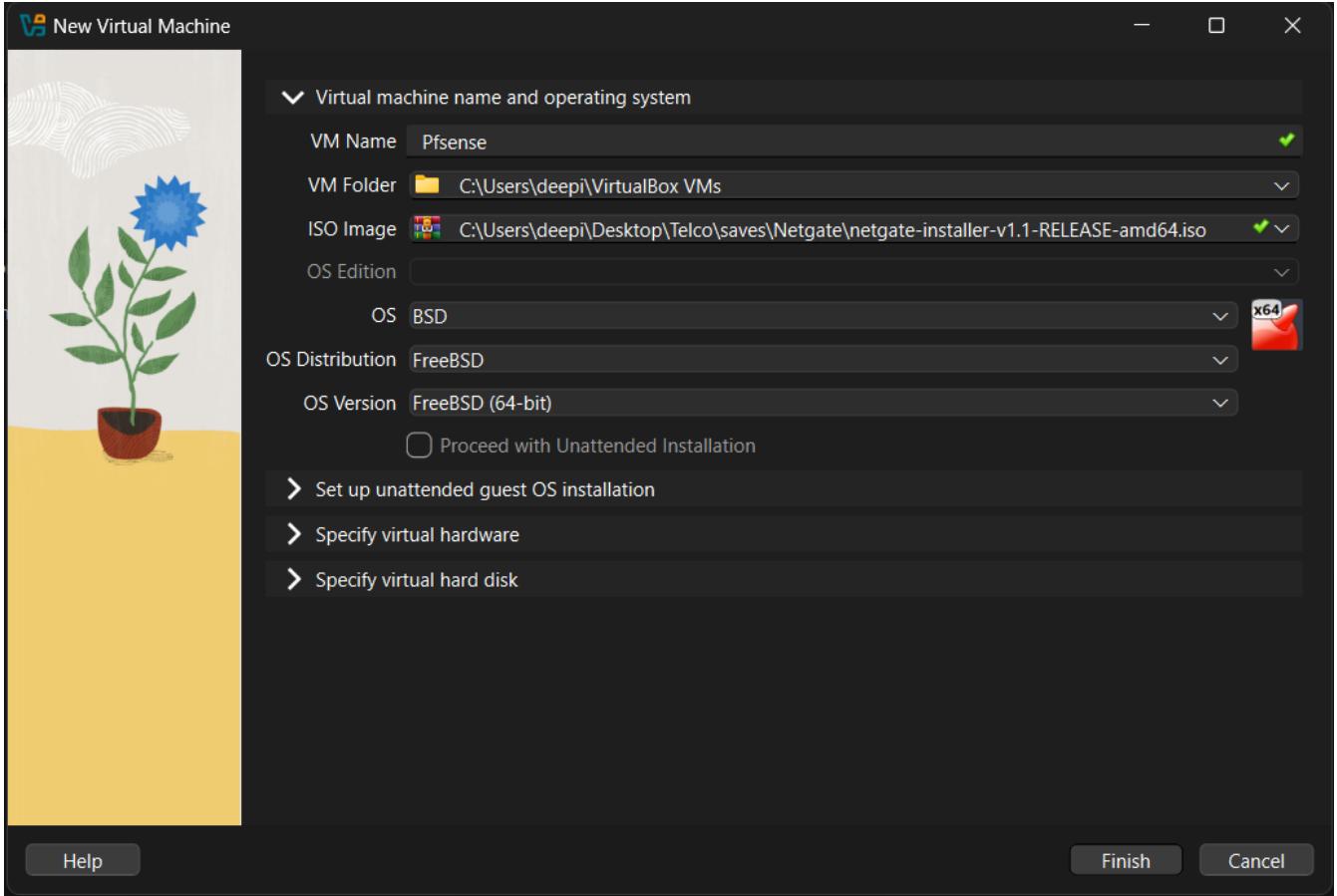


Figure 1: Creating the pfSense VM in VirtualBox and attaching the pfSense installer ISO (FreeBSD 64-bit).

