Firewall Configuration with pfsense

Executive Summary

This project aimed to leverage virtualization to design and deploy a secure and efficient system comprising external and internal virtual machines (VMs) interconnected via a firewall VM, equipped with dual Network Interface Cards (NICs). The primary goal of this endeavor was to enhance network security, streamline communication between external and internal environments, and optimize resource utilization.

Requirements:

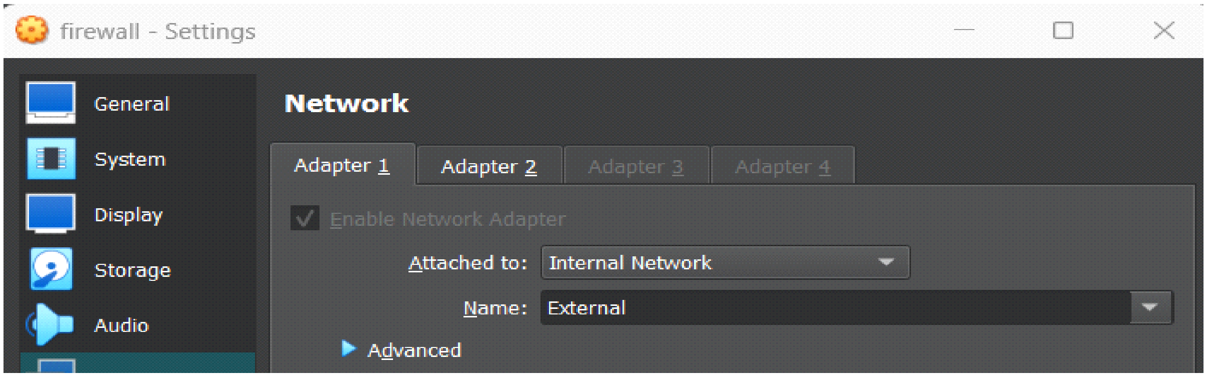
Virtualization hypervisor - Oracle VirtualBox 7.0.4

Open-source firewall - pfSense 2.6

Internal and external virtual machines - windows 2016 server.

Construction of machines:

The pfsense firewall had 2 Network adapters that are set to internal network. I gave them 2 different names i.e.; one was 'Internal' and the other is was 'External'

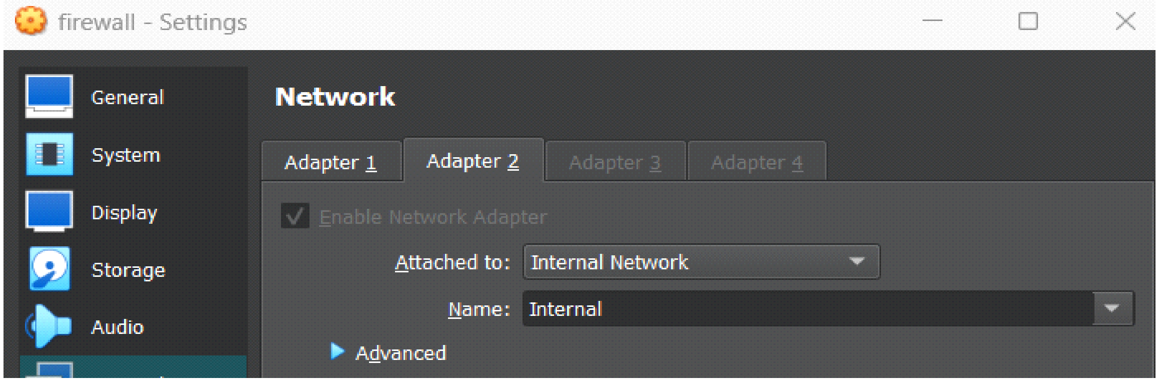


firewall - Settings

Network

Attached to: Internal Network

Name: External

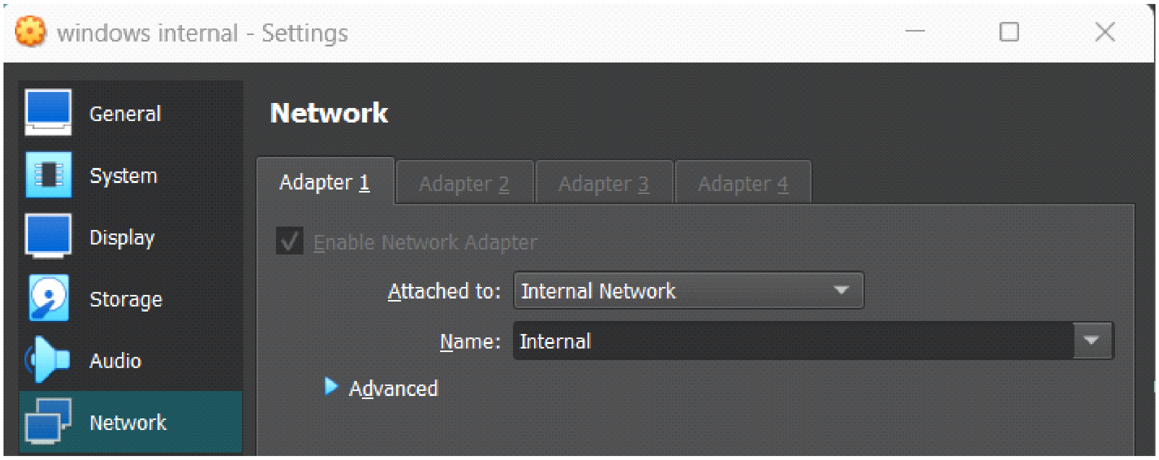


☑ Enable Network Adapter

Attached to: Internal Network

Name: Internal

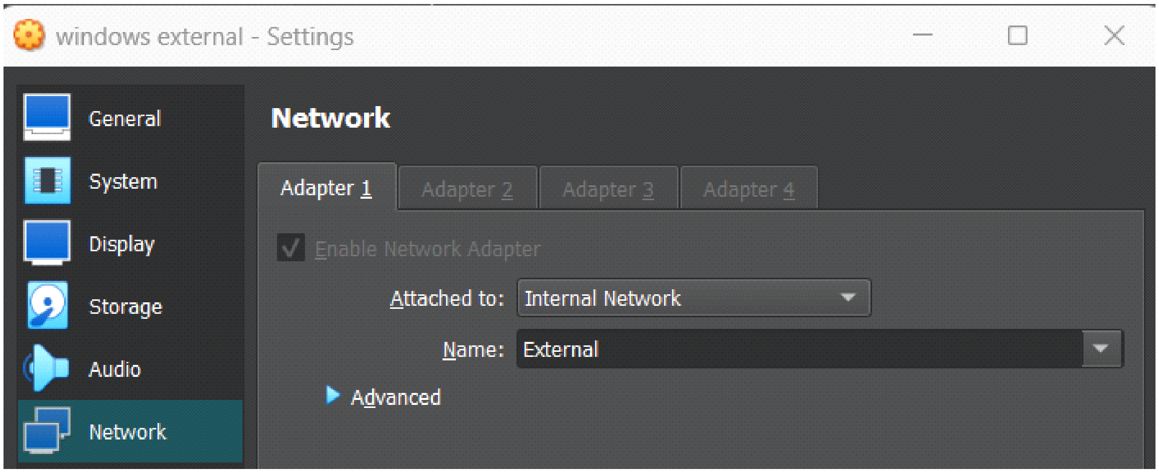
Both the windows server 2016 machines were attached to internal network. Since I had already given 2 names for adapter when we setup the firewall. external machine was set to 'External' and internal machine was set to 'Internal'.



☑ Enable Network Adapter

Attached to: Internal Network

Name: Internal



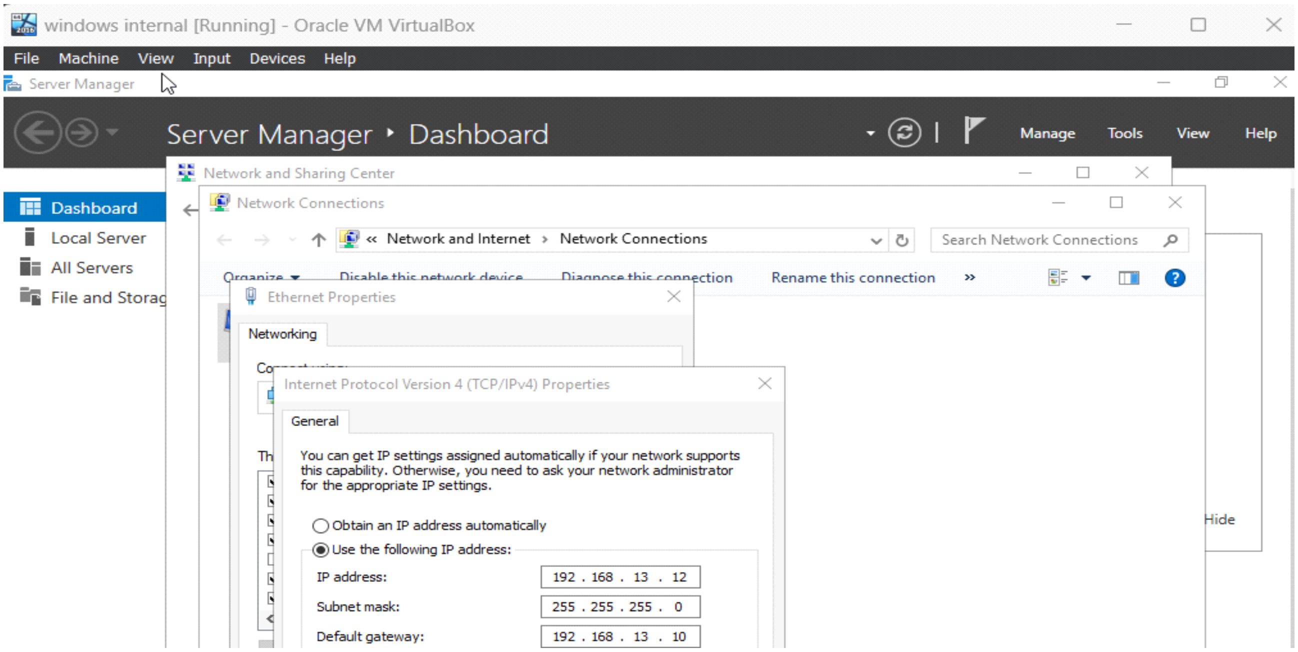
☑ Enable Network Adapter

Attached to: Internal Network

Name: External

After I customized each virtual machine according to the host system specifications and importing the iso files, I installed the operating systems in the respective VMs.

In pfsense, since I attached 2 network adapters. I saw only see IP address for LAN. The addresses of WAN and LAN was the gateway the IP address of External and Internal machine respectively. Next, I configured both external and internal machines. By default, both the windows machines were allocated with random IP and gateway addresses. I changed IP and gateway address of both machines to class C address as shown below.


windows internal [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Server Manager
Server Manager ‣ Dashboard
Manage Tools View Help
Dashboard
Local Server
All Servers
File and Storag
Network and Sharing Center
Network Connections
« Network and Internet › Network Connections
Search Network Connections
Organize ▾ Disable this network device Diagnose this connection Rename this connection »
Ethernet Properties
Networking
Hide

Internet Protocol Version 4 (TCP/IPv4) Properties

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

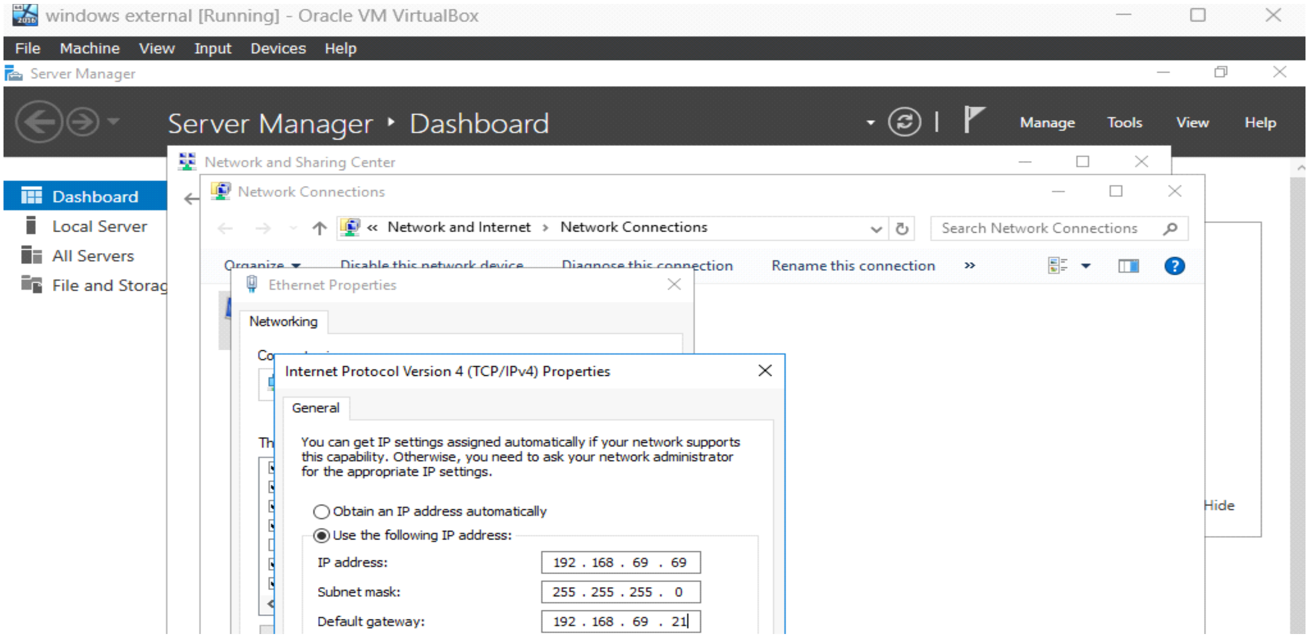
○ Obtain an IP address automatically

● Use the following IP address:

IP address: 192 . 168 . 13 . 12

Subnet mask: 255 . 255 . 255 . 0

Default gateway: 192 . 168 . 13 . 10


windows external [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Server Manager
Server Manager ‣ Dashboard
Manage Tools View Help
Dashboard
Local Server
All Servers
File and Storag
Network and Sharing Center
Network Connections
« Network and Internet › Network Connections
Search Network Connections
Organize ▾ Disable this network device Diagnose this connection Rename this connection »
Ethernet Properties
Networking
Hide

Internet Protocol Version 4 (TCP/IPv4) Properties

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

○ Obtain an IP address automatically

● Use the following IP address:

IP address: 192 . 168 . 69 . 69

Subnet mask: 255 . 255 . 255 . 0

Default gateway: 192 . 168 . 69 . 21

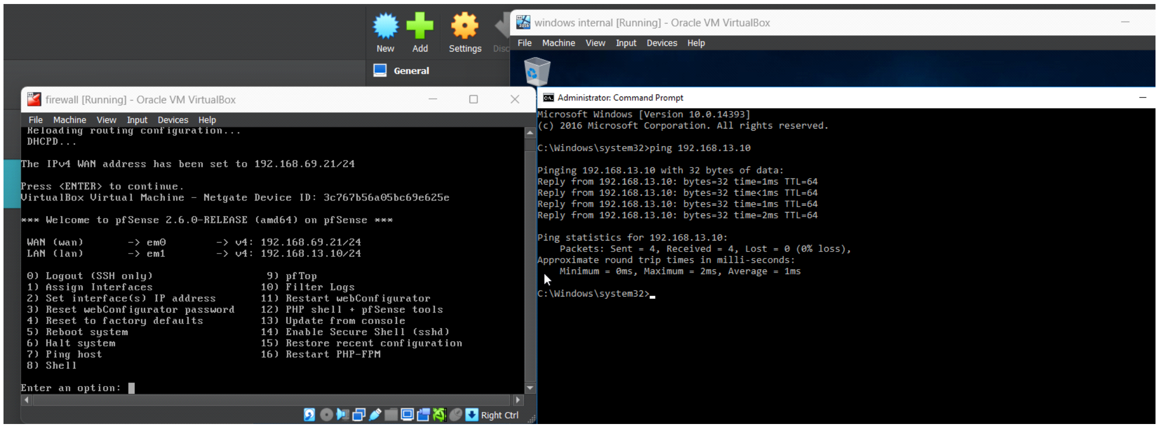
IP address of external machine: 192.168.69.69

Gateway address of external machine/ WAN address of firewall: 192.168.69.21

IP address of internal machine: 192.168.13.12

Gateway address of internal machine/LAN address of firewall: 192.168.13.10

After I configured the networks, I pinged the internal machine to firewall as shown below.

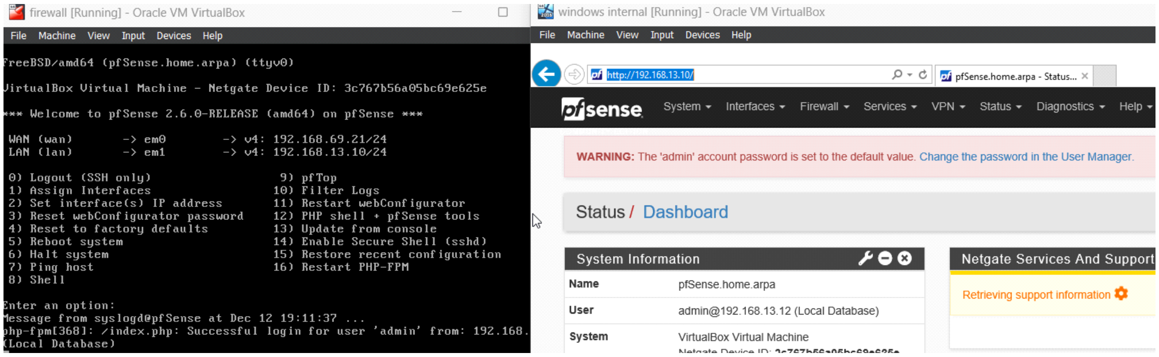

New
Add
Settings
General
firewall [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Right Ctrl
windows internal [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Administrator: Command Prompt

```
Reloading routing configuration...
DHCPD...

The IPv4 WAN address has been set to 192.168.69.21/24

Press <ENTER> to continue.
VirtualBox Virtual Machine - Netgate Device ID: 3c767b56a05bc69e625e

*** Welcome to pfSense 2.6.0-RELEASE (amd64) on pfSense ***

 WAN (wan)       -> em0        -> v4: 192.168.69.21/24
 LAN (lan)       -> em1        -> v4: 192.168.13.10/24

 0) Logout (SSH only)                  9) pfTop
 1) Assign Interfaces                 10) Filter Logs
 2) Set interface(s) IP address       11) Restart webConfigurator
 3) Reset webConfigurator 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: 
```

```
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserved.

C:\Windows\system32>ping 192.168.13.10

Pinging 192.168.13.10 with 32 bytes of data:
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64
Reply from 192.168.13.10: bytes=32 time<1ms TTL=64
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64
Reply from 192.168.13.10: bytes=32 time=2ms TTL=64

Ping statistics for 192.168.13.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 2ms, Average = 1ms

C:\Windows\system32>_
```

That meant I had access to pfsense web interface with the gateway address of LAN on internal machine.

After I logged on pfsense I could access all the default rules and components of pfsense.


firewall [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
windows internal [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
http://192.168.13.10/
pfSense.home.arpa - Status...
pfsense
System
Interfaces
Firewall
Services
VPN
Status
Diagnostics
Help

```
FreeBSD/amd64 (pfSense.home.arpa) (ttyv0)

VirtualBox Virtual Machine - Netgate Device ID: 3c767b56a05bc69e625e

*** Welcome to pfSense 2.6.0-RELEASE (amd64) on pfSense ***

 WAN (wan)       -> em0        -> v4: 192.168.69.21/24
 LAN (lan)       -> em1        -> v4: 192.168.13.10/24

 0) Logout (SSH only)                  9) pfTop
 1) Assign Interfaces                 10) Filter Logs
 2) Set interface(s) IP address       11) Restart webConfigurator
 3) Reset webConfigurator 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:
Message from syslogd@pfSense at Dec 12 19:11:37 ...
php-fpm[368]: /index.php: Successful login for user 'admin' from: 192.168.
(Local Database)
```

WARNING: The 'admin' account password is set to the default value. Change the password in the User Manager.

Status / Dashboard

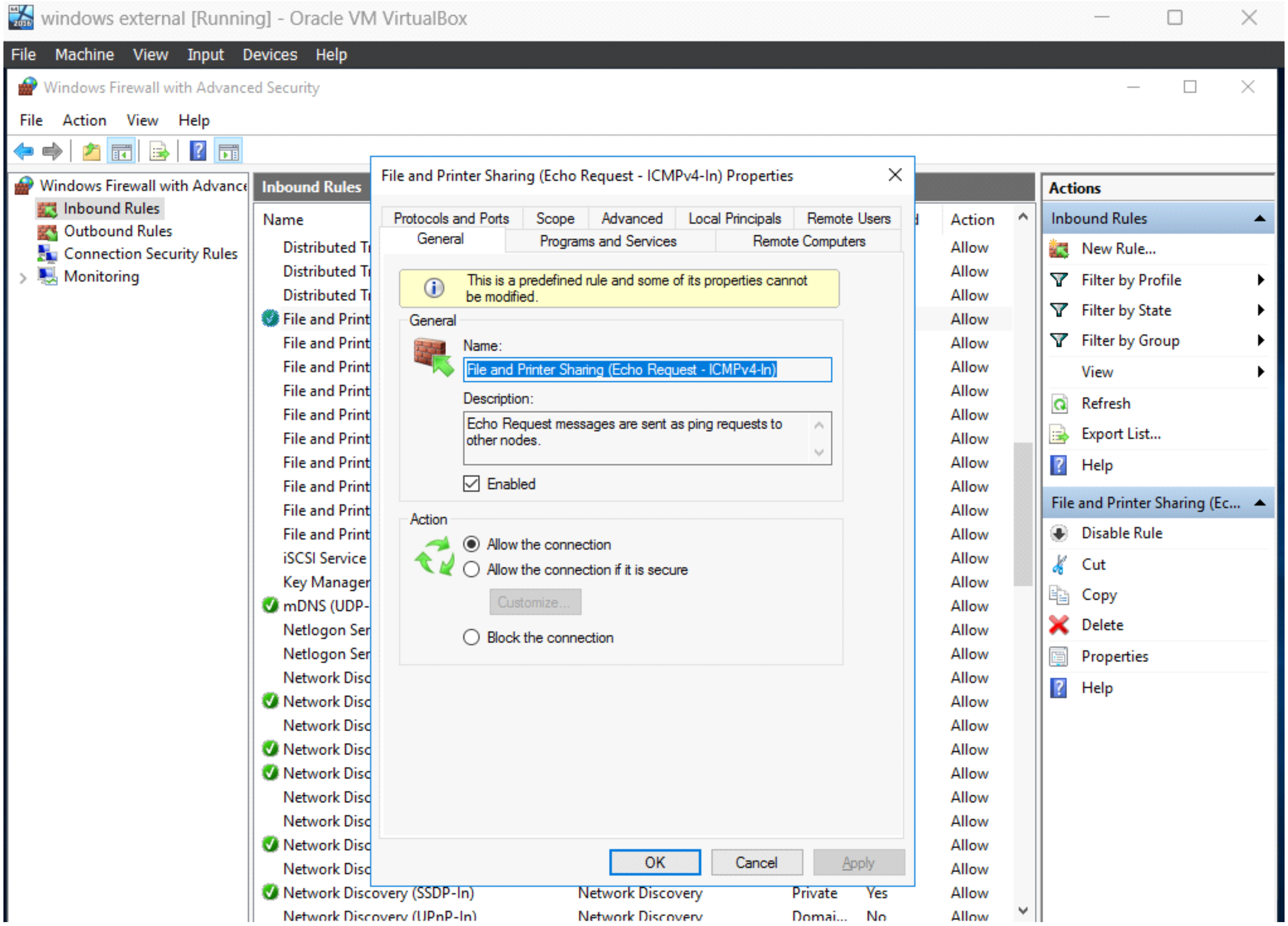
System Information

Name	pfSense.home.arpa
User	admin@192.168.13.12 (Local Database)
System	VirtualBox Virtual Machine Netgate Device ID: 3c767b56a05bc69e625e

Netgate Services And Support

Retrieving support information

First, I was not be able to ping with external network because of the firewall restrictions in windows.



File and Printer Sharing (Echo Request - ICMPv4-In) Properties

This is a predefined rule and some of its properties cannot be modified.

General

Name:
File and Printer Sharing (Echo Request - ICMPv4-In)

Description:
Echo Request messages are sent as ping requests to other nodes.

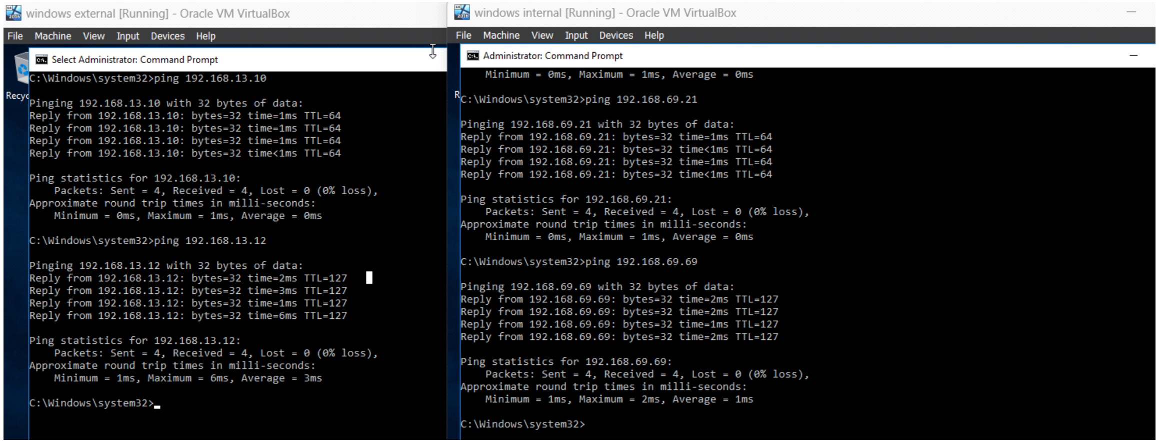
☑ Enabled

Action

● Allow the connection

○ Allow the connection if it is secure

○ Block the connection

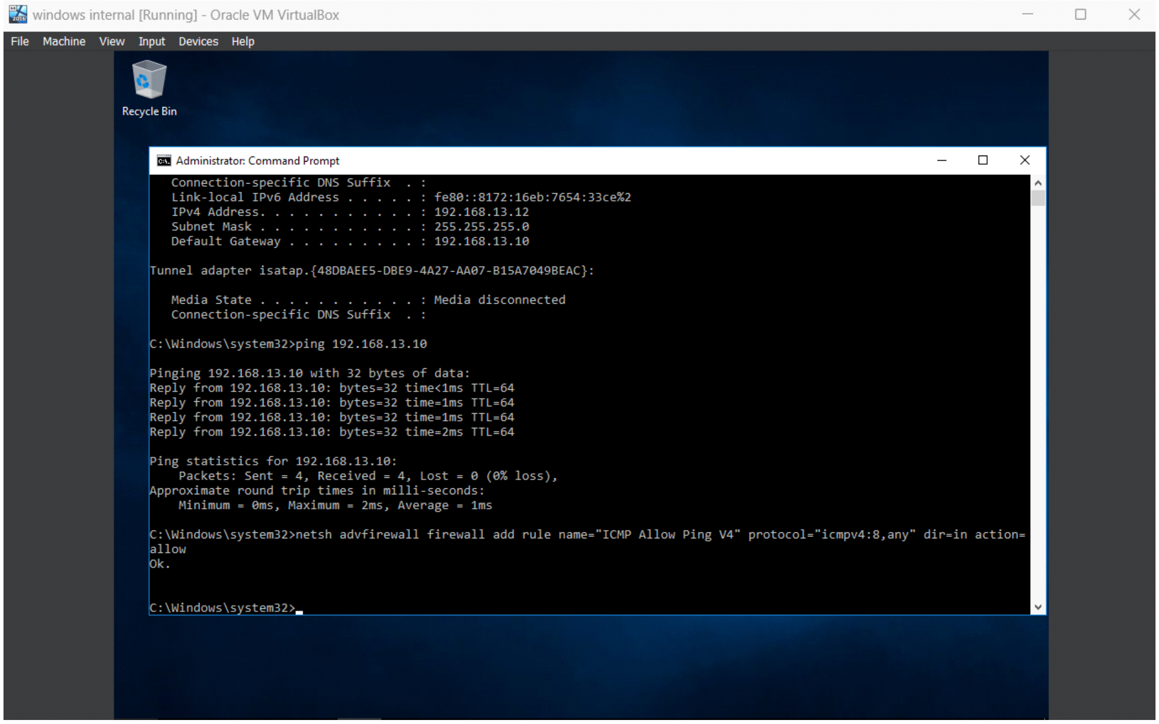


windows external [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Select Administrator: Command Prompt
windows internal [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Administrator: Command Prompt

