FortiWLC - Virtual Controller Deployment Guide

Version 8.6.0

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FortiWLC 8.6.0 Virtual Controller Deployment Guide

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Change log

Date	Change description
2021-01-07	FortiWLC version 8.6.0 document release.
2021-03-03	Updated the Windows server version for Hyper-V.
2021-09-21	Updated the NPlus1 compatibility matrix for High Availability.

About FortiWLC Virtual Controllers

The Virtual Controllers are a software version of the FortiWLC Appliance Controllers that are installed on an existing hardware platform provided that the platform implements a supported virtual hosting software solution.

The Virtual Controllers are built on the same System Director operating system that powers the FortiWLC WLAN Controller for the enterprise delivering superior reliability, scalability and predictability for WLAN deployments. They run on the widely deployed **VMware vSphere**, **RHEL Kernel-based Virtual Machine (KVM)**, and **Windows based Hyper-V** virtualization platforms installed on industry-standard hardware.

When a virtual controller is purchased, the controller image can be downloaded from the *Customer Support Portal* and, once properly installed, can be configured just as a standard physical machine.

This section includes the following topics:

- Advantages of FortiWLC Virtual Controllers on page 5
- Supported Hardware Configuration on page 6
- FortiWLC Virtual Controller Deployment Modes on page 6
- FWC-VM Series Virtual Controllers on page 7
- Virtual Controller Requirements on page 7
- Common Terminology on page 7

Advantages of FortiWLC Virtual Controllers

These are some of the advantages of the FortiWLC Virtual Controllers.

- Flexibility in hardware selection based on your requirements.
- Reduced cost, space requirements, and other overheads since multiple appliances can be replaced with single hardware running multiple instances of the controllers, FWLM Management; which is a web based application suite which manages controllers and access points mapped to the network to provide real-time data that enables centralized and remote monitoring of the network, and FortinetConnect; which is a complete provisioning, management, and reporting system that provides temporary network access for guests, visitors, contractors, consultants, or customers..
- Independent and mutually exclusive instances allow administrators to use multiple virtual controllers to manage different locations or scale the deployment using the same hardware.
- Enable features provided by the virtualization software, including High Availability, failover protection, and ease of migration.
  VMWare vMotion Storage and Snapshots are supported. Hyper-V specific features (Snapshot, Failover (HA), Replication, Hot swapping) are not supported.
- Centralized control and visibility at every level of the virtual infrastructure.

Supported Hardware Configuration

This section lists the controller models available for the new FWC-VM Series Virtual Controllers and their corresponding requirements.

Models		FWC-VM-50	FWC-VM200	FWC-VM500	FWC-VM-1000	FWC-VM-3000
Scale	AP	50	200	500	1000	3000
	Clients	1250	2500	6250	10000	30000
vCPU		4	4	8	24	48
Memory		4GB	8GB	12GB	32GB	64GB
vNIC		1-4	1-4	1-4	1-4	1-8
Disk Space		16GB (Fixed)	16GB (Fixed)	16GB (Fixed)	16GB (Fixed)	16GB (Fixed)

FortiWLC Virtual Controller Deployment Modes

The FWC-VM series Virtual Controllers can be deployed in different modes.

The following list summarizes the recommended 3rd party software requirements for installing and configuring FortiWLC Virtual Controllers.

Platforms	Supported
VMWare, vSphere client	vSphere ESXi 6.0, 6.5, and 6.7
Linux KVM	Ubuntu 16.04.2 LTS
Hyper-V	Windows 2016

Web based configuration interface has been tested with the following browsers:

- Internet Explorer versions 10 and 11 on Windows
- Firefox on Windows
- Safari on MAC OS

FWC-VM Series Virtual Controllers

The FWC-VM Series Virtual Controllers are tested on Dell PowerEdge R730 CPUs– Intel(R) Xeon(R) CPU E5-2697 v4 @ 2.30GHz. Any equivalent h/w that has support for Virtualization should work.