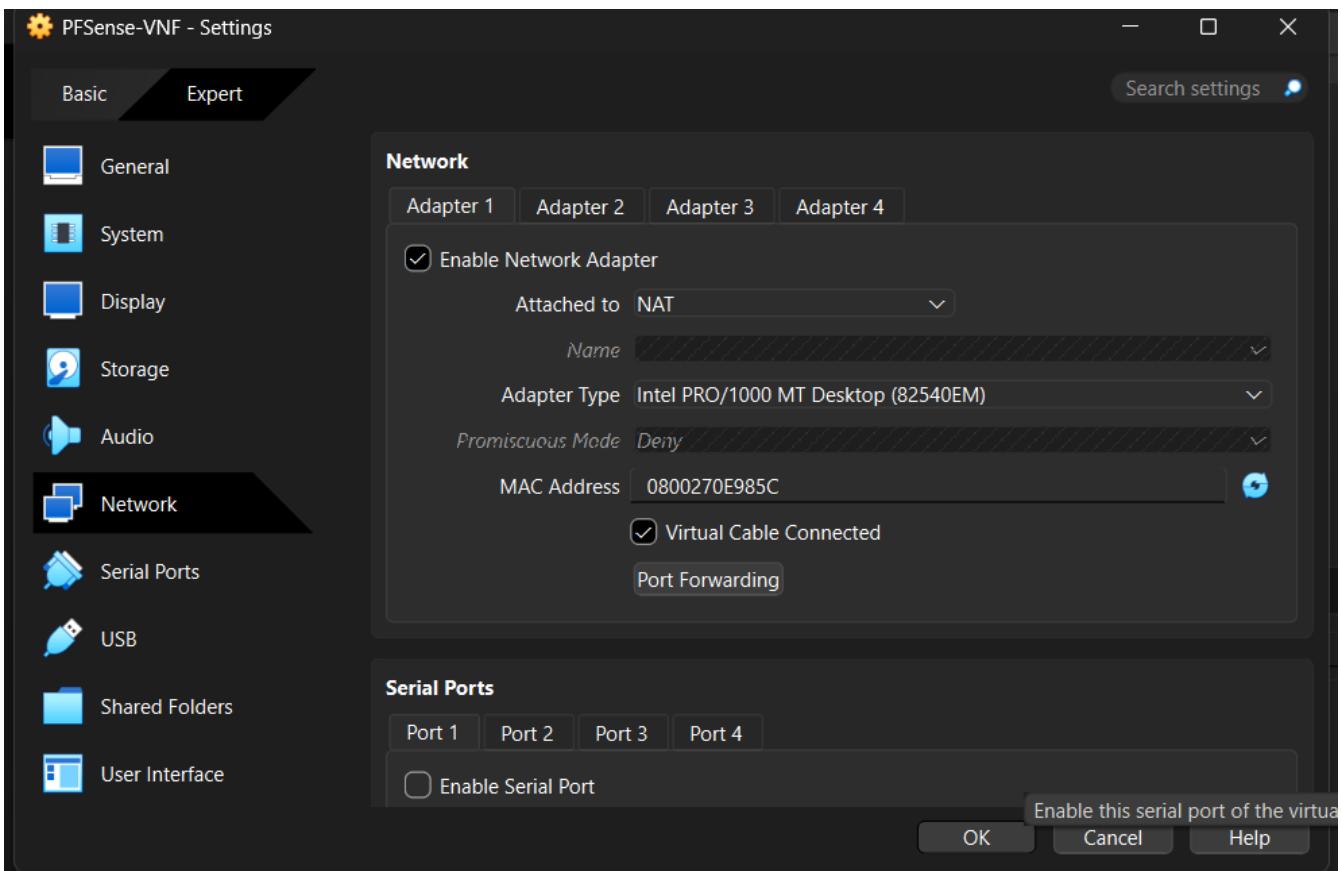


Figure 2: VirtualBox VM list showing the running PFSense-VNF instance and saved Ubuntu VM.