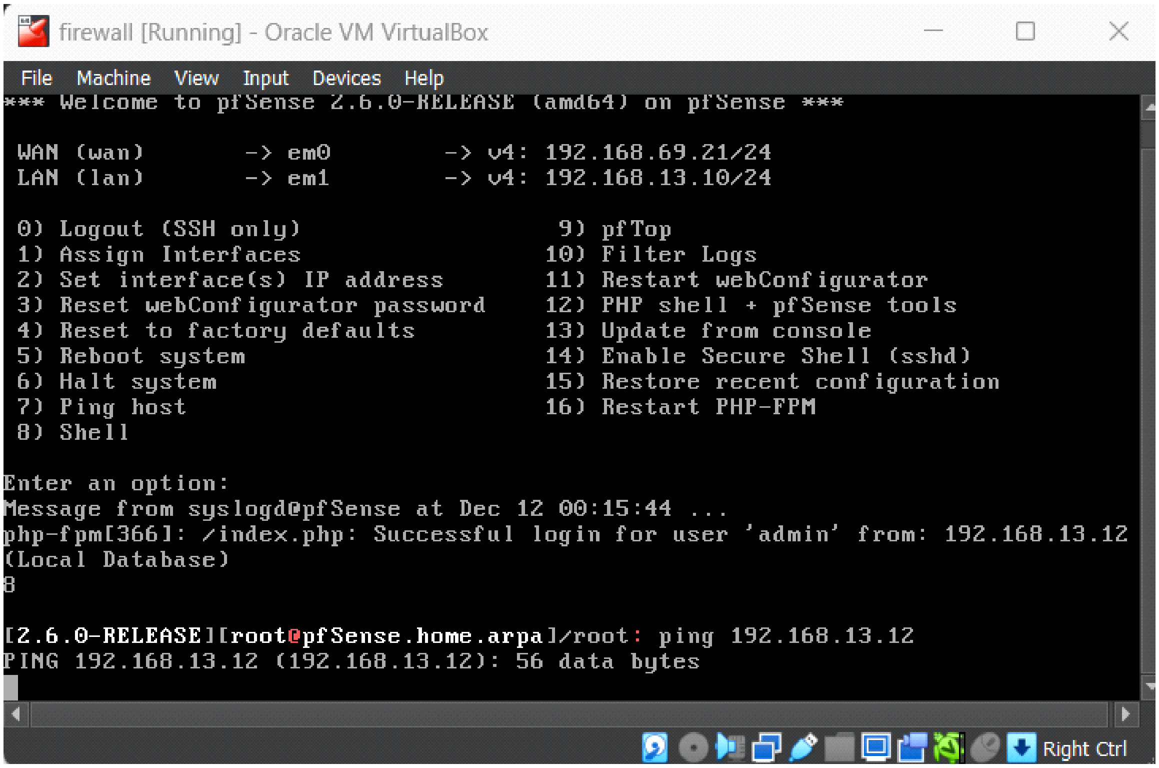
```
C:\Windows\system32>ping 192.168.13.10

Pinging 192.168.13.10 with 32 bytes of data:
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64
Reply from 192.168.13.10: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.13.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Windows\system32>ping 192.168.13.12

Pinging 192.168.13.12 with 32 bytes of data:
Reply from 192.168.13.12: bytes=32 time=2ms TTL=127
Reply from 192.168.13.12: bytes=32 time=3ms TTL=127
Reply from 192.168.13.12: bytes=32 time=1ms TTL=127
Reply from 192.168.13.12: bytes=32 time=6ms TTL=127

Ping statistics for 192.168.13.12:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 6ms, Average = 3ms

C:\Windows\system32>_
```

```
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Windows\system32>ping 192.168.69.21

Pinging 192.168.69.21 with 32 bytes of data:
Reply from 192.168.69.21: bytes=32 time=1ms TTL=64
Reply from 192.168.69.21: bytes=32 time<1ms TTL=64
Reply from 192.168.69.21: bytes=32 time=1ms TTL=64
Reply from 192.168.69.21: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.69.21:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\Windows\system32>ping 192.168.69.69

Pinging 192.168.69.69 with 32 bytes of data:
Reply from 192.168.69.69: bytes=32 time=2ms TTL=127
Reply from 192.168.69.69: bytes=32 time=2ms TTL=127
Reply from 192.168.69.69: bytes=32 time=1ms TTL=127
Reply from 192.168.69.69: bytes=32 time=2ms TTL=127

Ping statistics for 192.168.69.69:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 2ms, Average = 1ms

C:\Windows\system32>
```

I was able to ping from firewall to both the machines with the following command as shown in below screenshot.


windows internal [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Recycle Bin
Administrator: Command Prompt

```
   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::8172:16eb:7654:33ce%2
   IPv4 Address. . . . . . . . . . . : 192.168.13.12
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 192.168.13.10

Tunnel adapter isatap.{48DBAEE5-DBE9-4A27-AA07-B15A7049BEAC}:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

C:\Windows\system32>ping 192.168.13.10

Pinging 192.168.13.10 with 32 bytes of data:
Reply from 192.168.13.10: bytes=32 time<1ms TTL=64
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64
Reply from 192.168.13.10: bytes=32 time=2ms TTL=64

Ping statistics for 192.168.13.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 2ms, Average = 1ms

C:\Windows\system32>netsh advfirewall firewall add rule name="ICMP Allow Ping V4" protocol="icmpv4:8,any" dir=in action=
allow
Ok.


C:\Windows\system32>
```

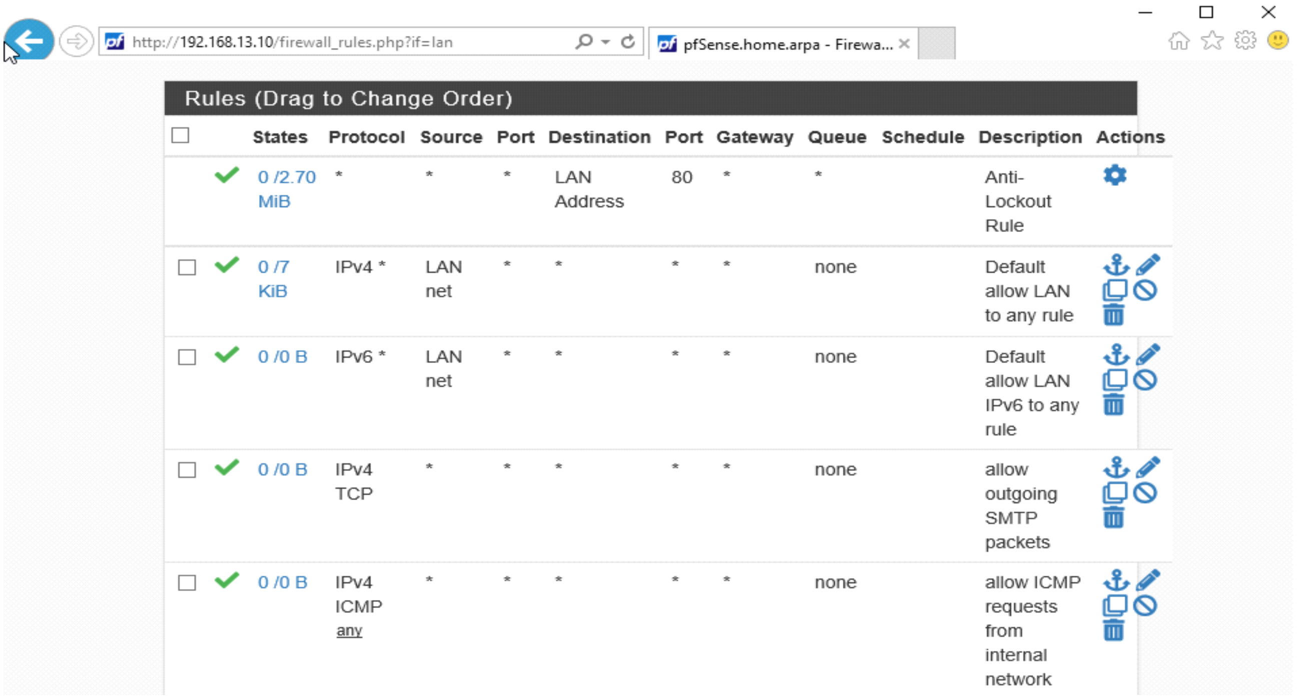

firewall [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Right Ctrl

```
*** Welcome to pfSense 2.6.0-RELEASE (amd64) on pfSense ***

 WAN (wan)       -> em0       -> v4: 192.168.69.21/24
 LAN (lan)       -> em1       -> v4: 192.168.13.10/24

 0) Logout (SSH only)                  9) pfTop
 1) Assign Interfaces                 10) Filter Logs
 2) Set interface(s) IP address       11) Restart webConfigurator
 3) Reset webConfigurator 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:
Message from syslogd@pfSense at Dec 12 00:15:44 ...
php-fpm[366]: /index.php: Successful login for user 'admin' from: 192.168.13.12
(Local Database)
8

[2.6.0-RELEASE][root@pfSense.home.arpa]/root: ping 192.168.13.12
PING 192.168.13.12 (192.168.13.12): 56 data bytes
```

I accessed pfsense and implement rules for firewall.

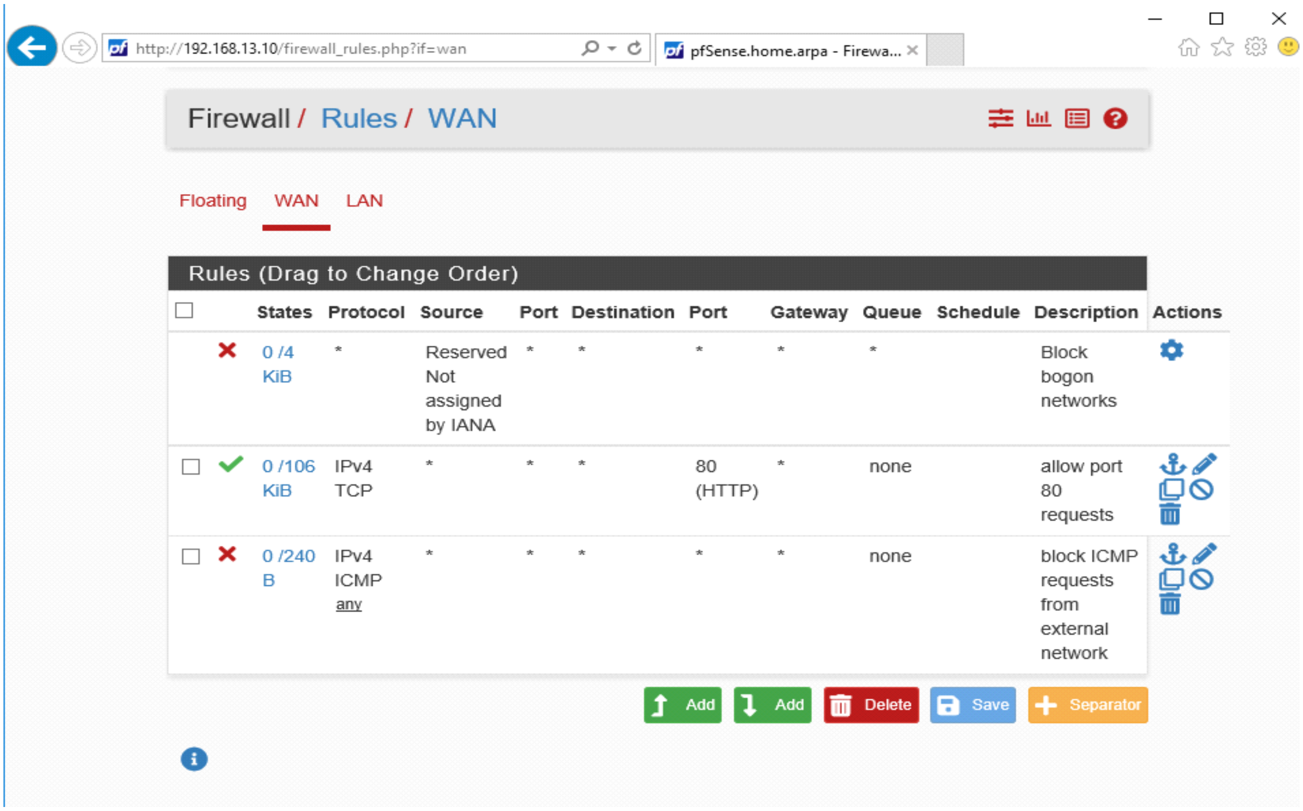
Firewall configuration:

- **Block external ICMP messages (ping, traceroute, etc.), but should allow these from interior clients.**


http://192.168.13.10/firewall_rules.php?if=lan
pfSense.home.arpa - Firewa...