Virtual Controller Requirements

The following points are general advisories regarding Virtual Controllers.

- The number of Virtual Ports configured for the controller will vary depending on the controller's model; be sure to configure the appropriate number of ports for the model being installed.
- If you are operating more than one Virtual Controller on a single host machine, ensure that the Virtual Interface for each Virtual Controller is configured in its own port group on the Virtual Switch. This will prevent network loops.
- Virtual Controller Ports can be configured for active-active mode or active/redundant mode.

Common Terminology

The following are some of the Networking VMware elements that will be used to configure the Virtual Controller to operate in VMware environment:

vSwitch

This is a virtual switch, similar to a physical switch, performs functions including the Layer 2 forwarding engine, VLAN tagging, stripping, and filtering, security, checksum, and segmentation. The vSwitch links VMs to each other locally as well as to physical networks. A controller VE should connect to a vSwitch through virtual machine port groups.

Port Groups

Port groups are not VLANs. They are configuration templates for the vNIC ports on the vSwitch. Administrators can set specific QoS, security policies, and VLANs by port group. This is where you should enable promiscuous mode (and not on the vSwitch).

Promiscuous Mode (VMWare ESXi only)

Virtual Controllers are typically deployed as an in-line device on the data path and all the packets pass through the controller. Because of this, it needs to operate in Promiscuous mode. vSphere's vSwitch and port group properties have the option to enable promiscuous mode. Again, it is highly recommended to enable this on the port group.

VM-NIC Queues Usage

The field **VM NIC Queues** in the**sh controller** commandindicates the value assigned to a Controller for better performance, based on different platforms/hypervisors. This field mainly applies for the Virtual Controller Instance's deployed using VMWare and Linux KVM and **not** for Hyper-V.

For Virtual Controller models deployed using Hyper-V Platform, this field is not applicable and shows **N** for all Controller models.

For the Virtual Controller models deployed using different platforms, these are the VM NIC Queues values.

Platforms	FWC-VM-50	FWC-VM-200	FWC-VM-500	FWC-VM-1000	FWC-VM-3000
VMWare	4	4	8	8	8
Linux KVM	2	2	4	8	16
Hyper-V	N	N	N	N	N

Deploying FortiWLC Virtual Controllers with VMWare ESXi

This section describes the virtual controller deployment procedure on VMWare ESXi. This section includes the following topics:

Pre-requisites

For deployment and management of the Virtual Controller, you will need to download any of these VMware suites to the workstation:

- Single ESXi server management − Use VMware vSphere Client.
- Multiple ESXi servers requires vCenter − Advance features are also tied with vCenter which needs separate licenses (vMotion, and so on).

Virtual Controllers can be deployed in these 2 modes in a VMWare setup.

Note: Fortinet recommends that you deploy the Virtual Controllers in the dedicated mode. This mode of deployment achieves the maximum throughput for each Controller model, especially when using the APs in Tunnel mode where all the traffic will be tunneled by the APs to the controller and then to the Network.

The deployed Virtual controllers have a dedicated NIC, vSwitch and vPort Group.

Start the **VMware vSphere Client**, and log in to the ESXi server. Go to **Configuration** and click **Networking**.

As you can see, there are existing 2 VM running on the host, using the same vSwitch0 and same Virtual Machine port Group. The vSwitch is also used by the vKernel Port that is responsible for the ESXi management.

Downloading the Virtual Controller PackageFile

You can download the virtual controller packages from the *Fortinet Customer Support* website. To access the support website you need a *Fortinet Customer Support* account.