2. Virtual Network Adapter Settings (NAT, Bridged, Host-Only)

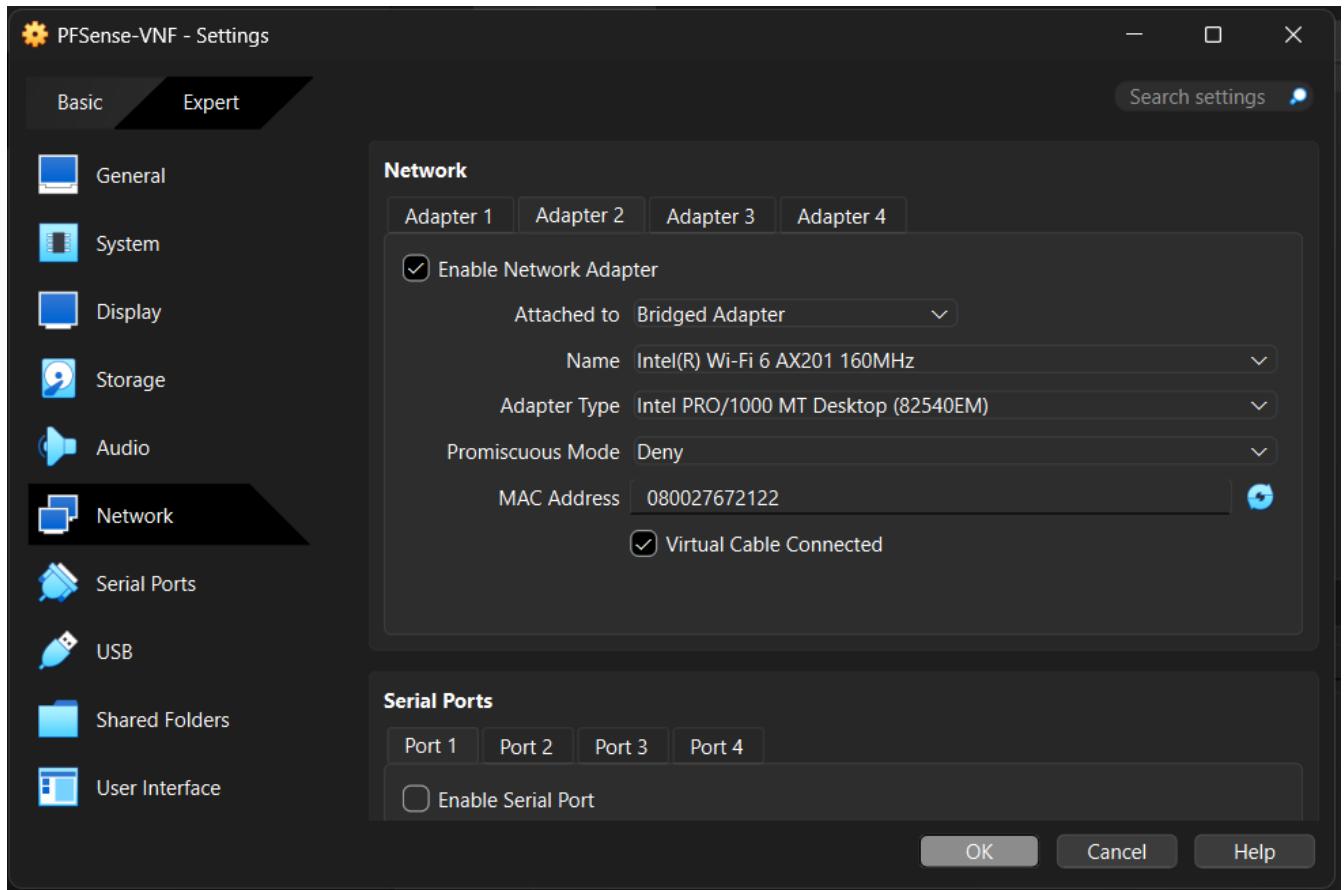


Figure 3: Adapter 1 configured as a NAT adapter to provide upstream internet access for pfSense WAN.

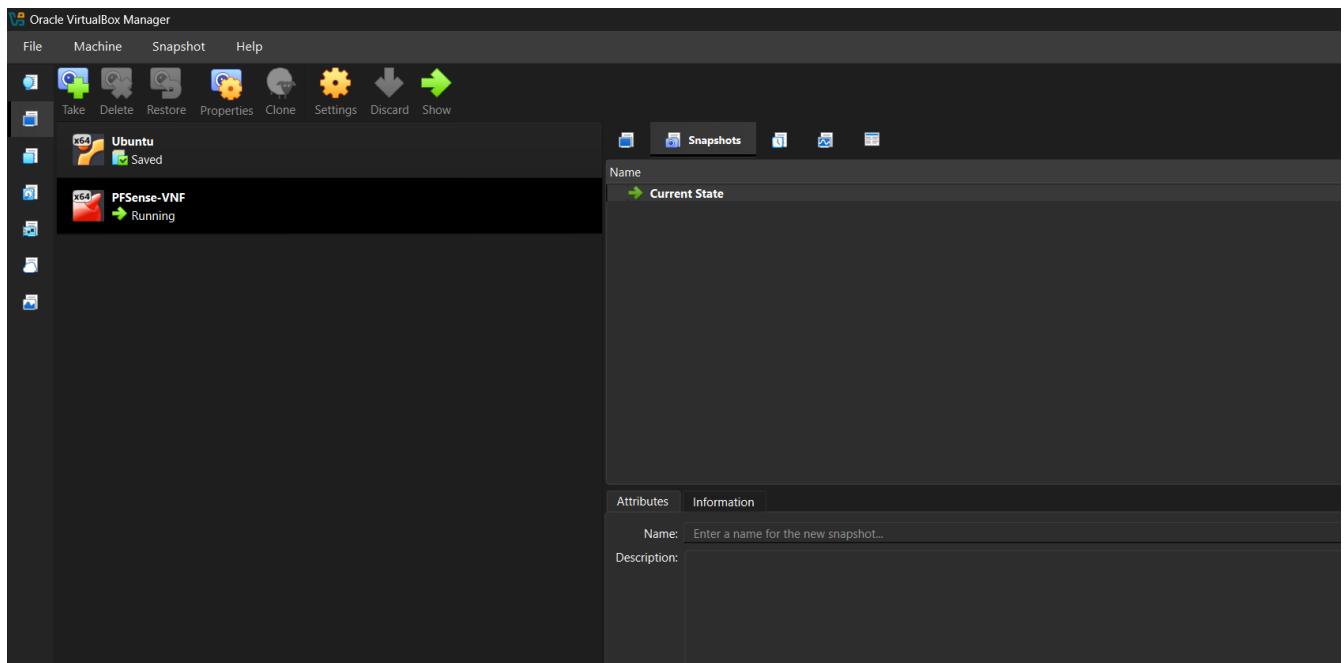


Figure 4: Adapter 2 configured as a Bridged adapter mapped to the physical WiFi NIC for direct LAN connectivity.