Rules (Drag to Change Order)

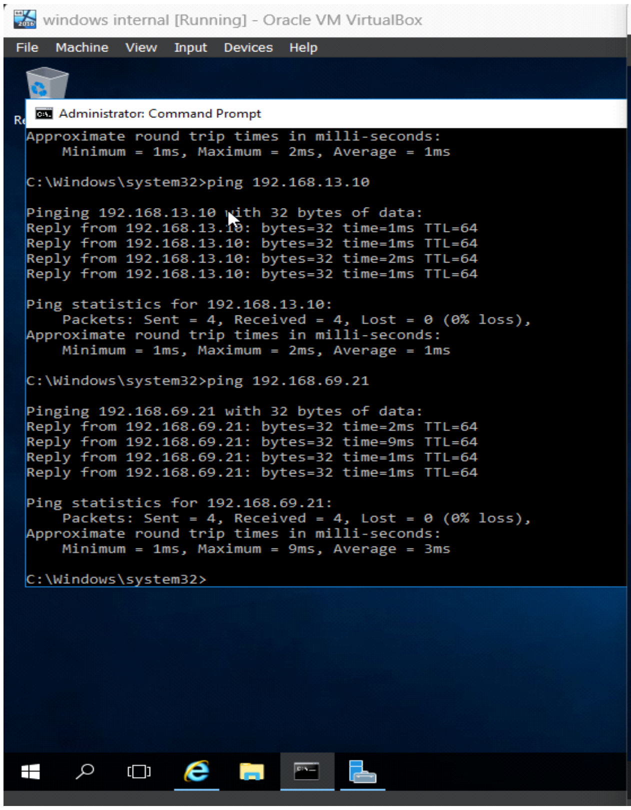
□		States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
	✓	0 /2.70 MiB	*	*	*	LAN Address	80	*	*		Anti-Lockout Rule	
□	✓	0 /7 KiB	IPv4 *	LAN net	*	*	*	*	none		Default allow LAN to any rule	
□	✓	0 /0 B	IPv6 *	LAN net	*	*	*	*	none		Default allow LAN IPv6 to any rule	
□	✓	0 /0 B	IPv4 TCP	*	*	*	*	*	none		allow outgoing SMTP packets	
□	✓	0 /0 B	IPv4 ICMP any	*	*	*	*	*	none		allow ICMP requests from internal network	


http://192.168.13.10/firewall_rules.php?if=wan
pfSense.home.arpa - Firewa...
Firewall / Rules / WAN
Floating
WAN
LAN
Add
Add
Delete
Save
Separator

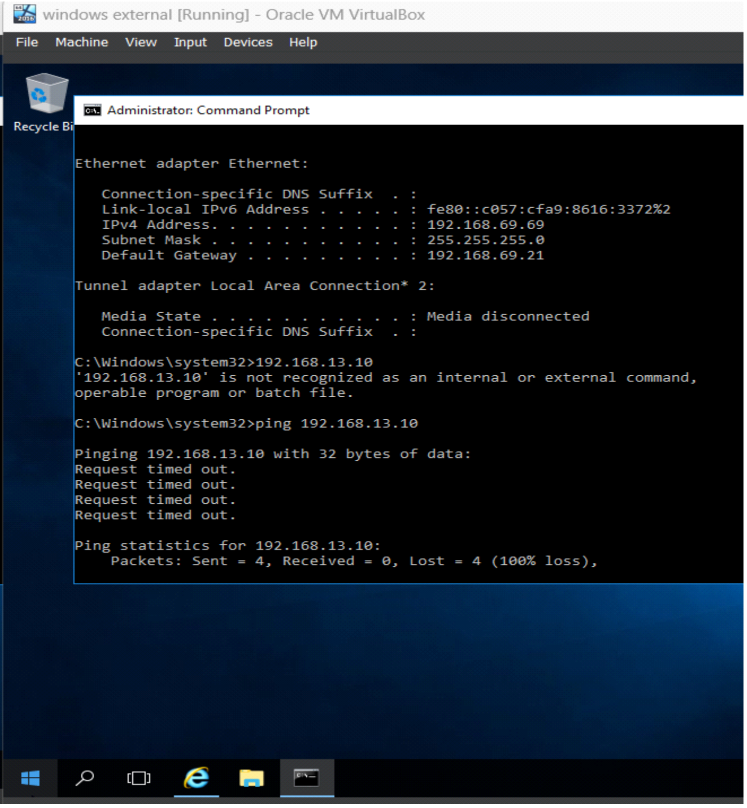
Rules (Drag to Change Order)

□		States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
	✗	0 /4 KiB	*	Reserved Not assigned by IANA	*	*	*	*	*		Block bogon networks	⚙
□	✓	0 /106 KiB	IPv4 TCP	*	*	*	80 (HTTP)	*	none		allow port 80 requests	
□	✗	0 /240 B	IPv4 ICMP any	*	*	*	*	*	none		block ICMP requests from external network	

In pfsense web configuration the settings were applied such that firewall blocks ICMP messages from external network but allows when requested by internal network, As shown below.

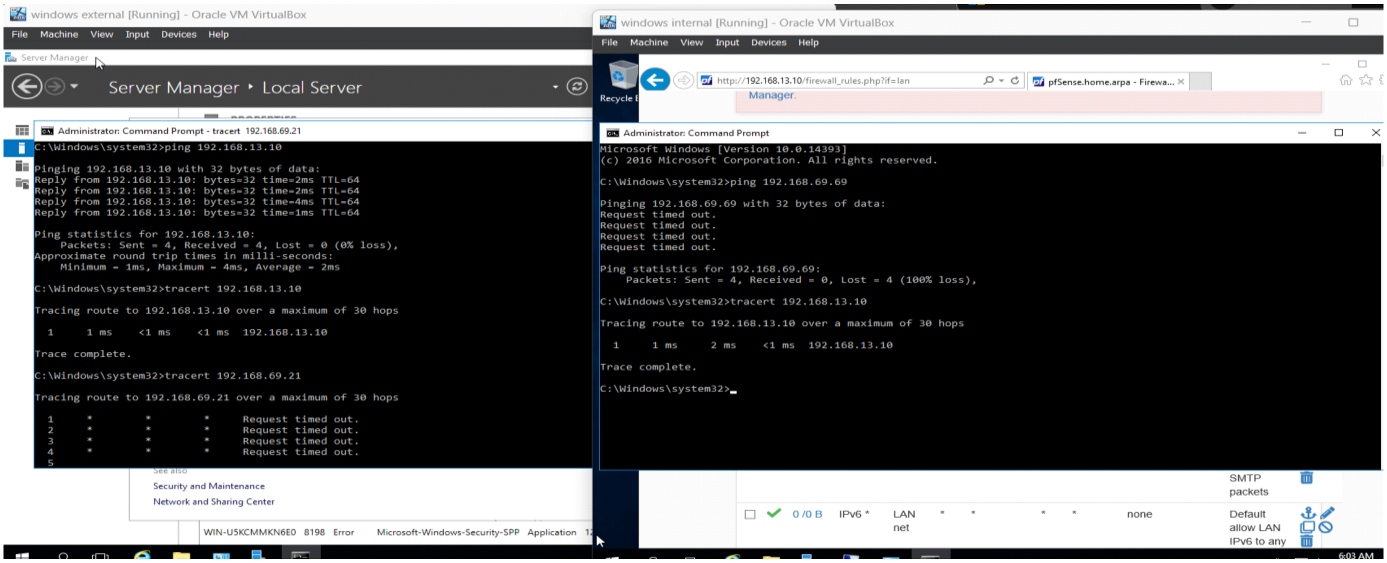

windows internal [Running] - Oracle VM VirtualBox
File
Machine
View
Input
Devices
Help
Administrator: Command Prompt

```
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 2ms, Average = 1ms

C:\Windows\system32>ping 192.168.13.10

Pinging 192.168.13.10 with 32 bytes of data:
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64
Reply from 192.168.13.10: bytes=32 time=2ms TTL=64
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64

Ping statistics for 192.168.13.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 2ms, Average = 1ms

C:\Windows\system32>ping 192.168.69.21

Pinging 192.168.69.21 with 32 bytes of data:
Reply from 192.168.69.21: bytes=32 time=2ms TTL=64
Reply from 192.168.69.21: bytes=32 time=9ms TTL=64
Reply from 192.168.69.21: bytes=32 time=1ms TTL=64
Reply from 192.168.69.21: bytes=32 time=1ms TTL=64

Ping statistics for 192.168.69.21:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 9ms, Average = 3ms

C:\Windows\system32>
```


windows external [Running] - Oracle VM VirtualBox
File
Machine
View
Input
Devices
Help
Recycle Bi
Administrator: Command Prompt

```
Ethernet adapter Ethernet:

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::c057:cfa9:8616:3372%2
   IPv4 Address. . . . . . . . . . . : 192.168.69.69
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 192.168.69.21

Tunnel adapter Local Area Connection* 2:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

C:\Windows\system32>192.168.13.10
'192.168.13.10' is not recognized as an internal or external command,
operable program or batch file.

C:\Windows\system32>ping 192.168.13.10

Pinging 192.168.13.10 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.13.10:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

I could ping from internal network to firewall but not from external network. Similarly traceroute also worked in internal network but not from external network as shown below.


windows external [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Server Manager
Server Manager ‣ Local Server
Administrator: Command Prompt - tracert 192.168.69.21
See also
Security and Maintenance
Network and Sharing Center
WIN-U5KCMMKN6E0 8198 Error Microsoft-Windows-Security-SPP Application

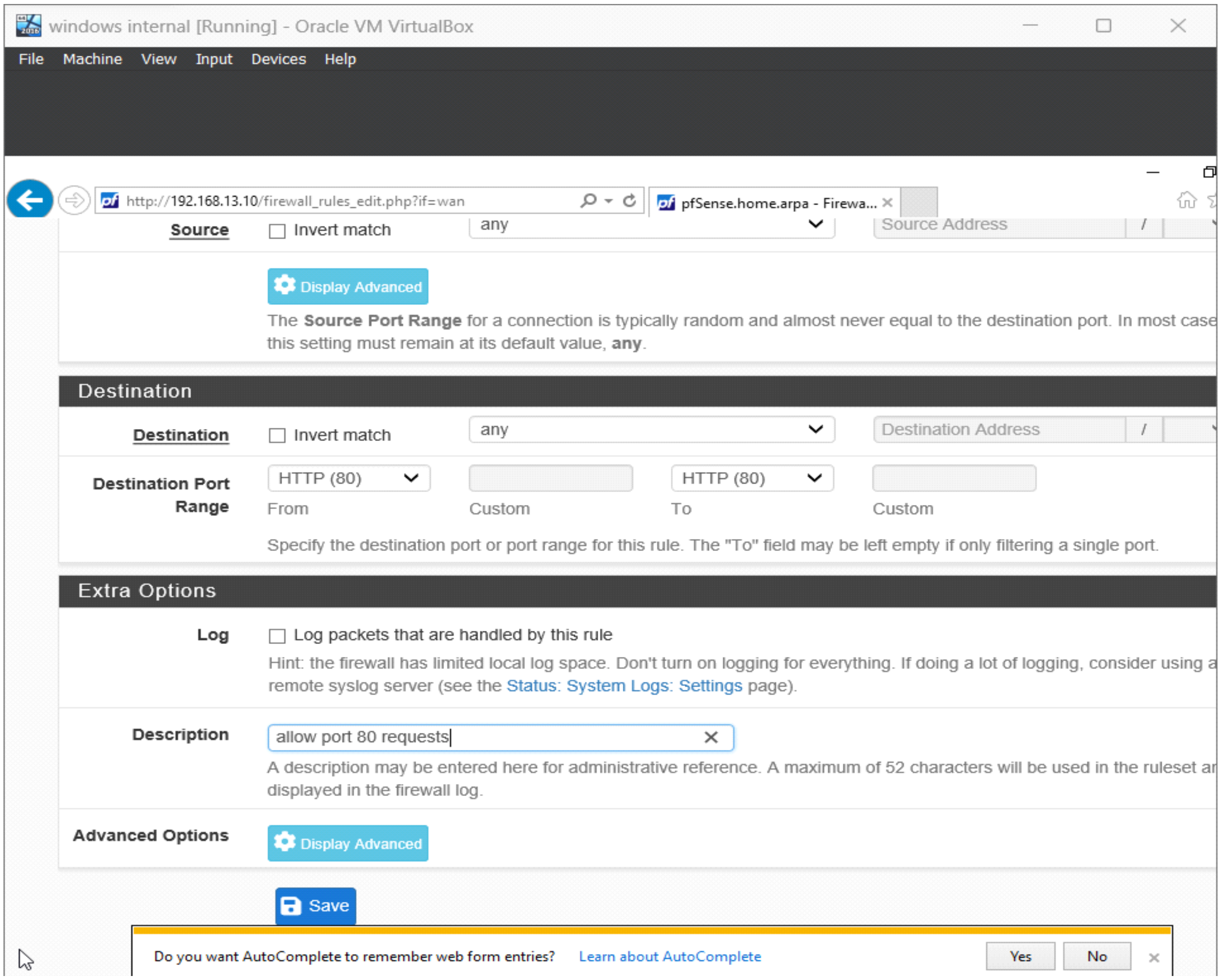
```
C:\Windows\system32>ping 192.168.13.10

Pinging 192.168.13.10 with 32 bytes of data:
Reply from 192.168.13.10: bytes=32 time=2ms TTL=64
Reply from 192.168.13.10: bytes=32 time=2ms TTL=64
Reply from 192.168.13.10: bytes=32 time=4ms TTL=64
Reply from 192.168.13.10: bytes=32 time=1ms TTL=64

Ping statistics for 192.168.13.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 4ms, Average = 2ms

C:\Windows\system32>tracert 192.168.13.10

Tracing route to 192.168.13.10 over a maximum of 30 hops

  1     1 ms    <1 ms    <1 ms  192.168.13.10

Trace complete.