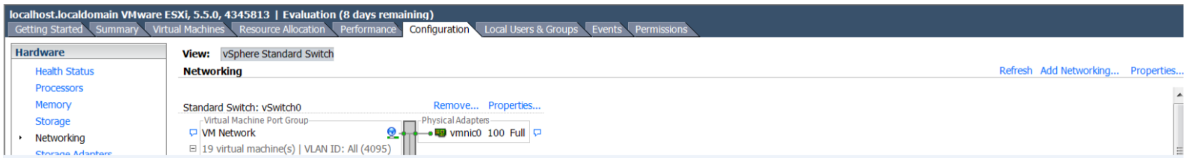
The file name is, *forti-x.x-xbuild-0-x86_64.ova*, where x.x-x is the release version number. For example, 8.6.0.

Configuring the Virtual Controller

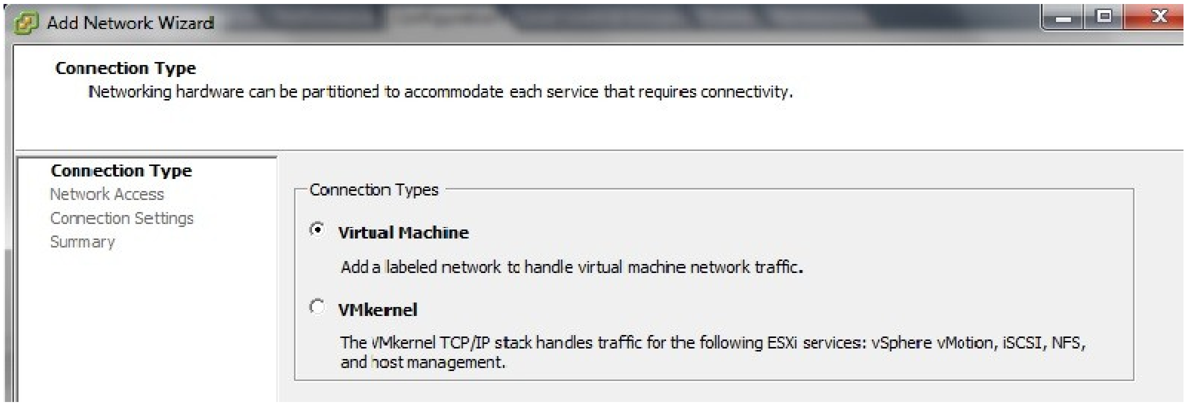
In this deployment, we will be using an added NIC card with 2 Gig Ethernet ports as shown in the **Network Adapters** wizard.

The 2 gig interfaces are connected to a Switch that support Link Aggregation (LAG). It is assumed in this procedure that the LAG is created on the switch and has the appropriate VLAN configuration.

1. Create a new Virtual Switch: Go to **Networking** and click Add**Networking…**



2. Select **Virtual Machine**and click **Next**.



Connection Type

Networking hardware can be partitioned to accommodate each service that requires connectivity.