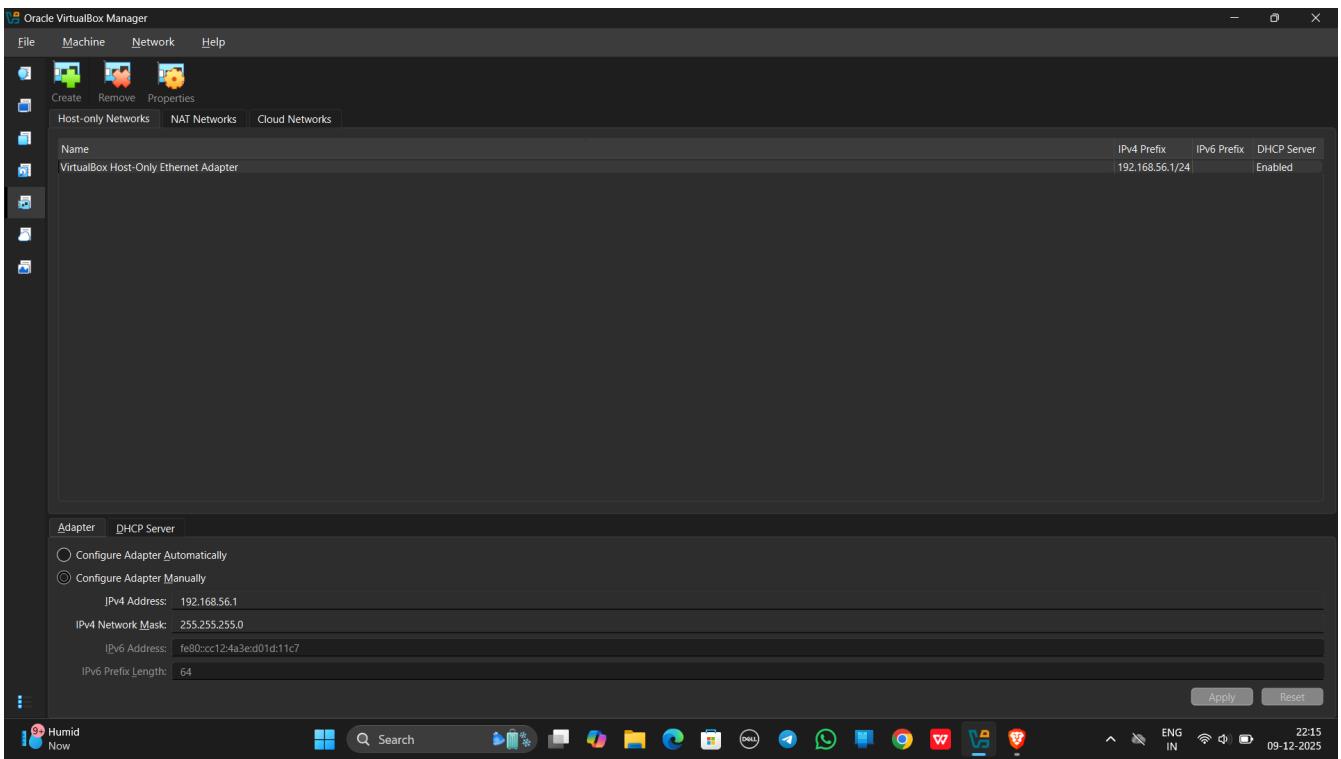


Figure 5: VirtualBox Host-Only network adapter configuration with IPv4 address 192.168.56.1/24.

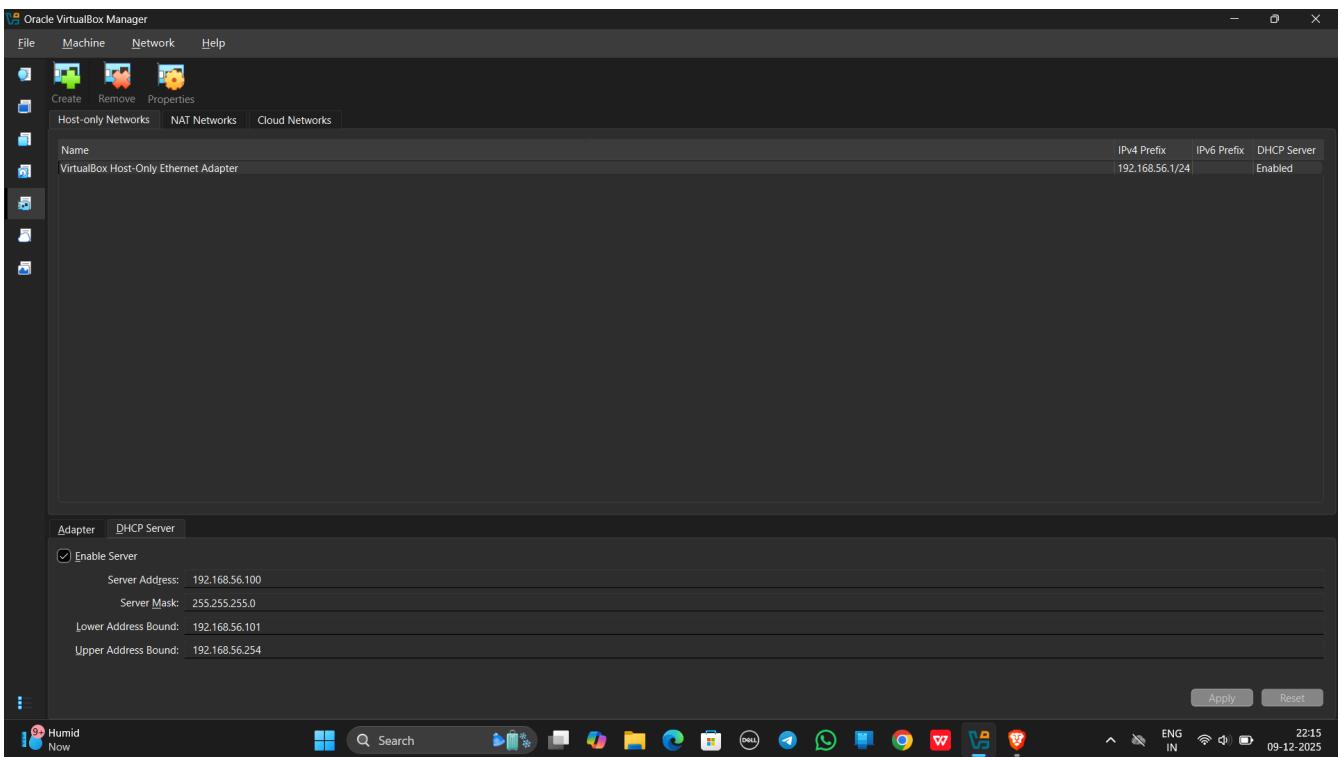


Figure 6: Host-Only DHCP server enabled to automatically assign 192.168.56.x addresses to LAN clients.