C:\Windows\system32>tracert 192.168.69.21

Tracing route to 192.168.69.21 over a maximum of 30 hops

  1     *        *        *     Request timed out.
  2     *        *        *     Request timed out.
  3     *        *        *     Request timed out.
  4     *        *        *     Request timed out.
  5
```

windows internal [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Recycle B
http://192.168.13.10/firewall_rules.php?if=lan
pfSense.home.arpa - Firewa...
Manager.
Administrator: Command Prompt

```
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserved.

C:\Windows\system32>ping 192.168.69.69

Pinging 192.168.69.69 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.69.69:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Windows\system32>tracert 192.168.13.10

Tracing route to 192.168.13.10 over a maximum of 30 hops

  1     1 ms     2 ms    <1 ms  192.168.13.10

Trace complete.

C:\Windows\system32>_
```

SMTP packets
□ ✓ 0 /0 B IPv6 * LAN net * * * * none Default allow LAN IPv6 to any
6:03 AM

- **Allow port 80 requests to the interior client**



windows internal [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
http://192.168.13.10/firewall_rules_edit.php?if=wan
pfSense.home.arpa - Firewa...

Source □ Invert match any Source Address /

Display Advanced

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

Destination

Destination □ Invert match any Destination Address /

Destination Port Range HTTP (80) From | Custom | HTTP (80) 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.

Extra Options

Log □ Log packets that are handled by this rule

Hint: the firewall has limited local log space. Don't turn on logging for everything. If doing a lot of logging, consider using a remote syslog server (see the Status: System Logs: Settings page).

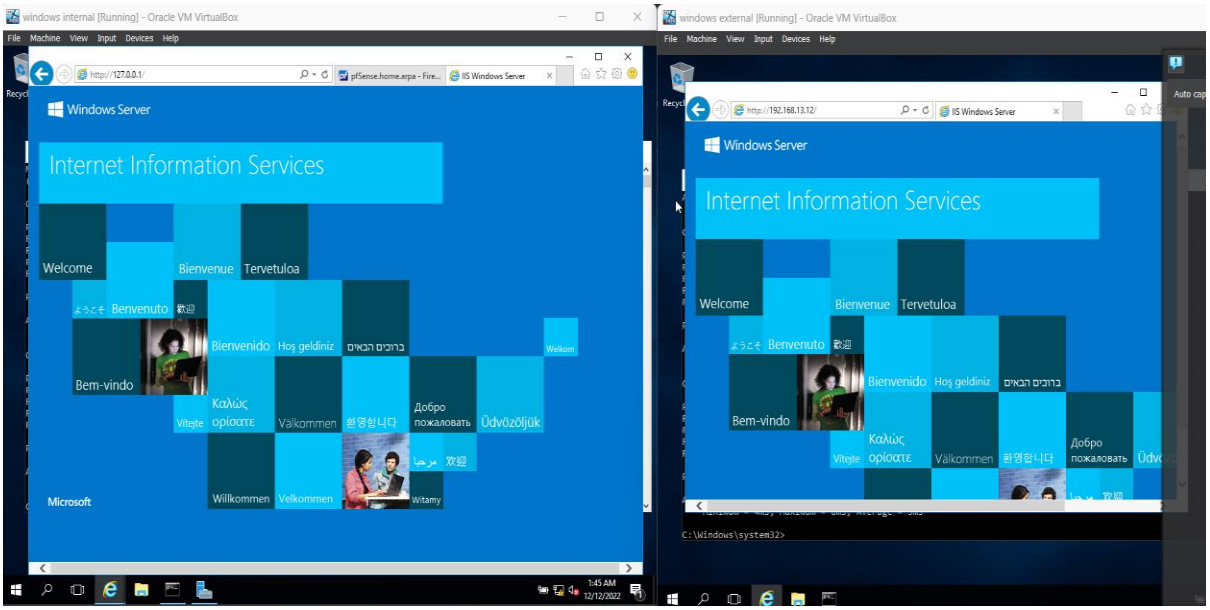
Description allow port 80 requests

A description may be entered here for administrative reference. A maximum of 52 characters will be used in the ruleset ar displayed in the firewall log.

Advanced Options Display Advanced

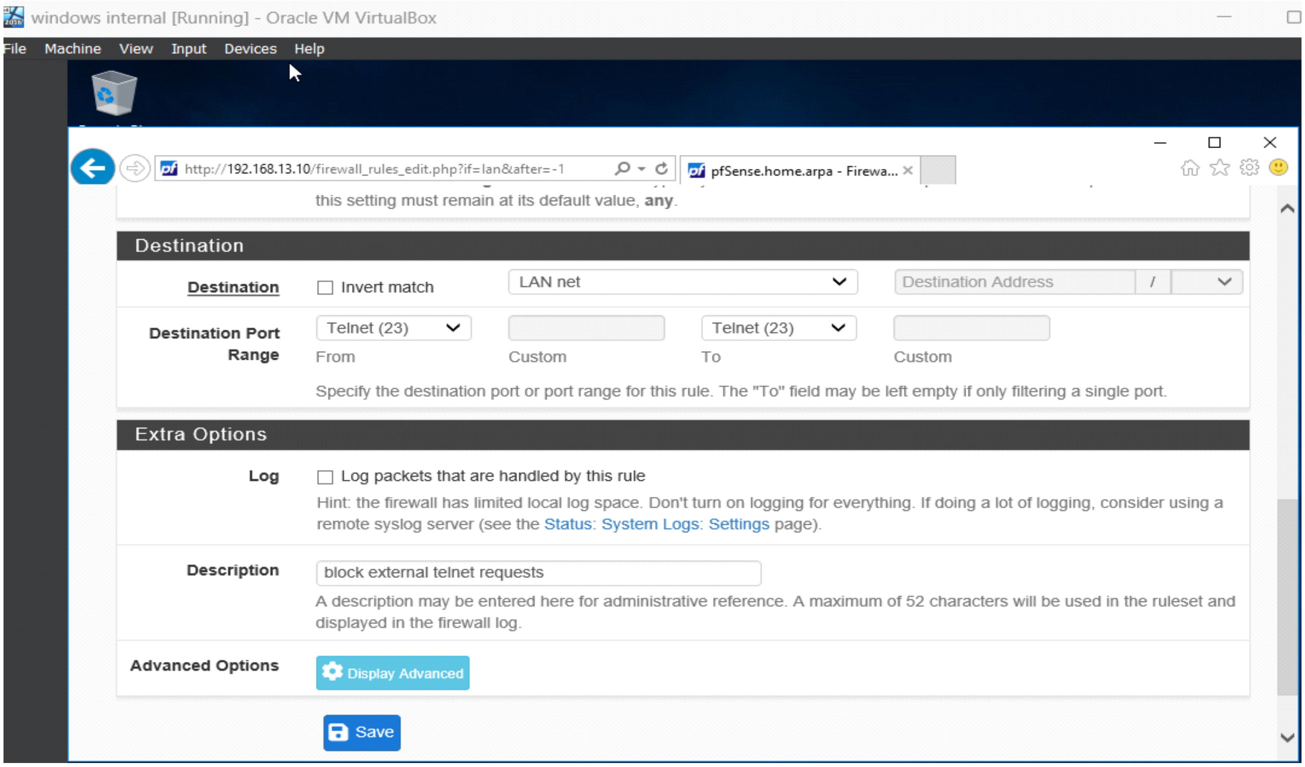
Save

Do you want AutoComplete to remember web form entries? Learn about AutoComplete Yes No



In the above screen I saw that external machine sent http request to internal machine and it was able to access the local server hosted by the internal machine.

- **Block external telnet, rlogin, and other similar requests**


windows internal [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
http://192.168.13.10/firewall_rules_edit.php?if=lan&after=-1
pfSense.home.arpa - Firewa...

this setting must remain at its default value, **any**.

Destination

Destination	□ Invert match	LAN net	Destination Address /
Destination Port Range	Telnet (23) From	Custom	Telnet (23) 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.

Extra Options

Log □ Log packets that are handled by this rule

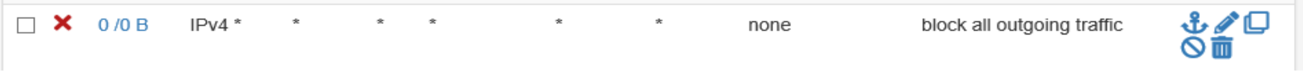
Hint: the firewall has limited local log space. Don't turn on logging for everything. If doing a lot of logging, consider using a remote syslog server (see the Status: System Logs: Settings page).

Description block external telnet requests

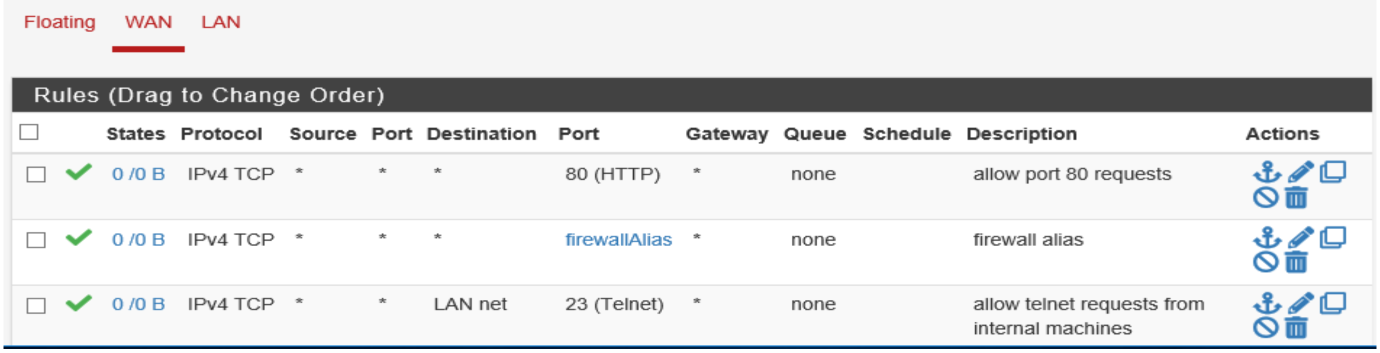
A description may be entered here for administrative reference. A maximum of 52 characters will be used in the ruleset and displayed in the firewall log.

Advanced Options Display Advanced

Save



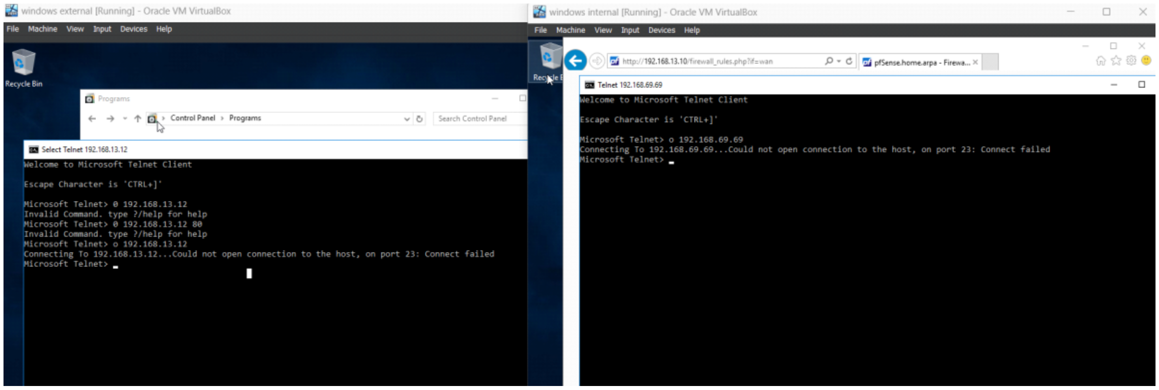
□	✗	0 /0 B	IPv4 *	*	*	*	*	*	none		block all outgoing traffic



Rules (Drag to Change Order)

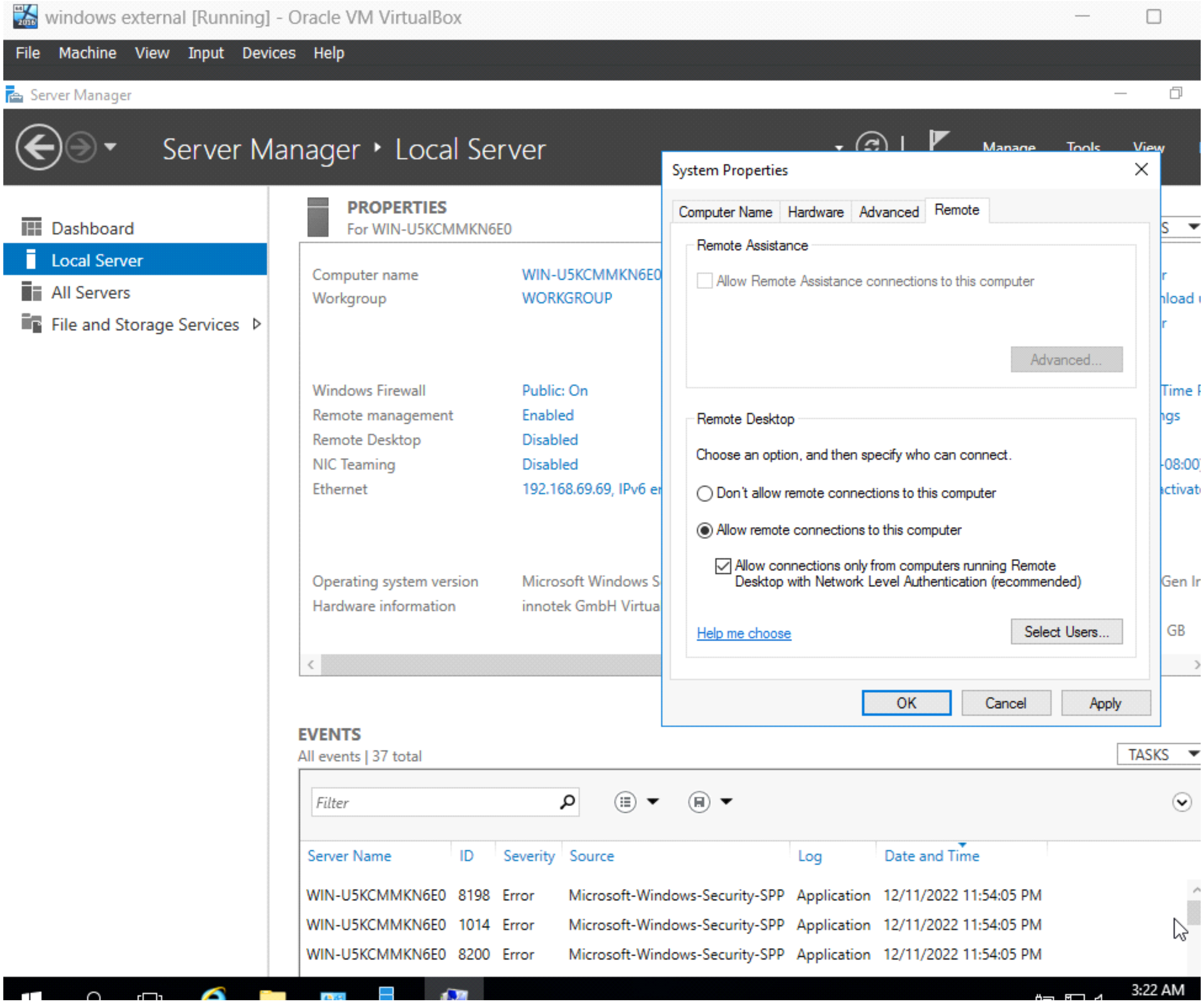
□		States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
□	✓	0 /0 B	IPv4 TCP	*	*	*	80 (HTTP)	*	none		allow port 80 requests	
□	✓	0 /0 B	IPv4 TCP	*	*	*	firewallAlias	*	none		firewall alias	
□	✓	0 /0 B	IPv4 TCP	*	*	LAN net	23 (Telnet)	*	none		allow telnet requests from internal machines	

By manual configuration within pfsense firewall. I could block telnet request from external to internal machine via firewall as shown below


windows external [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Recycle Bin
Programs
Control Panel › Programs
Search Control Panel
Select Telnet 192.168.13.12
windows internal [Running] - Oracle VM VirtualBox
http://192.168.13.10/firewall_rules.php?if=wan
pfSense.home.arpa - Firewa...
Telnet 192.168.69.69