Connection Types

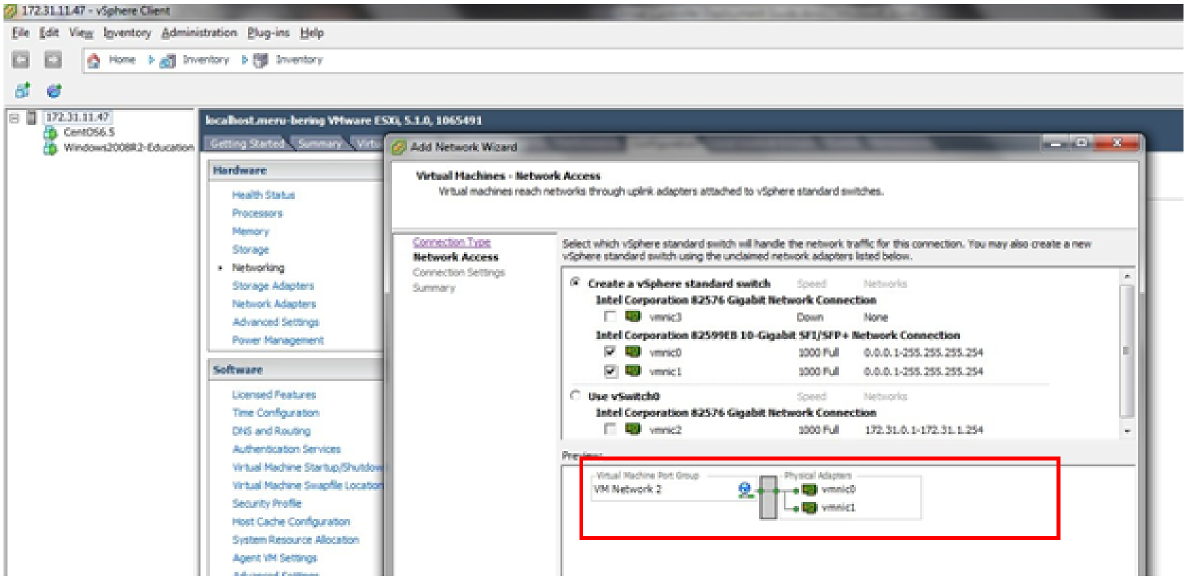
● Virtual Machine

Add a labeled network to handle virtual machine network traffic.

○ VMkernel

The VMkernel TCP/IP stack handles traffic for the following ESXi services: vSphere vMotion, iSCSI, NFS, and host management.

Create a vSwitch and assign the dedicated physical NIC. Click **Next** and provide a label for the vSwitch, for example, FWC-VM-50.



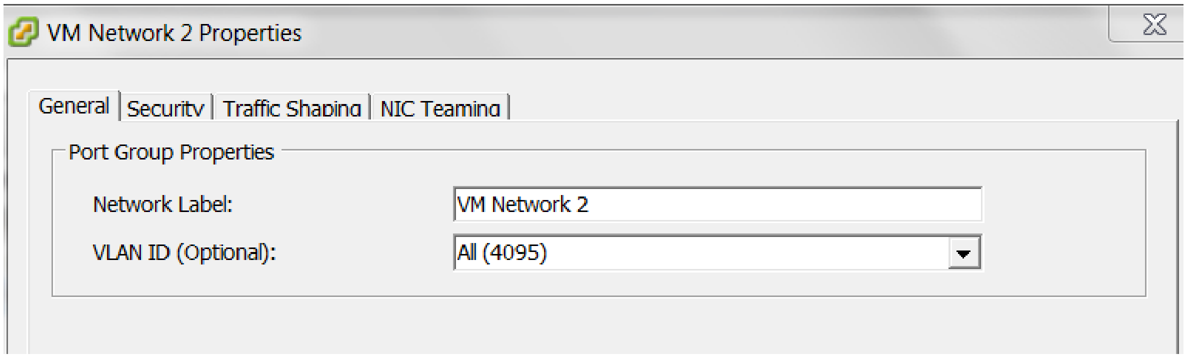
Virtual Machines - Network Access

Virtual machines reach networks through uplink adapters attached to vSphere standard switches.

Select which vSphere standard switch will handle the network traffic for this connection. You may also create a new vSphere standard switch using the unclaimed network adapters listed below.

	Speed	Networks
● Create a vSphere standard switch		
Intel Corporation 82576 Gigabit Network Connection		
□ vmnic3	Down	None
Intel Corporation 82599EB 10-Gigabit SFI/SFP+ Network Connection		
☑ vmnic0	1000 Full	0.0.0.1-255.255.255.254
☑ vmnic1	1000 Full	0.0.0.1-255.255.255.254
○ Use vSwitch0		
Intel Corporation 82576 Gigabit Network Connection		
□ vmnic2	1000 Full	172.31.0.1-172.31.1.254

3. For VLAN ID, select **All (4095)**, if you are using Trunk port on the switch. Click **Next** and then **Finish** to complete the vSwitch creation.

