Disclaimer

The author of this document shall not carry responsibility for any damage to the network, computer(s) software or hardware either direct or indirect as a result of following the instructions herein.

Introduction

This document provides steps on building a virtual network using **pfSense**. **pfSense** will act as a virtual router/Gateway interface between the existing production network and the virtual environment using **Oracle VirtualBox**. This gives us the ability to build a virtual lab of servers and workstations without interfering with the exiting services in a production environment, all for testing purpose and beyond.

This document also highlights steps on setting up remote desktop connection between a production workstation and a virtual instance, this in addition to a scenario where you may need to virtually connect multiple pfSense virtual routers together for certain testing, under **Additional Comments**.

You may find some of the steps confusing, just carry on and it will become clear and make sense at completion.

This document uses **Oracle VirtualBox 5.0.16 r105871** and **pfSense 2.2.6 64-bit**. Latest release for both products may be obtained from the following links, unless changes at a later date by manufacture:

https://www.virtualbox.org/ https://www.pfsense.org/download/

This document is intended for I.T. professionals. However, other users may find this document useful and straight forward to follow.

Requirements

- A PC with a network card, adequate processing power, adequate memory and hard drive capacity
- Oracle VirtualBox
- pfSense
- A virtual instance, such as **Windows Server 2012** to connect to the newly created virtual network by **pfSense** and test Internet connectivity

Brief

- On the PC, download and install Oracle VirtualBox
- On the PC, download and extract pfSense
- Create and configure a pfSense virtual instance
- Create and configure a virtual instance such as Windows Server 2012 for testing
- Test the virtual network connection and Internet access

Procedure

1. On the PC, download and install **Oracle VirtualBox**, accept defaults until installation is complete

You may consider changing the default path **VirtualBox** uses to create its virtual instances right after installation complete. Simply from the **File** menu, select **Preferences**, and under **General** type-in or browse to the desired location, then click **OK** as illustrated in snapshots **a** and **b** below:

a.	Oracle VM VirtualBox Manager File Machine Help Preferences Ctrl+G								
	🔗 VirtualBox - Prefe	erences							
	General	General							
b.	Input	Default Machine Folder: D:\VMs							

- 2. On the PC, download and extract pfSense, an ISO image should be available after extraction
- 3. Run **Oracle VirtualBox Manager** and click **New** to create a new virtual instance which will be utilized and configured as our **pfSense** virtual router:

🐧 Or	🗿 Oracle VM VirtualBox Manager										
File	Machine	Help									
New	Settings	Discard	Start,								
\sim				Welcome to VirtualBox!							

- 4. Follow below snapshots examples to complete creating the **pfSense** virtual router instance:
 - Enter name, type and version then click **Next** to continue

? 💌
Create Virtual Machine
Name and operating system
Please choose a descriptive name for the new virtual machine and select the type of operating system you intend to install on it. The name you choose will be used throughout VirtualBox to identify this machine.
Name: pfSense Type: BSD
Version: FreeBSD (64-bit)
Expert Mode Cancel

Set memory capacity as desired then click **Next** to continue

? <mark>- × -</mark>
Create Virtual Machine
Memory size
Select the amount of memory (RAM) in megabytes to be allocated to the virtual machine.
The recommended memory size is 64 MB.
512 🔄 MB
4 MB 32768 MB
Cancel

Keep default selection at Create a virtual hard disk now then click Create



- Select type of file then click Next to continue



Choose between Dynamically allocated and Fixed size then click Next to continue



Set virtual hard drive size as desired then click Create

	- ? - ?
Create Virtual Hard Disk	
File location and size	
Please type the name of the new virtual folder icon to select a different folder to	hard disk file into the box below or click on the create the file in.
pfSense	
Select the size of the virtual hard disk in file data that a virtual machine will be ab	megabytes. This size is the limit on the amount of le to store on the hard disk.
	10.00 G
4.00 MB	2.00 TB
	Create

A new pfSense virtual instance will appear on the left menu



- 5. Let's review the **Settings** of the **pfSense** virtual instance to make some necessary changes, follow as illustrated in the snapshot examples below:
 - Select **pfSense** and click on **Settings**



-

- In **System** untick **Floppy** from the **Boot Order** as it is not needed in this example

General	System		
System	Motherboard	Processor	Acceleration
Display	Base Mem	iory: -0	
Storage	555 M 100	4 MB	Elenny]
Audio	<u>B</u> oot Or	der	Optical +

In Storage under Storage Tree select the optical disk Empty, in Attributes click the optical drive icon to select Choose Virtual Optical Drive File...