```
Welcome to Microsoft Telnet Client

Escape Character is 'CTRL+]'

Microsoft Telnet> 0 192.168.13.12
Invalid Command. type ?/help for help
Microsoft Telnet> 0 192.168.13.12 80
Invalid Command. type ?/help for help
Microsoft Telnet> o 192.168.13.12
Connecting To 192.168.13.12...Could not open connection to the host, on port 23: Connect failed
Microsoft Telnet> _
```

```
Welcome to Microsoft Telnet Client

Escape Character is 'CTRL+]'

Microsoft Telnet> o 192.168.69.69
Connecting To 192.168.69.69...Could not open connection to the host, on port 23: Connect failed
Microsoft Telnet> _
```


windows external [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Server Manager
Server Manager › Local Server
Manage Tools View
Dashboard
Local Server
All Servers
File and Storage Services
TASKS

PROPERTIES
For WIN-U5KCMMKN6E0

Computer name	WIN-U5KCMMKN6E0
Workgroup	WORKGROUP
Windows Firewall	Public: On
Remote management	Enabled
Remote Desktop	Disabled
NIC Teaming	Disabled
Ethernet	192.168.69.69, IPv6 e
Operating system version	Microsoft Windows S
Hardware information	innotek GmbH Virtua

System Properties

Computer Name | Hardware | Advanced | Remote

Remote Assistance

□ Allow Remote Assistance connections to this computer

Advanced...

Remote Desktop

Choose an option, and then specify who can connect.

○ Don't allow remote connections to this computer

● Allow remote connections to this computer

☑ Allow connections only from computers running Remote Desktop with Network Level Authentication (recommended)

Help me choose | Select Users...

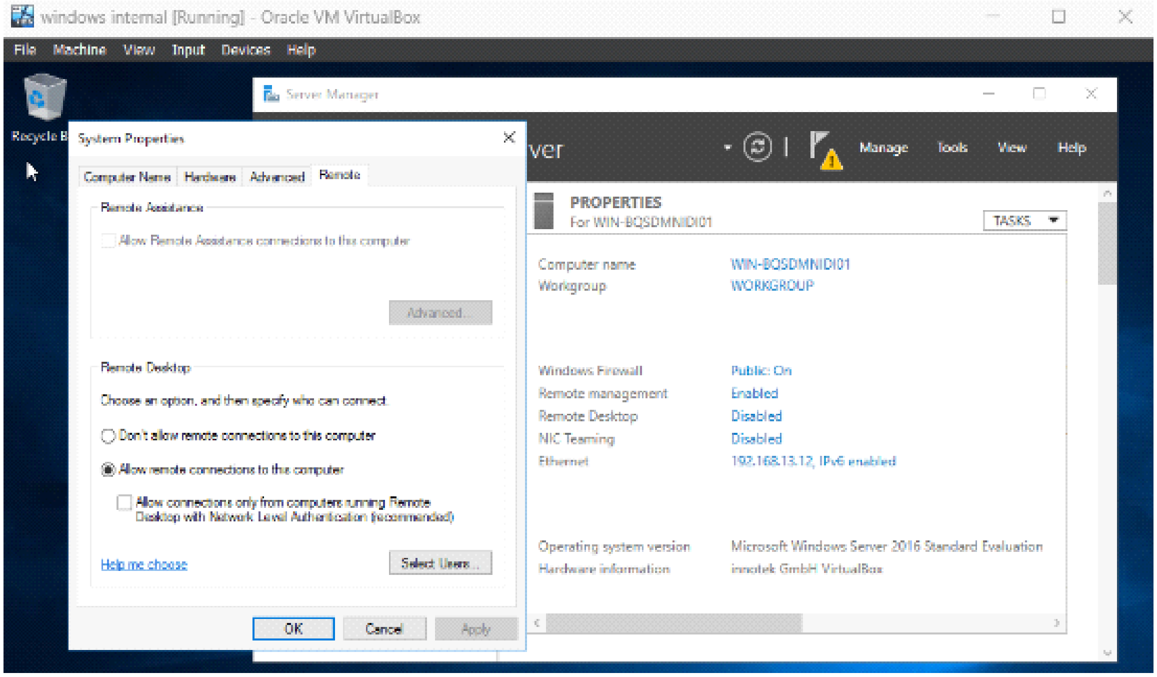
OK | Cancel | Apply

EVENTS
All events | 37 total

Filter

Server Name	ID	Severity	Source	Log	Date and Time
WIN-U5KCMMKN6E0	8198	Error	Microsoft-Windows-Security-SPP	Application	12/11/2022 11:54:05 PM
WIN-U5KCMMKN6E0	1014	Error	Microsoft-Windows-Security-SPP	Application	12/11/2022 11:54:05 PM
WIN-U5KCMMKN6E0	8200	Error	Microsoft-Windows-Security-SPP	Application	12/11/2022 11:54:05 PM

3:22 AM


windows internal [Running] - Oracle VM VirtualBox

System Properties

Remote Assistance

□ Allow Remote Assistance connections to this computer

Remote Desktop

Choose an option, and then specify who can connect.

○ Don't allow remote connections to this computer

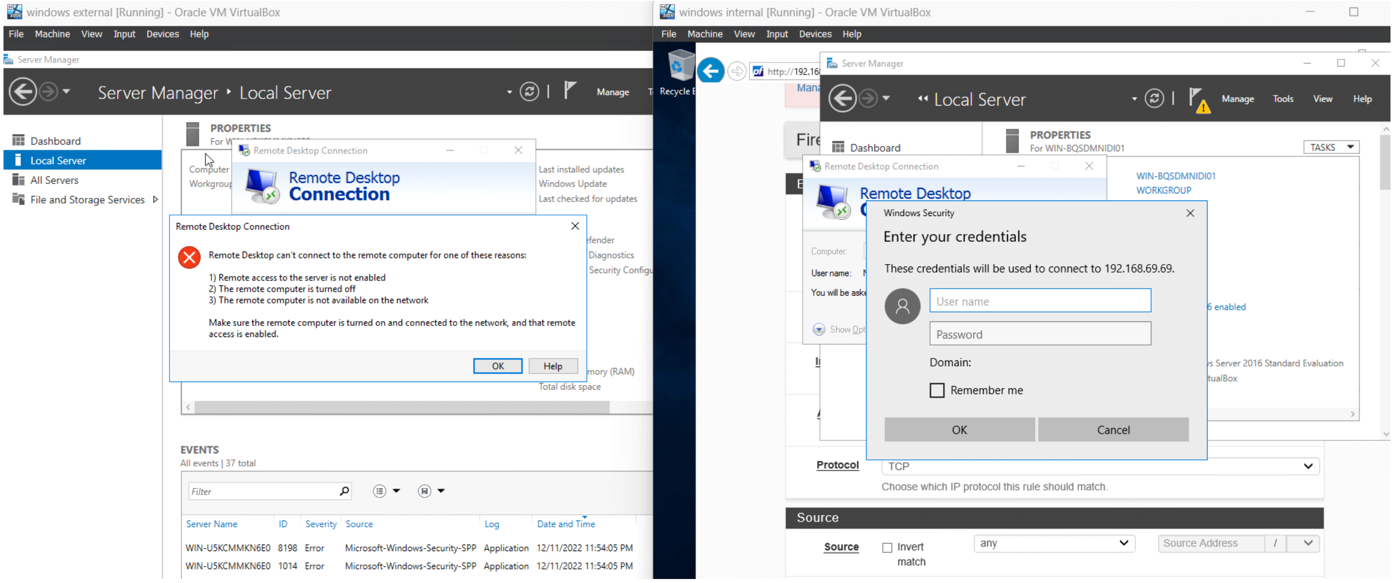
● Allow remote connections to this computer

□ Allow connections only from computers running Remote Desktop with Network Level Authentication (recommended)

PROPERTIES
For WIN-BQSDMNIDI01

Computer name	WIN-BQSDMNIDI01
Workgroup	WORKGROUP
Windows Firewall	Public: On
Remote management	Enabled
Remote Desktop	Disabled
NIC Teaming	Disabled
Ethernet	192.168.13.12, IPv6 enabled
Operating system version	Microsoft Windows Server 2016 Standard Evaluation
Hardware information	innotek GmbH VirtualBox

Because the telnet (23) port was blocked in WAN, I was unable to send remote login request from external machine to internal machine but vice versa was possible because I didn't add a telnet block rule in LAN as shown below.


windows external [Running] - Oracle VM VirtualBox

Remote Desktop Connection

Remote Desktop can't connect to the remote computer for one of these reasons:

1) Remote access to the server is not enabled
2) The remote computer is turned off
3) The remote computer is not available on the network

Make sure the remote computer is turned on and connected to the network, and that remote access is enabled.

EVENTS
All events | 37 total

Server Name	ID	Severity	Source	Log	Date and Time
WIN-U5KCMMKN6E0	8198	Error	Microsoft-Windows-Security-SPP	Application	12/11/2022 11:54:05 PM
WIN-U5KCMMKN6E0	1014	Error	Microsoft-Windows-Security-SPP	Application	12/11/2022 11:54:05 PM

windows internal [Running] - Oracle VM VirtualBox