3. pfSense Console – Boot and Interface Assignment

```
0) Logout / Disconnect SSH          9) pfTop
1) Assign Interfaces                10) Filter Logs
2) Set interface(s) IP address      11) Restart GUI
3) Reset admin account and password 12) PHP shell + pfSense tools
4) Reset to factory defaults       13) Update from console
5) Reboot system                   14) Enable Secure Shell (sshd)
6) Halt system                     15) Restore recent configuration
7) Ping host                       16) Restart PHP-FPM
8) Shell
```

Enter an option: 8

```
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8): 56 data bytes
64 bytes from 8.8.8.8: icmp_seq=0 ttl=255 time=36.215 ms
64 bytes from 8.8.8.8: icmp_seq=1 ttl=255 time=41.952 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=255 time=22.677 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=255 time=28.817 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=255 time=24.114 ms
^C
--- 8.8.8.8 ping statistics ---
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 22.677/30.755/41.952/7.325 ms
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ]
```

Figure 7: pfSense boot menu inside the VirtualBox console.

```
5) Reboot system                  14) Enable Secure Shell (sshd)
6) Halt system                    15) Restore recent configuration
7) Ping host                      16) Restart PHP-FPM
8) Shell
```

Enter an option: 8

```
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8): 56 data bytes
ping: sendto: No route to host
^C
--- 8.8.8.8 ping statistics ---
12 packets transmitted, 0 packets received, 100.0% packet loss
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ]
```

Figure 8: pfSense main console showing WAN (em0) and LAN (em1) interfaces with DHCP-assigned IPv4 addresses.

4. Connectivity Testing from pfSense Console (Ping & Traceroute)

```
The IPv4 WAN address has been set to dhcp
The IPv6 WAN address has been set to dhcp6
Press <ENTER> to continue.
VirtualBox Virtual Machine - Netgate Device ID: ab646085ecef9e2bd9c2
*** Welcome to pfSense 2.8.1-RELEASE (amd64) on pfSense ***
WAN (wan) -> em0 -> v4/DHCP4: 172.24.240.49/24
                           v6/DHCP6: 2409:40f2:20:8d1b:a00:27ff:fe0e:985c/64
LAN (lan) -> em1 -> v4/DHCP4: 192.168.56.102/24

0) Logout / Disconnect SSH      9) pfTop
1) Assign Interfaces           10) Filter Logs
2) Set interface(s) IP address 11) Restart GUI
3) Reset admin account and password 12) PHP shell + pfSense tools
4) Reset to factory defaults   13) Update from console
5) Reboot system               14) Enable Secure Shell (sshd)
6) Halt system                 15) Restore recent configuration
7) Ping host                   16) Restart PHP-FPM
8) Shell

Enter an option: █
```

Figure 9: Initial ping and traceroute attempts towards 8.8.8.8 showing partial connectivity and packet loss.

```
5) Reboot system               14) Enable Secure Shell (sshd)
6) Halt system                 15) Restore recent configuration
7) Ping host                   16) Restart PHP-FPM
8) Shell

Enter an option: 8

[2.8.1-RELEASE][root@pfSense.home.arpal/root: ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8): 56 data bytes
64 bytes from 8.8.8.8: icmp_seq=0 ttl=111 time=49.076 ms
64 bytes from 8.8.8.8: icmp_seq=1 ttl=111 time=41.061 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=111 time=34.657 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=111 time=33.863 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=111 time=54.406 ms
64 bytes from 8.8.8.8: icmp_seq=5 ttl=111 time=57.701 ms
64 bytes from 8.8.8.8: icmp_seq=6 ttl=111 time=78.109 ms
64 bytes from 8.8.8.8: icmp_seq=7 ttl=111 time=49.638 ms
64 bytes from 8.8.8.8: icmp_seq=8 ttl=111 time=42.196 ms
64 bytes from 8.8.8.8: icmp_seq=9 ttl=111 time=45.934 ms
64 bytes from 8.8.8.8: icmp_seq=10 ttl=111 time=42.996 ms
^C
--- 8.8.8.8 ping statistics ---
11 packets transmitted, 11 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 33.863/48.149/78.109/11.810 ms
[2.8.1-RELEASE][root@pfSense.home.arpal/root: █
```