🥝 p	fSense - Settings			8	×	
	General	Storage				
	System	Storage Tree	Attributes		\checkmark	•
	Display	Controller: IDE	Optical Drive	IDE Secondary Master 🔹		
		pfSense.vdi		Live CD/DVD		Choose Virtual Optical Disk File
	Storage	Empty	Information —		-	Host Drive 'D:'
	Audio		Type:		6	Remove Disk from Virtual Drive
	.		Size:		_	
	PNetwork		Attached to:			
	Serial Ports		Attached to			
6	🖗 USB					
Ľ	Shared Folders					
	User Interface					
		E 🗖 🕹				
			ОК	Cancel Help		

Browse to and select the pfSense ISO image file extracted earlier then click Open

🧿 Please choose	a virtual optical o	lisk file												×
GO - I	Computer	pfSense								• {	Search pfSei	nse		م
Organize 🔻	New folder											•		0
🚢 (C:)		Â	Name		^			Date modified	Туре		Size			
		=	🕜 pfSer	nse-LiveCD-	2.2.6-RELI	EASE-amd64-3	2	21/12/2015 04:22	ISO Image l	File	302,124 KB			
		Ψ.										_		
	File <u>n</u> ame:	pfSense	-LiveCD-2.2	.6-RELEASE	-amd64-2	0151221-1450)			•	All virtual opt	ical disk	files (*.dr	r 🔻
										(Open 🔓		Cancel	

- In Audio deselect option as it is not needed in this example

🥝 pfSense - Settings		
🣃 General	Audio	
System	Enable <u>A</u> udio	
Display	HOST Audio Driver:	Windows DirectSound
😥 Storage	Audio <u>C</u> ontroller:	ICH AC97
խ Audio)	

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Under Network set Adapter 1 to Bridged Adapter (pfSense will use this as its WAN interface)

🥝 pfSense - Settings	
🦲 General	Network
🛒 System	Adapter <u>1</u> Adapter <u>2</u> Adapter <u>3</u> Adapter <u>4</u>
Display	C Enable Network Adapter
😥 Storage	
┢ Audio	Name: Intel(R) 82579LM Gigabit Network Connection
Network	
Serial Ports	
🌽 USB	
Shared Folders	
📰 User Interface	
	OK Cancel <u>H</u> elp

Enable and set Adapter 2 to Internal Network (pfSense will use this as its LAN interface)

😳 pfS	ense - Settings	? <mark>×</mark>
	General	Network
	System	Adapter 1 Adapter 2 Adapter 3 Adapter 4
	Display	🗹 Enable Network Adapter
\bigcirc	Storage	
	Audio	<u>N</u> ame: intnet
₽	Network	
	Serial Ports	
Ø	USB	
	Shared Folders	
:	User Interface	
		OK Cancel Help

In USB deselect option as it is not needed in this example then click OK to save and exit settings

🙆 pfSe	ense - Settings	8	×
	General	USB	
	System	Enable USB Controller	
	Display	USB <u>1</u> , 1 (OHCI) Controller	
	Storage	 USB <u>2</u>.0 (EHCI) Controller USB 3.0 (xHCI) Controller 	
	Audio	USB Device <u>Fi</u> lters	
₽	Network		ß
	Serial Ports		8
	USB		A D
	Shared Folders		ß
	User Interface		
			,

6. Now, let's start the **pfSense** virtual instance by clicking **Start**:



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7. As we attached the **pfSense ISO** file to the storage selection, our virtual instance will boot up from this ISO image:



8. Watch carefully the boot up screen, as soon as prompted press 'i' to launch the installer:



9. Select Accept these Settings then press the Enter key to carry on:



10. Press the Enter key for the Quick/Easy Install selection:

File Machine View Input Devices Help F10=Refresh Display Select Task Choose one of the following tasks to perform. (Quick/Easy Install) Custom Install) Custom Install) Custom Install) Custom Install) Custom Install > Custom Installer with minimal questions	📓 pfSense [Running] - Oracle VM VirtualBox	
F10=Refresh Display Select Task Choose one of the following tasks to perform. (Quick/Easy Install) (Ustom Install) (Rescue config.xml) (Rescue config.xml) (Exit) Invoke Installer with minimal questions	File Machine View Input Devices Help	
Select Task Choose one of the following tasks to perform. (Quick/Easy Install) (Custom Install) (Rescue config.xml) (Reboot) (Exit) Invoke Installer with minimal questions	F10=Refresh Display	
Invoke Installer with minimal questions	Select Task Choose one of the following tasks to perform. (Quick/Easy Install > (Custom Install > (Rescue config.xml > (Reboot > (Exit >	
	Invoke Installer with minimal questions	

11. Press the **Enter** key for **OK** and wait for next prompt:



12. Press the Enter key for Standard Kernel and wait until installation complete:



13. When complete press the **Enter** key to reboot the virtual instance:

📓 pfSense [Running] - Oracle V	M VirtualBox	
File Machine View Input	Devices Help	
F10=Refresh Display		
	Reboot This machine is about to be shut down. After the machine has reached its shutdown state, you may remove the CD from the CD-ROM drive tray and press Enter to reboot from the HDD. Keboot > Return to Select Task >	
		🕽 🕢 🗣 Right Ctri

14. As soon as you get the Oracle VM start-up screen click the **X** button corner to power off the virtual instance:



15. Go to the pfSense Settings and in System untick Optical from the Boot Order list:

🧿 Oracle VM V	tualBox Manager 🗖 🗖 🖾
File Machine	Help
New Settings	Discard Start
64 pfSens	🤣 pfSense - Settings 💦 💽
	General System
	System Motherboard Processor Acceleration
	Display Base Memory: 1024 MB 荣
	Storage 4MB 32768 MB
	Audio Audio
	Network Network
	Serial Ports Chipset: PIIX3
	USB Pointing Device: PS/2 Mouse
	Shared Folders Extended Features: V Enable I/O APIC
	User Interface Hardware Clock in UTC Time
	OK Cancel <u>H</u> elp

16. In **Storage** under **Storage Tree** select the **pfSense-LiveCD**.., click the optical drive icon and select **Remove Disk from Virtural Drive** then click **OK**:

Oracle VM V File Machine	irtualBox Manager Help				
New Settings	Discard Start		Details 💿 Snapshots		
pfSens Pov	prSense - Setti General General System Display Storage Audio Network Serial Port WSB Shared Fo	storage Storage Tree Controller: IDE P pfSense.vdi pfSense-LiveCD-2.2.6-RELEAS storage Tree	Attributes Optical Drive: IDE Secondary Master Difformation Type: Image Size: 295.04 MB Location: C:\pfSense\pfSense-LiveCD- Attached to: pfSense	-2.	Choose Virtual Optical Disk File Host Drive 'D:' pfSense-LiveCD-2.2.6-RELEASE-amd64-20151221-1450.iso Remove Disk from Virtual Drive
			OK Cancel He	lp	

17. Start the **pfSense** virtual instance. When boot-up completes a window similar to below will appear. **pfSense** will be assigned an IP address from the production network for its **WAN** interface (*presuming that DHCP is enabled on this production network*). As **pfSense** has its own internal DHCP service, **pfSense** will provide a **LAN** interface with a default Gateway address. Now, **pfSense** is acting as a virtual router and is ready to assign IP addresses to the properly configured connected virtual instances:



<u>Note</u>: Now all new VM created, which its network adapter is set to **Internal Network**, will be assigned an internal IP address from **pfSense** by default

- 18. You may confirm the **WAN** setting as illustrated in the snapshots below:
 - Enter 2 for Set interfaces(s) IP address option



- 19. Minimize the **pfSense** window let it running in the background. Currently **pfSense** is acting as a virtual router providing a virtual network environment
- 20. Now we are ready to create a lab of virtual instances of servers and workstations and connect them together on this virtual network. The only requirement to be part of this virtual network is during setting up a new virtual instance its network adapter must be attached to the Internal Network. Let's carry on by creating a virtual Windows Server 2012 instance as an example:

Steps to create a new virtual instance are no different than creating **pfSense**, just set the new virtual instance **Settings** as desired. You may carry on as per the following example:

- Back to the **Oracle VM VirtualBox Manager**, click **New** to create a new virtual instance. Type a name for this virtual instance such as **DC1**, select **Type** and **Version** then click **Next** to continue

Create Virtual Machine
Name and operating system Please choose a descriptive name for the new virtual machine and select the type of operating system you intend to install on it. The name you choose will be used throughout VirtualBox to identify this machine. Name: DC1 Type: Microsoft Windows Version: Windows 2012 (64-bit)
Expert Mode Cancel

Set memory capacity as desired then click **Next** to continue

? 🔀
Create Virtual Machine
Memory size
Select the amount of memory (RAM) in megabytes to be allocated to the virtual machine.
The recommended memory size is 2048 MB.
2048 * MB
4 MB 32768 MB

Keep default selection at Create a virtual hard disk now then click Create



Select type of file then click **Next** to continue



Choose between Dynamically allocated and Fixed size as desired then click Next to continue



- Set virtual hard drive size as desired then click Create



A new **DC1** virtual instance will appear on the left side menu. Now let's carry on by making some necessary changes to the **DC1 Settings**, similar to what we did earlier with **pfSense**

In System untick Floppy from the Boot order



In **Storage** under **Storage Tree** select the optical disk **Empty**, in **Attributes** click the optical drive icon to select **Host Drive 'D:'**, which represents the **DVD** drive where the **Windows Server 2012** DVD medium will be placed to start the installation from

🥝 DC1 - Settings		?	×	
General Storage				
System Storage Tree -	Attributes		3	
Display	: SATA Optical Driv	e: SATA Port 1	2	hoose Vietual Optical Dick File
Storage		Hot-pluggable	П	lost Drive 'D:'
Audio	Information – Typ	e:	R	emove Disk from Virtual Drive
Network	Siz	e:		
Serial Ports	Attached t	io:		
DSB				
Shared Folders				
User Interface				
	📑 🚍 🛟 🔄			
	ОК	Cancel <u>H</u> elp		

- In Audio you may keep defaults configuration or deselect option as desired
- In Network, Adapter 1, Attached to, select Internal Network then click OK to save changes and exit Settings

😳 DC1 - Settings	? <mark>*</mark>
🧕 General	Network
🛒 System	Adapter 1 Adapter 2 Adapter 3 Adapter 4
Display	Enable Network Adapter
5 Storage	
┢ Audio	Name: intrict
Network	
Serial Ports	
DSB	
Shared Folders	
User Interface	

- 21. Insert the **Windows Server 2012** DVD medium into the PC DVD drive and start the **DC1** virtual instance. As we attached the virtual optical drive to the PC drive letter our DC1 virtual instance will boot up from the Windows Server 2012 DVD disk medium. Follow the prompts until installation all complete
- 22. After completion, shutdown the Windows Server 2012 virtual instance and remove the optical disk from the PC optical drive
- 23. Similar to what we did earlier after **pfSense** installation completed (steps 15 and 16 above), open the **Setting** of the **Windows Server 2012** virtual instance, in **System** untick **Optical** from the **Boot Order**, and in **Storage** remove the disk from the virtual drive
- 24. Start the Windows Server 2012 virtual instance, login and open up the browser
- 25. In the browser address bar enter the **pfSense** default Gateway address which should be **192.168.1.1** to test the ability to reach it

<u>Note</u>: As this is the first time to open up the **pfSense** GUI you may be prompted to wait until building setup wizard is complete. You also may need to add **192.168.1.1** to your Internet Explorer **Trusted Sites** and refresh the browser screen to keep going. You may continue with the prompts until wizard completes. The **pfSense** default username is **admin** and default password is **pfsense**

- 26. Test the ability to connect to the Internet by browsing different websites
- 27. Open the **Command Prompt** and check the IP settings to ensure we are getting our IP address from **pfSense**:

Administrator: Command Prompt	
lindows IP Configuration	^
Ethernet adapter Ethernet:	≡
Connection-specific DNS Suffix : localdomain Link-local IPv6 Address : fe805e84:49d:9059:72dd%12 IPv4 Address : 192.168.1.100 Subnet Mask : : 255.255.255.0 Default Gateway : : : : fe801-1×12 192.168.1.1	
unnel adapter Teredo Tunneling Pseudo-Interface:	
Connection-specific DNS Suffix . : IPv6 Address 2001:0:9d38:90d7:20f8:2052:3f57:fe9b Link-local IPv6 Address : fe80::20f8:2052:3f57:fe9b%14 Default Gateway : ::	
unnel adapter isatap.localdomain:	
Media State Media disconnected Connection-specific DNS Suffix . : localdomain	
	~

You may carry on by creating other virtual server and workstation instances for your lab as desired

Additional Comments

1. To shutdown **pfSense** go to the **Shell** session by entering option **8** then type the command **poweroff** followed by pressing the **Enter** key as illustrated in snapshot next page:



<u>Note</u>: By shutting down **pfSense** all connected virtual instances will lose network and Internet connectivity until **pfSense** is started back ON

2. If there is a requirement to remote desktop from a production workstation to a virtual instance behind **pfSense**, here is how it can be done:

Keeping our **pfSense** virtual instance running in the background, start **DC1** if not started already, login, enable remote desktop connection on it, then run the browser. In the browser address bar enter the pfSense Gateway address **192.168.1.1**, login to the pfSense GUI and change as follow

- In the Interfaces menu open WAN



In the Interfaces: WAN screen untick Block private networks then click Save followed by Apply changes
 Private networks



In the Firewall menu open NAT



- Under **Port Forward** click the **+** sign to create a new rule:

Port Forward 1:1 Outbound NPt	Firewall:	NAT:	Port For	ward						
If Proto Src. addr Src. ports Dest. addr Dest. ports NAT IP NAT Ports Description	Port Forward	1:1 0	utbound NP	t						
	If	Proto	Src. addr	Src. ports	Dest. addr	Dest. ports	NAT IP	NAT Ports	Description	

 In the Port Forward: Edit screen set as per the snapshot example below then click Save followed by Apply Changes

Destination port range	from: (other) 3395 to: (other) Specify the port or port range for the destinal Hint: you can leave the 'to'field empty if you
Redirect target IP	192.168.1.100 Enter the internal IP address of the server on e.g. 192.168.1.12
Redirect target port	

Note:

- Port number **3395** used as an example but you may use a different port number
- We presume that **Remote Desktop** is allowed on **DC1** and its virtual internal IP address assigned to it by pfSense remains same **192.168.1.100**
- If you wish to remote connect to another VM behind pfSense, follow the above steps to create a new rule using a unique port number and the virtual IP address of the VM you wish to remote connect to

Now you should be able to remote desktop to the **DC1** virtual instance from a production workstation. Presuming the pfSense **WAN** IP address remains same **192.168.100.35**, move to a production workstation, open up remote desktop connection and enter as per the snapshot example below:

semote Desktop Connection	
Remote Desktop Connection	
<u>C</u> omputer: 192.168.100.35:3395 User name: None specified You will be asked for credentials when you com	▼
Show Options	Connect <u>H</u> elp

3. In some cases there may be a need to setup multiple virtual routers attached to each other letting some virtual machines receiving their IP addresses from the later one for certain testing. If this is the case here is how it can be done:

 Start the pfSense virtual instance if not started. Enter 2 for Set interface(s) IP address option, this to switch to LAN static configuration



Switch to LAN static configuration as illustrated in the snapshot example below and when complete press the Enter key to go back to the pfSense main menu selection. Please note all virtual machines set to automatically obtaining their IP addresses and connected to the current pfSense virtual network will lose connectivity as a result of this step



 Create the second pfSense instance, let's call it pfSense_2 using the same steps we used earlier to create the first pfSense (steps 3 to 18) with the following changes instead:

Ø pfSense_2 - Settings	
E General	Network
🛒 System	Adapter 1 Adapter 2 Adapter 3 Adapter 4
Display	Enable Network Adapter
Storage	Attached to: Internal Network
խ Audio	
Network	
🙆 pfSense 2 - Settings	
procinc_e bettings	
General	Network
General System	Network Adapter 1 Adapter 2 Adapter 3 Adapter 4
General System Display	Network Adapter 1 Adapter 2 Adapter 3 Adapter 4 Image: Construction of the second seco
General System Display Storage	Network Adapter 1 Adapter 2 Adapter 3 Adapter 4 Image: Constraint of the second se
General System Display Storage Audio	Network Adapter 1 Adapter 2 Adapter 3 Adapter 4 Enable Network Adapter Attached to: Internal Network Ivalle: Inthet Advanced

In Network, set Adapter 1 and Adapter 2 to Internal Network

- When installation all complete start the **pfSense_2** virtual instance and make the following changes:
- Pick an Internal IP address available from the private pool of pfSense and assign it to the WAN interface of pfSense_2 as illustrated in the snapshots a and b below, we used 192.168.1.44 as an example



Available interfaces: 1 - WAN (em0 - dhcp, dhcp6) LAN (em1 - static) Enter the number of the interface you wish to configure:(1) Configure IPv4 address WAN interface via DHCP? (y/n)(n) En<u>ter the new W</u>AN IPv4 address. Press <ENTER> for none: 192.168.1.44 Subne<u>t masks are entere</u>d as bit counts (as in CIDR notation) in pfSense. e.g. 255.255.255.0 = 24 255.255.0.0 = 16= 8 255.0.0.0 Enter the new WAN IPv4 subnet bit count (1 to 31): 24 For a WAN, enter the new WAN IPv4 upstream gateway address. To<u>r a LAN, pre</u>ss <ENTER> for none: 192.168.1.1 Configure IPv6 address WAN interface via DHCP6? (y/n) 🕥 Enter the new WAN IPv6 address. Press <ENTER> for none: Do you want to revert to HTTP as the webConfigurator protocol? (y/n)(y)Please wait while the changes are saved to WAN... Reloading filter... Reloading routing configuration... DHCPD... Restarting webConfigurator... The IPv4 WAN address has been set to 192.168.1.44/24 p. Press <ENTER> to continue.

- Set the LAN interface of pfSense_2 as illustrated in the snapshots a and b below

а.



```
Available interfaces:
1 <u>– WAN (em0 – static)</u>
2 – LAN (em1 – static)
Enter the number of the interface you wish to configure:[2]
Enter the new LAN IPv4 address. Press <ENTER> for none:
 192.168.2.1
Subnet <u>masks are entere</u>d as bit counts (as in CIDR notation) in pfSense.
 .g. 255.255.255.0 = 24
     255.255.0.0 = 16
     255.0.0.0
                   = 8
Enter the new LAN IPv4 subnet bit count (1 to 31):
 24
For a WAN, enter the new LAN IPv4 upstream gateway address.
for a LAN, press <ENTER> for none:
Enter the new LAN IPv6 address. Press <ENTER> for none:
Do you want to enable the DHCP server on LAN? (y/n)(y)
Enter the start address of the IPv4 client address range: [192.168.2.2]
Enter the end address of the IPv4 client address range: 192.168.2.254
Please wait while the changes are saved to LAN...
 Reloading filter...
 Reloading routing configuration...
 DHCPD...
The IPv4 LAN address has been set to 192.168.2.1/24
You can now access the webConfigurator by opening the following URL in your web
browser:
                http://192.168.2.1/
Press <ENTER> to continue.
```

You may need to **poweroff** both **pfSense** and **pfSense_2** instances and start them back one at a time respectively in case of connectivity issues

Now, as **pfSense_2 DHCP** service is the one enabled, all newly created VMs configured to automatic DHCP should pick up its IP address from **pfSense_2** router instance. You may need to restart all existing running VMs, alternatively you may run the **Command Prompt** and use the commands below to release and renew the IP configuration on each running VM without restarting:

ipconfig /release ipconfig /flushdns ipconfig /renew

b.

References:

pc-addicts.com: <u>Building the Ultimate VirtualBox Lab – Install pfSense</u> Building the Ultimate VirtualBox Lab – RDP to VMs

End of document.