Windows Security

Enter your credentials

These credentials will be used to connect to 192.168.69.69.

User name

Password

Domain:

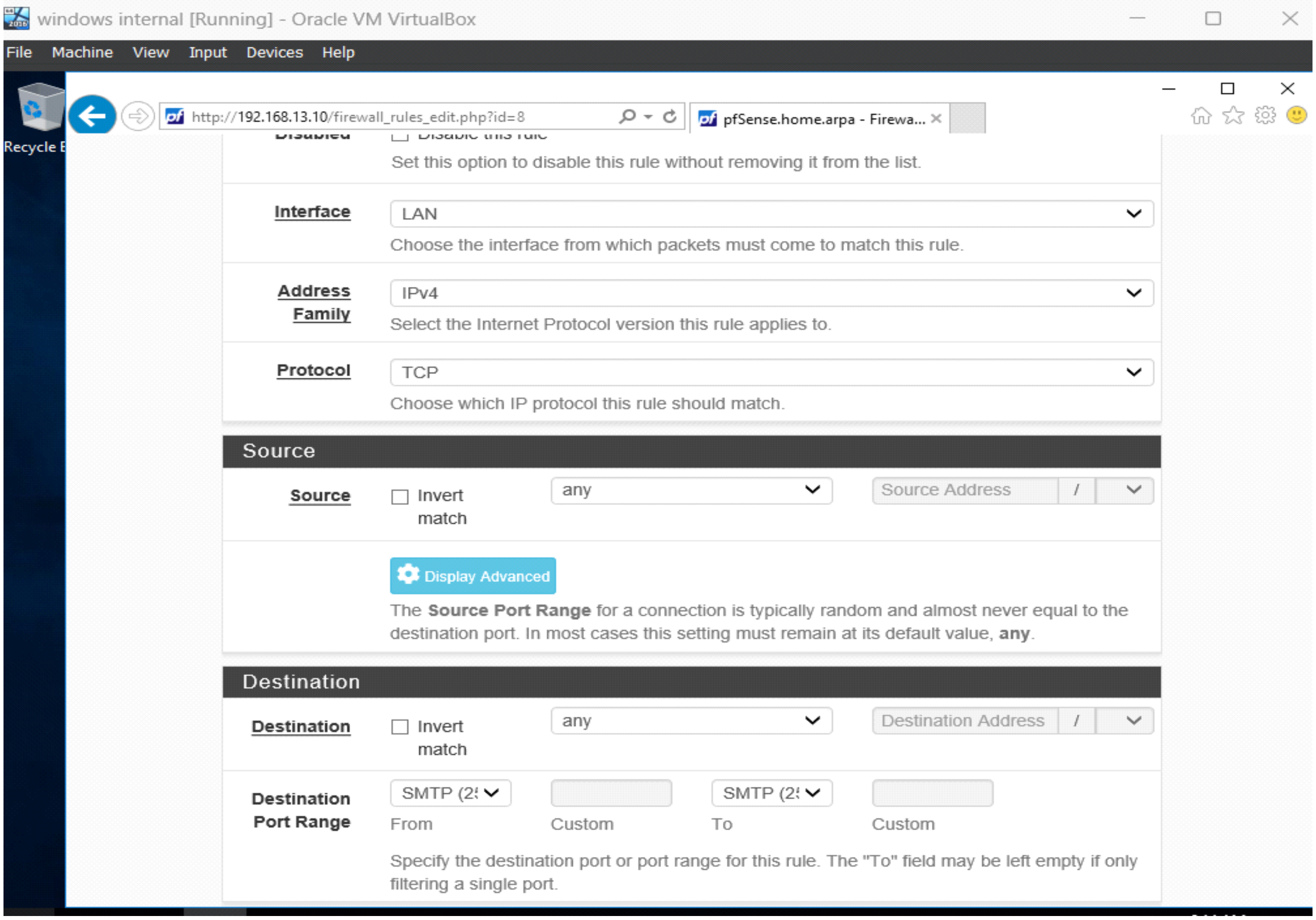
□ Remember me

Protocol: TCP
Choose which IP protocol this rule should match.

Source

Source: □ Invert match — any — Source Address

- **Allow internal messages using SMTP to be sent through the firewall**



windows internal [Running] - Oracle VM VirtualBox

http://192.168.13.10/firewall_rules_edit.php?id=8

pfSense.home.arpa - Firewa...

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

Interface LAN
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 any Source Address /

Display Advanced

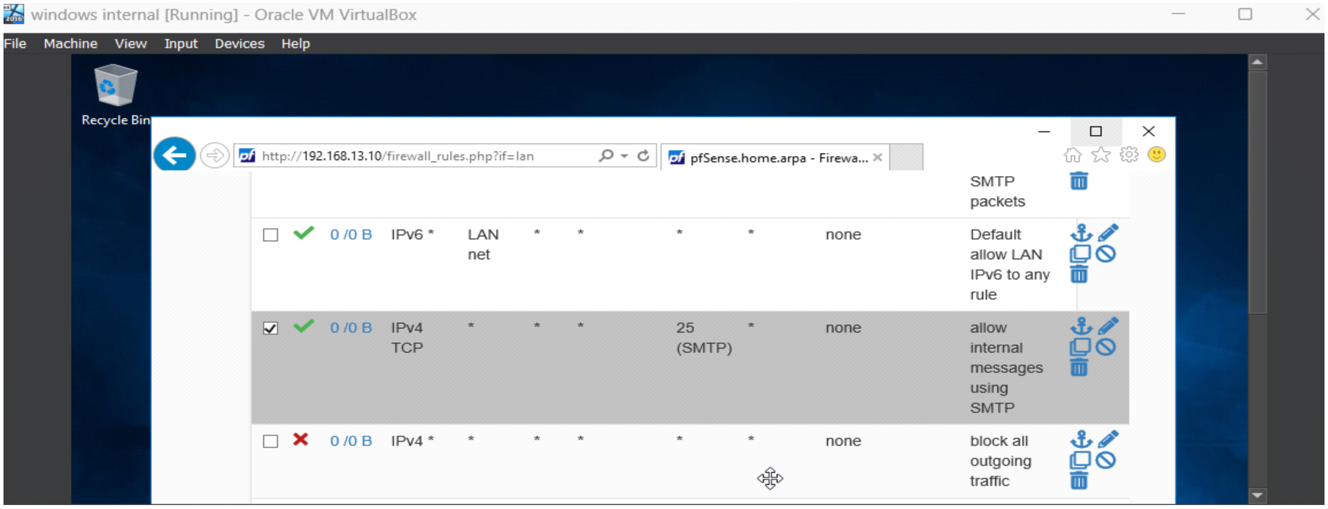
The **Source Port Range** for a connection is typically random and almost never equal to the destination port. In most cases this setting must remain at its default value, **any**.

Destination

Destination □ Invert match any Destination Address /

Destination Port Range From: SMTP (2! Custom: To: SMTP (2! Custom:

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



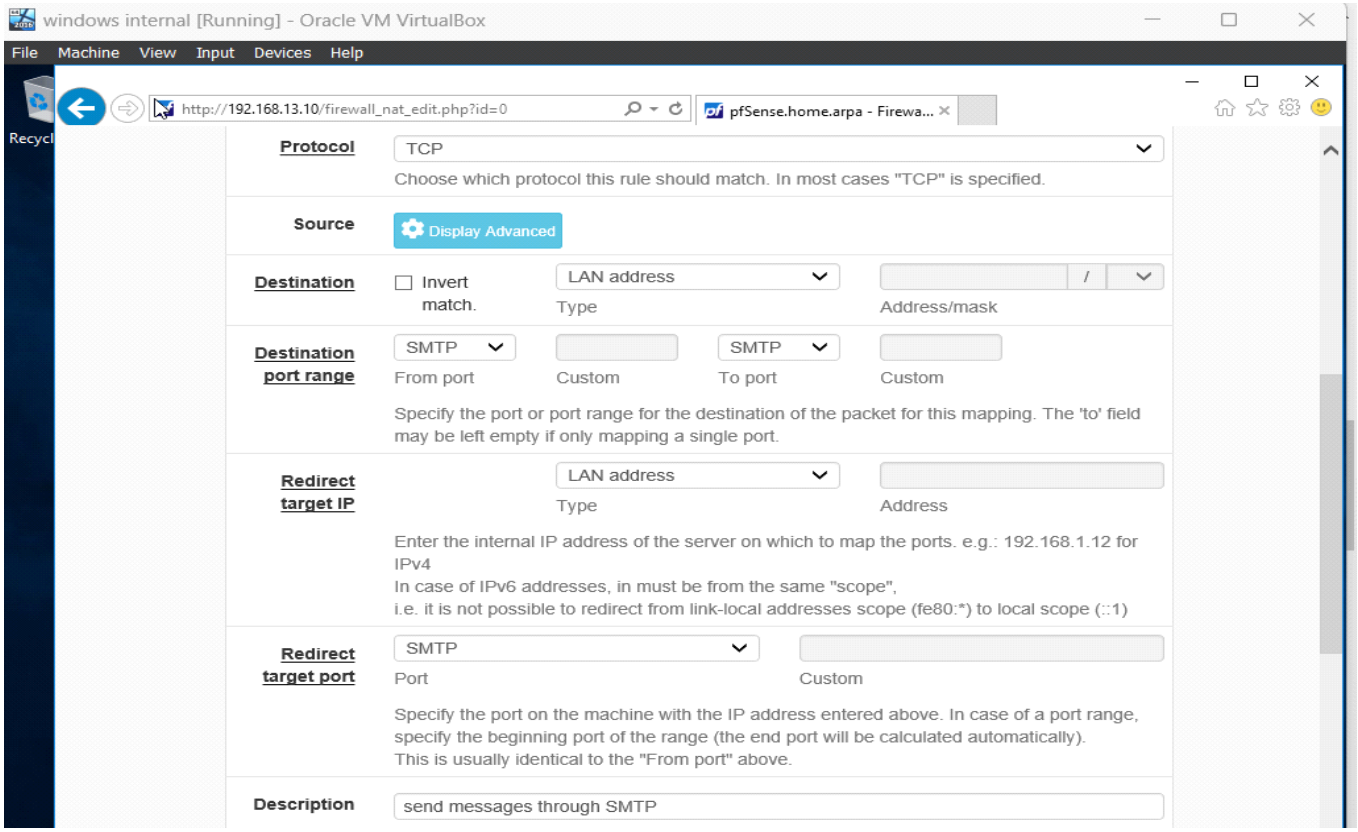
windows internal [Running] - Oracle VM VirtualBox

http://192.168.13.10/firewall_rules.php?if=lan

pfSense.home.arpa - Firewa...

											SMTP packets
□	✓	0 /0 B	IPv6 *	LAN net	*	*	*	*	none		Default allow LAN IPv6 to any rule
☑	✓	0 /0 B	IPv4 TCP	*	*	*	25 (SMTP)	*	none		allow internal messages using SMTP
□	✗	0 /0 B	IPv4 *	*	*	*	*	*	none		block all outgoing traffic

I blocked default outgoing traffic so that all the internal messages were sent through SMTP. Another way to forward outgoing traffic using SMTP was by selecting firewall -> NAT -> port forward option.


windows internal [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
http://192.168.13.10/firewall_nat_edit.php?id=0
pfSense.home.arpa - Firewa...
Recycl

Protocol: TCP

Choose which protocol this rule should match. In most cases "TCP" is specified.

Source: Display Advanced

Destination: □ Invert match. | LAN address (Type) | / (Address/mask)

Destination port range: SMTP (From port) | Custom | SMTP (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: LAN address (Type) | Address

Enter the internal IP address of the server on which to map the ports. e.g.: 192.168.1.12 for IPv4

In case of IPv6 addresses, in must be from the same "scope",

i.e. it is not possible to redirect from link-local addresses scope (fe80:*) to local scope (::1)

Redirect target port: SMTP (Port) | Custom

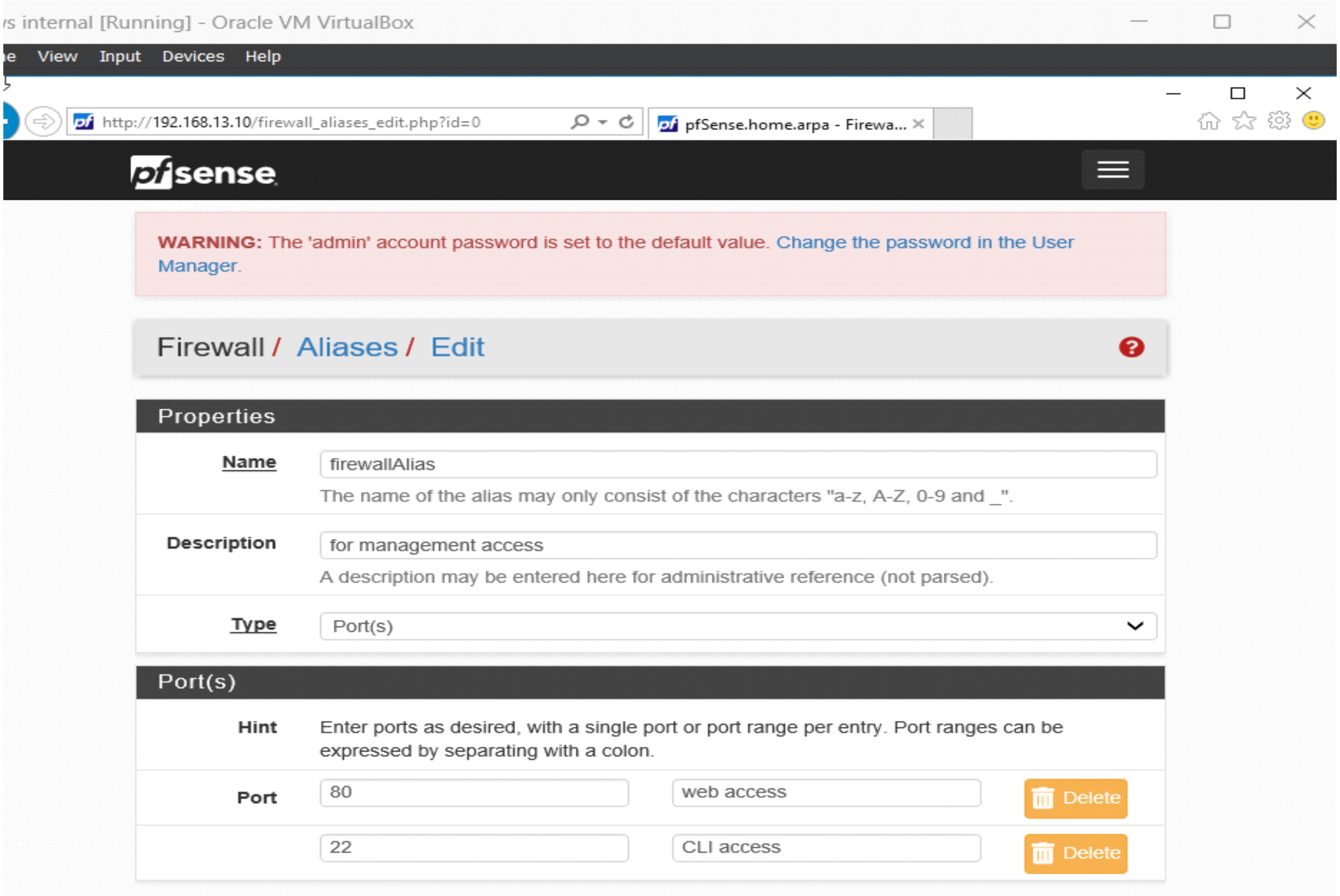
Specify the port on the machine with the IP address entered above. In case of a port range, specify the beginning port of the range (the end port will be calculated automatically).

This is usually identical to the "From port" above.

Description: send messages through SMTP

Additional functionality:

- Firewall aliases: This was used to add different IPs and ports and reference them in the rules.



's internal [Running] - Oracle VM VirtualBox
e View Input Devices Help
http://192.168.13.10/firewall_aliases_edit.php?id=0
pfSense.home.arpa - Firewa...
pfsense

WARNING: The 'admin' account password is set to the default value. Change the password in the User Manager.

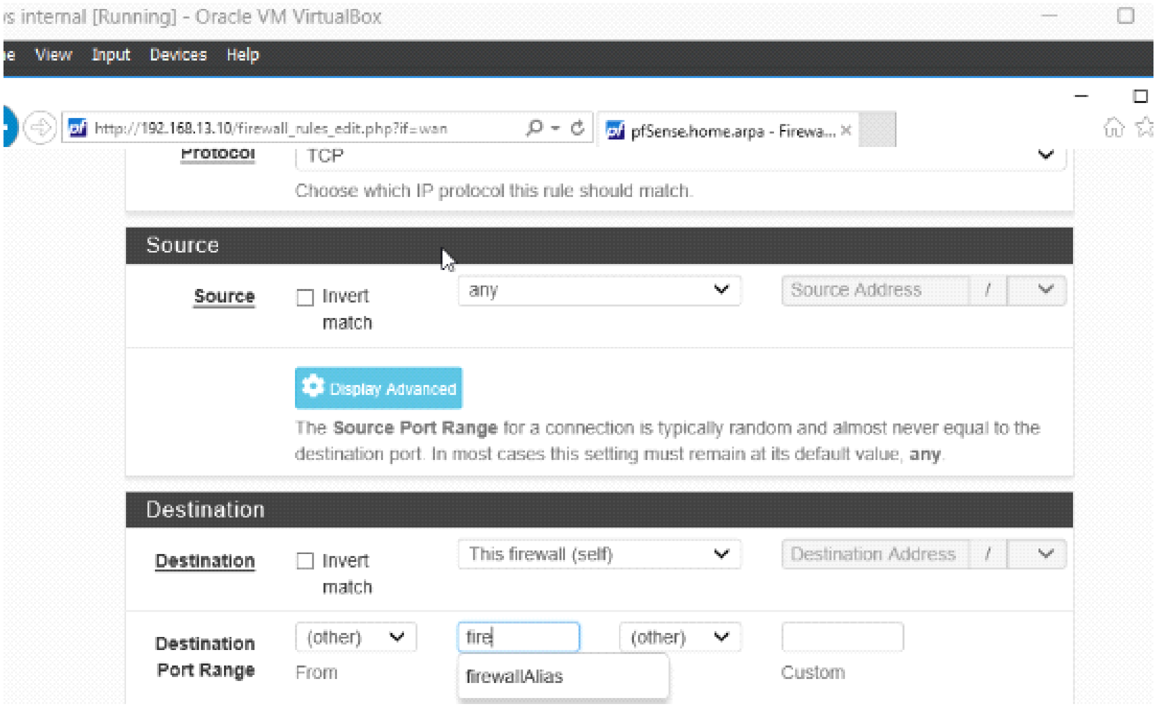
Firewall / Aliases / Edit

Properties

Name	firewallAlias The name of the alias may only consist of the characters "a-z, A-Z, 0-9 and _".
Description	for management access A description may be entered here for administrative reference (not parsed).
Type	Port(s)

Port(s)

Hint	Enter ports as desired, with a single port or port range per entry. Port ranges can be expressed by separating with a colon.		
Port	80	web access	Delete
	22	CLI access	Delete