Figure 10: Successful ICMP echo replies from 8.8.8.8 after correcting network configuration.

```
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ping 192.168.56.102
PING 192.168.56.102 (192.168.56.102): 56 data bytes
64 bytes from 192.168.56.102: icmp_seq=0 ttl=64 time=0.473 ms
64 bytes from 192.168.56.102: icmp_seq=1 ttl=64 time=1.371 ms
64 bytes from 192.168.56.102: icmp_seq=2 ttl=64 time=2.791 ms
64 bytes from 192.168.56.102: icmp_seq=3 ttl=64 time=1.745 ms
64 bytes from 192.168.56.102: icmp_seq=4 ttl=64 time=1.730 ms
64 bytes from 192.168.56.102: icmp_seq=5 ttl=64 time=0.434 ms
64 bytes from 192.168.56.102: icmp_seq=6 ttl=64 time=1.990 ms
^C
--- 192.168.56.102 ping statistics ---
7 packets transmitted, 7 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 0.434/1.505/2.791/0.777 ms
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ping 192.168.56.103
PING 192.168.56.103 (192.168.56.103): 56 data bytes
64 bytes from 192.168.56.103: icmp_seq=0 ttl=64 time=0.730 ms
64 bytes from 192.168.56.103: icmp_seq=1 ttl=64 time=1.037 ms
64 bytes from 192.168.56.103: icmp_seq=2 ttl=64 time=0.719 ms
64 bytes from 192.168.56.103: icmp_seq=3 ttl=64 time=0.855 ms
64 bytes from 192.168.56.103: icmp_seq=4 ttl=64 time=2.524 ms
^C
--- 192.168.56.103 ping statistics ---
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 0.719/1.173/2.524/0.685 ms
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ]
```

Figure 11: Stable ping statistics to 8.8.8.8 with 0% packet loss, confirming outbound routing via WAN.

```
2) Set interface(s) IP address      11) Restart GUI
3) Reset admin account and password 12) PHP shell + pfSense tools
4) Reset to factory defaults       13) Update from console
5) Reboot system                   14) Enable Secure Shell (sshd)
6) Halt system                     15) Restore recent configuration
7) Ping host                       16) Restart PHP-FPM
8) Shell
```

Enter an option: 8

```
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8): 56 data bytes
ping: sendto: No route to host
^C
--- 8.8.8.8 ping statistics ---
5 packets transmitted, 0 packets received, 100.0% packet loss
[2.8.1-RELEASE][root@pfSense.home.arpal/root: traceroute 8
traceroute: findsaddr: failed to connect to peer for src addr selection.
[2.8.1-RELEASE][root@pfSense.home.arpal/root: traceroute 8.8.8.8
traceroute: findsaddr: failed to connect to peer for src addr selection.
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ]
```

Figure 12: Connectivity tests from pfSense to internal host-only addresses 192.168.56.102 and 192.168.56.103.

```

5 packets transmitted, 0 packets received, 100.0% packet loss
[2.8.1-RELEASE][root@pfSense.home.arpal/root: traceroute 8
traceroute: findsaddr: failed to connect to peer for src addr selection.
[2.8.1-RELEASE][root@pfSense.home.arpal/root: traceroute 8.8.8.8
traceroute: findsaddr: failed to connect to peer for src addr selection.
[2.8.1-RELEASE][root@pfSense.home.arpal/root: tcpdump -i em0
tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on em0, link-type EN10MB (Ethernet), snapshot length 262144 bytes
15:52:11.620418 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor solicitation, who has fe80::2, length 32
15:52:12.799834 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor solicitation, who has fe80::2, length 32
15:52:13.800192 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor solicitation, who has fe80::2, length 32
15:52:14.850445 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor solicitation, who has fe80::2, length 32
15:52:15.994407 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor solicitation, who has fe80::2, length 32
15:52:17.009083 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor solicitation, who has fe80::2, length 32
^C
6 packets captured
6 packets received by filter
0 packets dropped by kernel
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ]

```

Figure 13: Example of ping and traceroute failures to 8.8.8.8 illustrating misconfiguration or upstream outage.

```

6) Halt system          15) Restore recent configuration
7) Ping host           16) Restart PHP-FPM
8) Shell

Enter an option: 8

[2.8.1-RELEASE][root@pfSense.home.arpal/root: ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8): 56 data bytes
64 bytes from 8.8.8.8: icmp_seq=0 ttl=118 time=22.465 ms
64 bytes from 8.8.8.8: icmp_seq=1 ttl=118 time=22.536 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=118 time=23.957 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=118 time=22.853 ms
64 bytes from 8.8.8.8: icmp_seq=5 ttl=118 time=20.093 ms
^C
--- 8.8.8.8 ping statistics ---
7 packets transmitted, 5 packets received, 28.6% packet loss
round-trip min/avg/max/stddev = 20.093/22.381/23.957/1.263 ms
[2.8.1-RELEASE][root@pfSense.home.arpal/root: traceroute 8.8.8.8
traceroute to 8.8.8.8 (8.8.8.8), 64 hops max, 40 byte packets
 1  192.168.1.1 (192.168.1.1)  60.504 ms  7.523 ms  13.889 ms
 2  * * *
 3  * * *
 4  * * *
 5  *^C
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ]

```

Figure 14: Final successful connectivity to 8.8.8.8 after resolving routing and DNS issues.

5. Packet Capture and Analysis using tcpdump

```

olicitation, who has fe80::2, length 32
15:52:17.009083 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor s
olicitation, who has fe80::2, length 32
^C
6 packets captured
6 packets received by filter
0 packets dropped by kernel
[2.8.1-RELEASE][root@pfSense.home.arpal/root: tcpdump -i em1
tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on em1, link-type EN10MB (Ethernet), snapshot length 262144 bytes
15:54:42.942414 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor s
olicitation, who has fe80::2, length 32
15:54:43.940892 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor s
olicitation, who has fe80::2, length 32
15:54:44.940510 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor s
olicitation, who has fe80::2, length 32
15:54:46.086461 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor s
olicitation, who has fe80::2, length 32
15:54:47.086790 IP6 fe80::a00:27ff:fe0e:985c > ff02::1:ff00:2: ICMP6, neighbor s
olicitation, who has fe80::2, length 32
^C
5 packets captured
5 packets received by filter
0 packets dropped by kernel
[2.8.1-RELEASE][root@pfSense.home.arpal/root: ]

```

Figure 15: tcpdump running on interface em0 capturing ICMPv6 neighbor solicitation traffic.