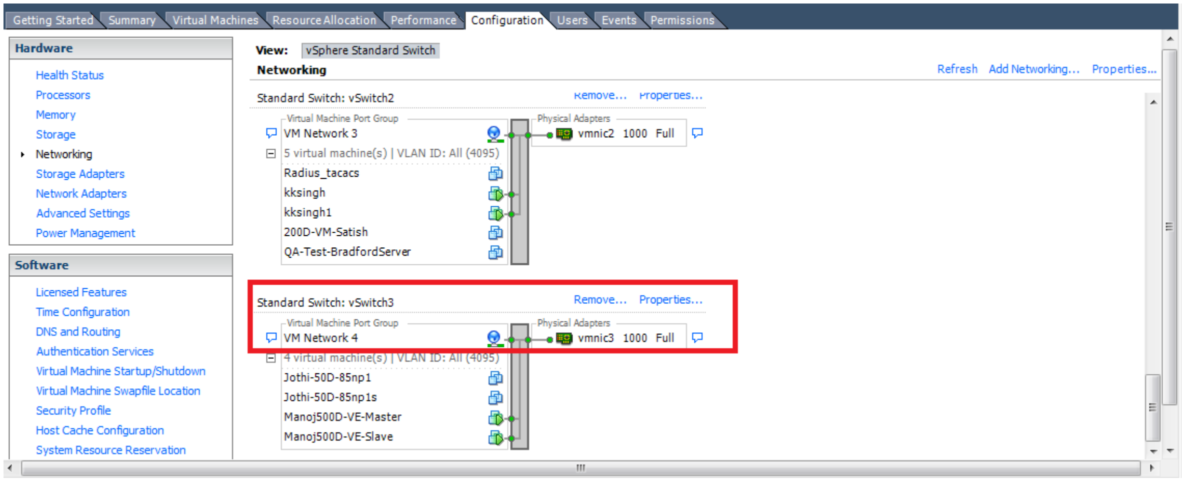


Port Group Properties

Network Label: VM Network 2

VLAN ID (Optional): All (4095)

4. The vSwitch and a virtual machine port group are created. For example, VM Network 4 port group is created as depicted in this image.



View: vSphere Standard Switch

Networking

Standard Switch: vSwitch2

Virtual Machine Port Group: VM Network 3

5 virtual machine(s) | VLAN ID: All (4095)