http://192.168.13.10/firewall_rules_edit.php?if=wan

Protocol: TCP

Choose which IP protocol this rule should match.

Source

Source: □ Invert match | any | Source Address /

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**.

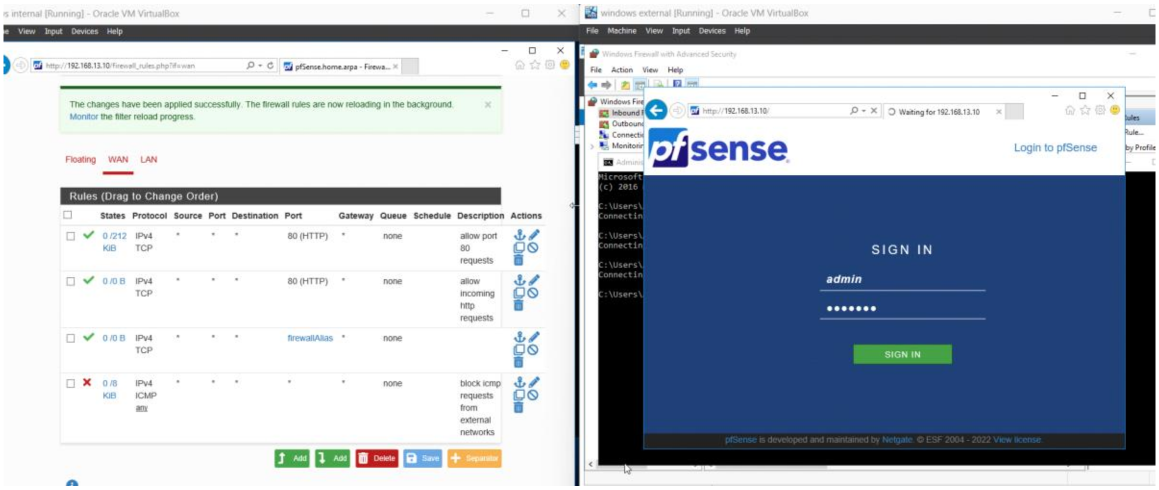
Destination

Destination: □ Invert match | This firewall (self) | Destination Address /

Destination Port Range: From (other) | fire | (other) | Custom

is internal [Running] - Oracle VM VirtualBox
View
Input
Devices
Help
pfSense.home.arpa - Firewa...
Display Advanced
firewallAlias

I added a firewall alias in the rule. This allowed traffic from external to internal machine on port 80 and 22 as shown in below. I was able to access 192.168.13.10 which is my internal network from external machine.



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

Rules (Drag to Change Order)

□		States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
□	✓	0 /212 KiB	IPv4 TCP	*	*	*	80 (HTTP)	*	none		allow port 80 requests	
□	✓	0 /0 B	IPv4 TCP	*	*	*	80 (HTTP)	*	none		allow incoming http requests	
□	✓	0 /0 B	IPv4 TCP	*	*	*	firewallAlias	*	none			
□	✗	0 /8 KiB	IPv4 ICMP any	*	*	*	*	*	none		block icmp requests from external networks	

http://192.168.13.10/

SIGN IN

admin

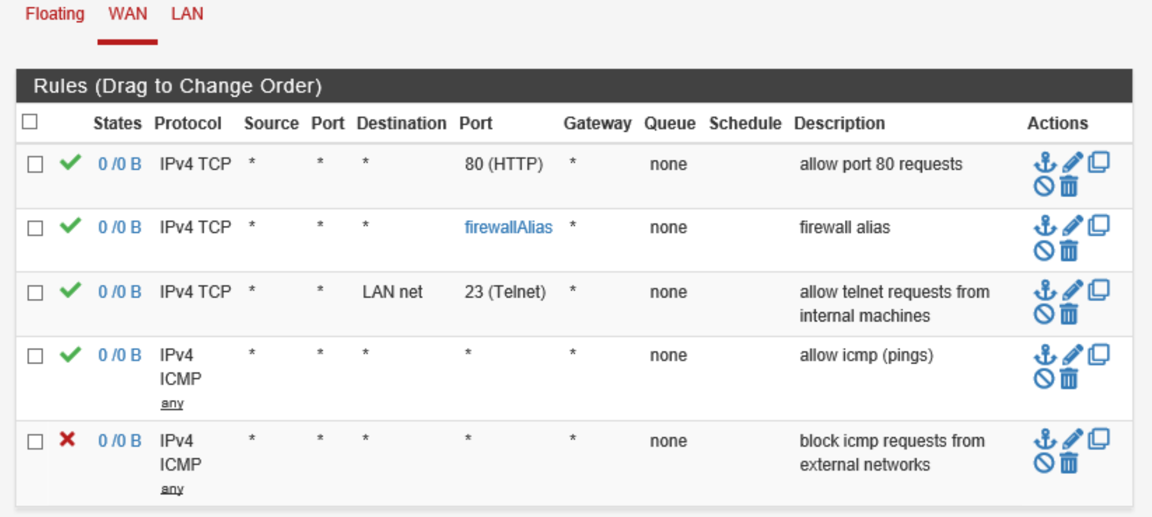
•••••••

pfSense is developed and maintained by Netgate. © ESF 2004 - 2022 View license

is internal [Running] - Oracle VM VirtualBox
View
Input
Devices
Help
http://192.168.13.10/firewall_rules.php?if=wan
pfSense.home.arpa - Firewa...
Floating
WAN
LAN
Add
Add
Delete
Save
Separator
windows external [Running] - Oracle VM VirtualBox
File
Machine
View
Input
Devices
Help
Windows Firewall with Advanced Security
Action
Waiting for 192.168.13.10
pfsense
Login to pfSense
SIGN IN

Final configured firewall:

WAN:

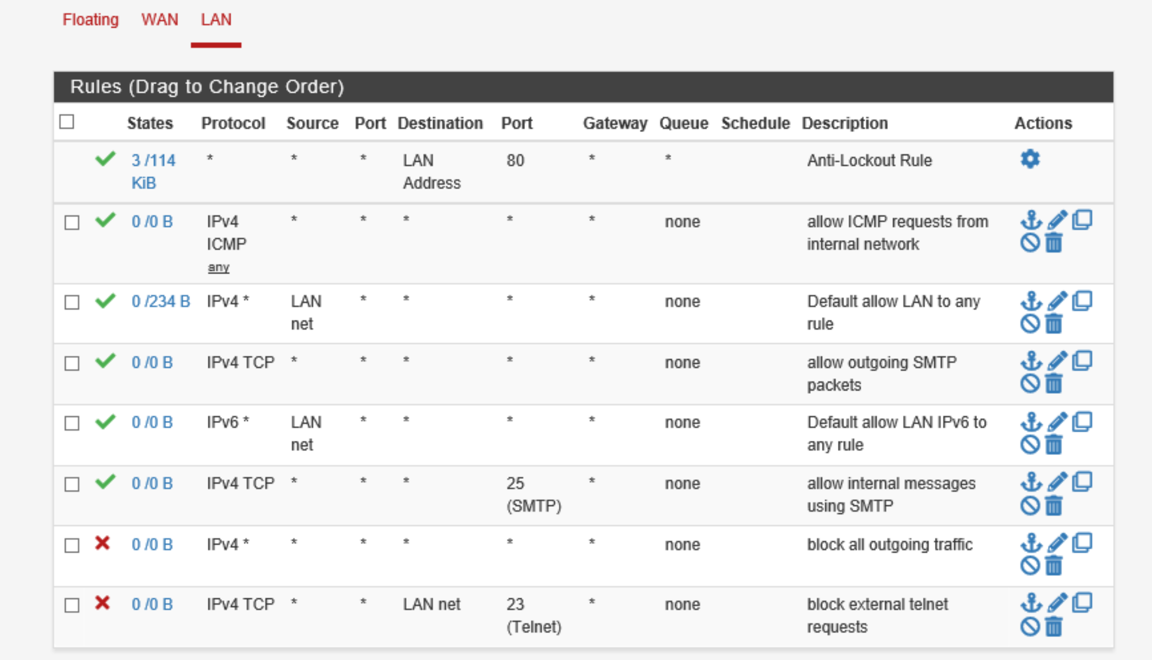


Floating WAN LAN

Rules (Drag to Change Order)

☐		States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
☐	✓	0 /0 B	IPv4 TCP	*	*	*	80 (HTTP)	*	none		allow port 80 requests	⚓ ✎ ⧉ ⊘ 🗑
☐	✓	0 /0 B	IPv4 TCP	*	*	*	firewallAlias	*	none		firewall alias	⚓ ✎ ⧉ ⊘ 🗑
☐	✓	0 /0 B	IPv4 TCP	*	*	LAN net	23 (Telnet)	*	none		allow telnet requests from internal machines	⚓ ✎ ⧉ ⊘ 🗑
☐	✓	0 /0 B	IPv4 ICMP any	*	*	*	*	*	none		allow icmp (pings)	⚓ ✎ ⧉ ⊘ 🗑
☐	✗	0 /0 B	IPv4 ICMP any	*	*	*	*	*	none		block icmp requests from external networks	⚓ ✎ ⧉ ⊘ 🗑

LAN:



Floating WAN LAN

Rules (Drag to Change Order)

☐		States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
	✓	3 /114 KiB	*	*	*	LAN Address	80	*	*		Anti-Lockout Rule	⚙
☐	✓	0 /0 B	IPv4 ICMP any	*	*	*	*	*	none		allow ICMP requests from internal network	⚓ ✎ ⧉ ⊘ 🗑
☐	✓	0 /234 B	IPv4 *	LAN net	*	*	*	*	none		Default allow LAN to any rule	⚓ ✎ ⧉ ⊘ 🗑
☐	✓	0 /0 B	IPv4 TCP	*	*	*	*	*	none		allow outgoing SMTP packets	⚓ ✎ ⧉ ⊘ 🗑
☐	✓	0 /0 B	IPv6 *	LAN net	*	*	*	*	none		Default allow LAN IPv6 to any rule	⚓ ✎ ⧉ ⊘ 🗑
☐	✓	0 /0 B	IPv4 TCP	*	*	*	25 (SMTP)	*	none		allow internal messages using SMTP	⚓ ✎ ⧉ ⊘ 🗑
☐	✗	0 /0 B	IPv4 *	*	*	*	*	*	none		block all outgoing traffic	⚓ ✎ ⧉ ⊘ 🗑
☐	✗	0 /0 B	IPv4 TCP	*	*	LAN net	23 (Telnet)	*	none		block external telnet requests	⚓ ✎ ⧉ ⊘ 🗑

Lessons learned:

- Aside from connecting the 3 virtual machines together, the problems mostly I had was I didn’t have much knowledge of how network adapters work before.
- From this project I was able to study how each network adapter works and in which scenario I should use specific network adapter.

- Implementation of telnet, login functionality was also bit challenging because initially, I was not able implement it properly.
- Initially I didn’t place the firewall rules in order. So, when I placed block outgoing traffic rule above all allow rules. The rules didn’t work so I had to place them in order.