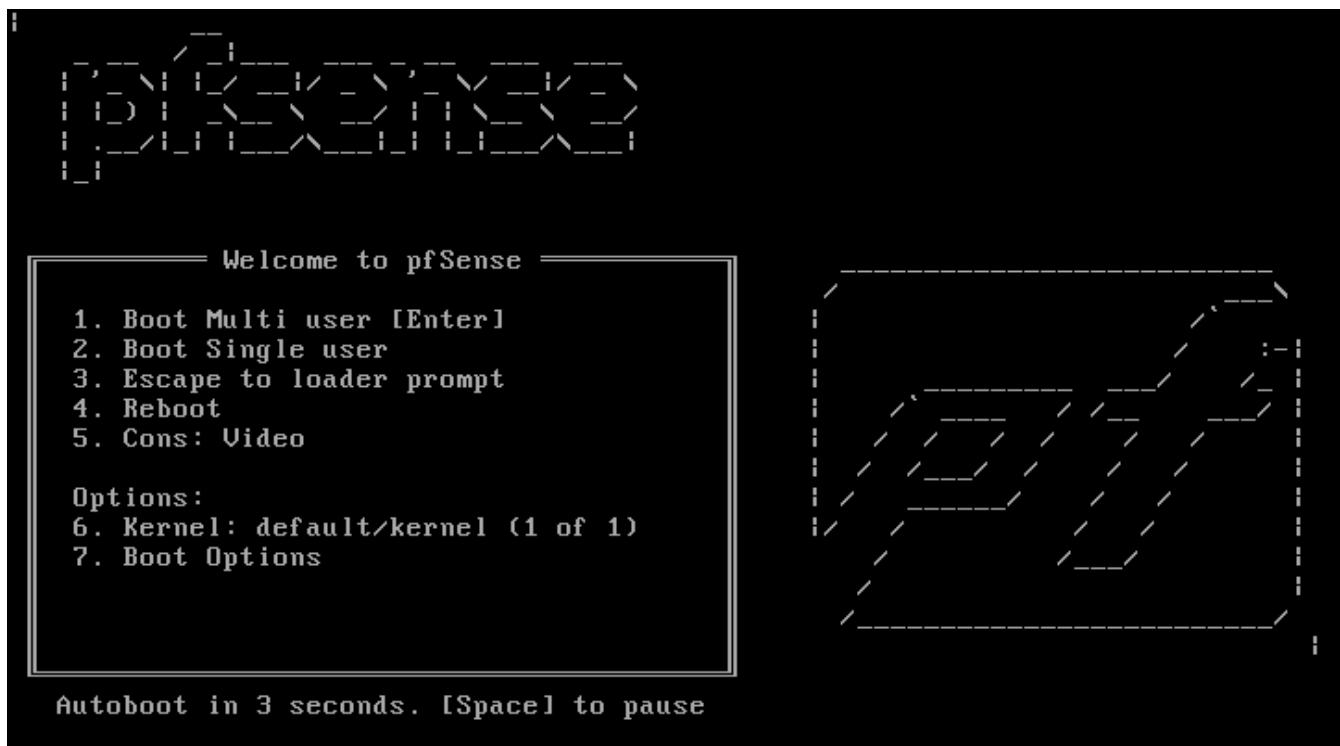


Figure 16: tcpdump running on interface em1 capturing LAN-side IPv6 packets and verifying bidirectional traffic.

6. pfSense Web GUI – Login, Interfaces and Dashboard

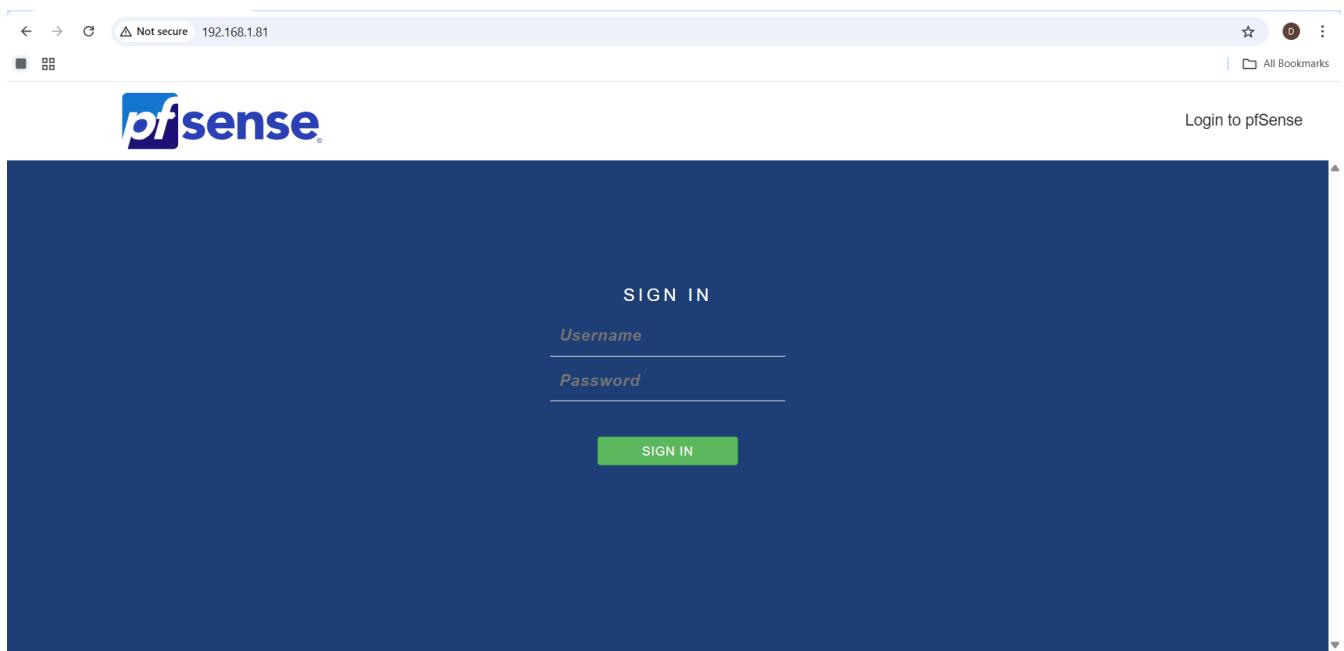


Figure 17: pfSense Web GUI login page accessed via the LAN IP (HTTPS).

A screenshot of the pfSense Web GUI showing the 'Interfaces / Interface Assignments' page. The URL bar shows 'Not secure 192.168.1.81/interfaces_assign.php'. A red warning box at the top states: 'WARNING: The password for this account is insecure. Password is currently set to the default value (pfSense). Change the password as soon as possible.' Below this, the interface assignments table shows two entries: 'WAN' mapped to 'em0' and 'LAN' mapped to 'em1'. A 'Save' button is visible. At the bottom, there are notes about lagg interfaces and wireless interface creation.

Figure 18: Web GUI interface assignment page showing WAN mapped to em0 and LAN mapped to em1.

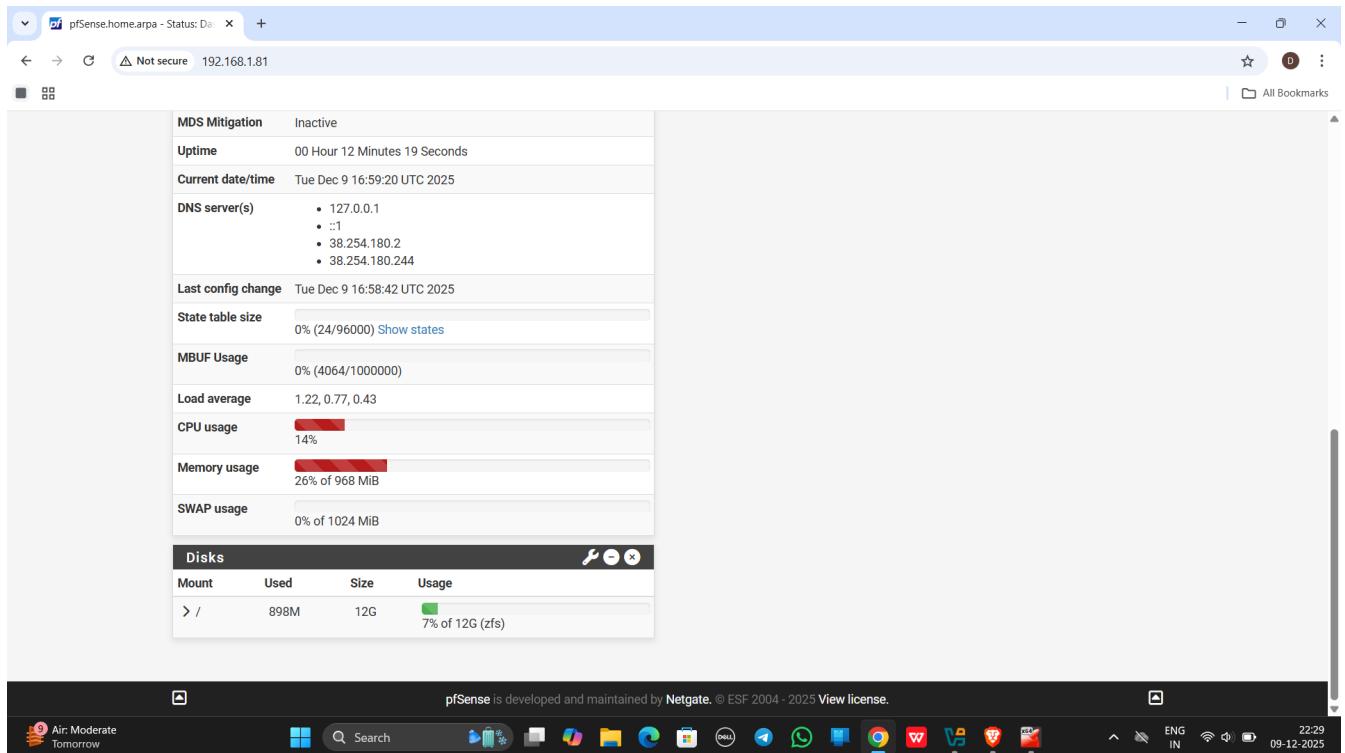


Figure 19: pfSense dashboard status view displaying system uptime, CPU/memory usage and disk utilization.