Radius_tacacs
kksingh
kksingh1
200D-VM-Satish
QA-Test-BradfordServer

Physical Adapters: vmnic2 1000 Full

Standard Switch: vSwitch3

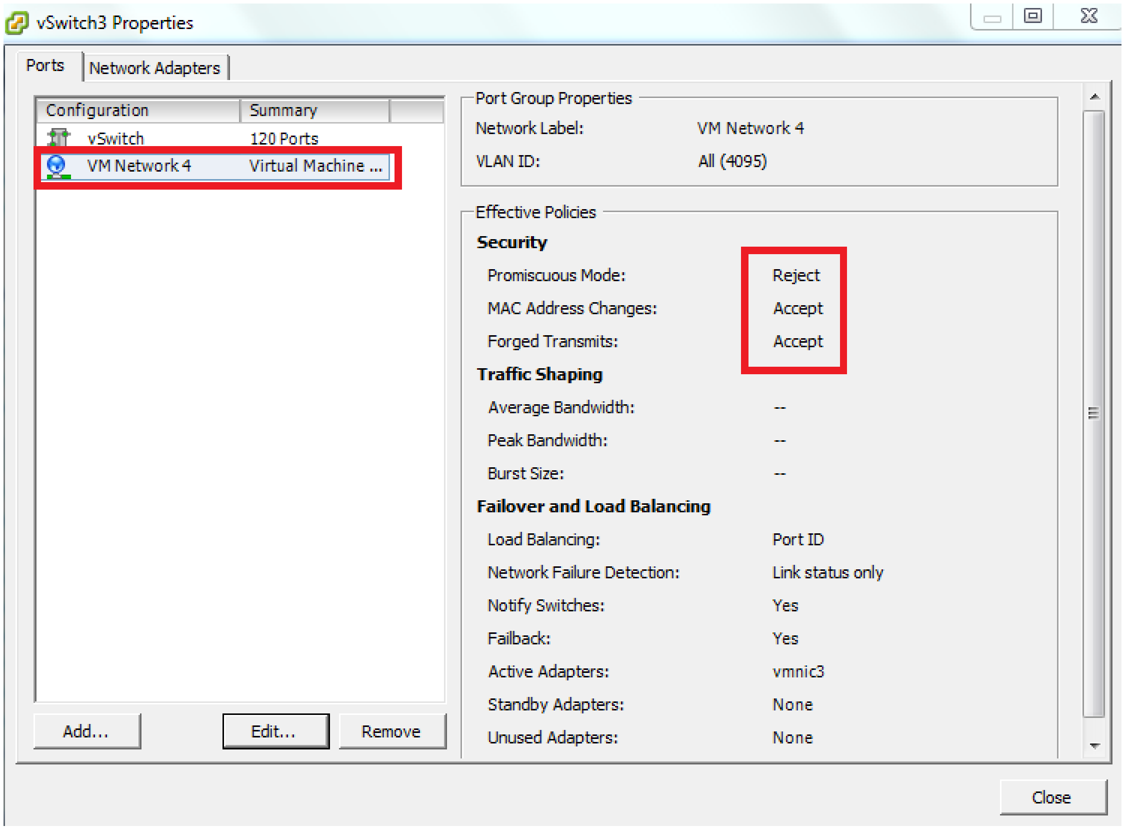
Virtual Machine Port Group: VM Network 4

4 virtual machine(s) | VLAN ID: All (4095)

Jothi-50D-85np1
Jothi-50D-85np1s
Manoj500D-VE-Master
Manoj500D-VE-Slave

Physical Adapters: vmnic3 1000 Full

5. Click on the vSwitch **Properties** and select the created port group; click **Edit**. In this example, the port group is VM Network 4.



Configuration	Summary
vSwitch	120 Ports
VM Network 4	Virtual Machine ...

Port Group Properties

Network Label:	VM Network 4
VLAN ID:	All (4095)

Effective Policies

Security

Promiscuous Mode:	Reject
MAC Address Changes:	Accept
Forged Transmits:	Accept

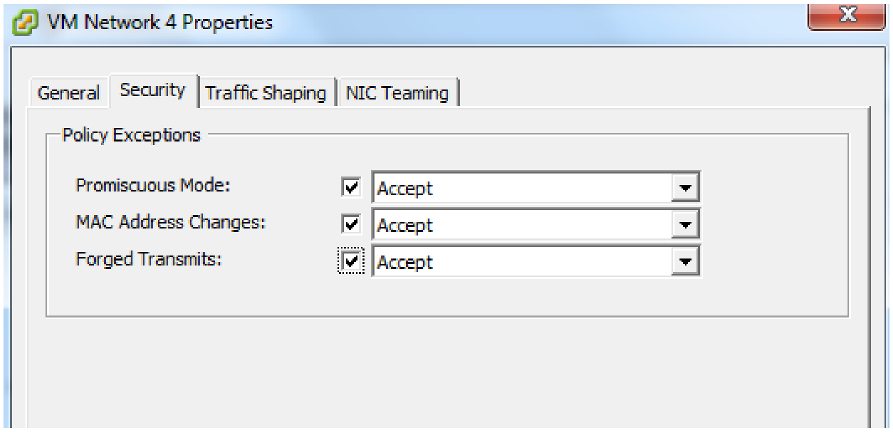
Traffic Shaping

Average Bandwidth:	--
Peak Bandwidth:	--
Burst Size:	--

Failover and Load Balancing

Load Balancing:	Port ID
Network Failure Detection:	Link status only
Notify Switches:	Yes
Failback:	Yes
Active Adapters:	vmnic3
Standby Adapters:	None
Unused Adapters:	None

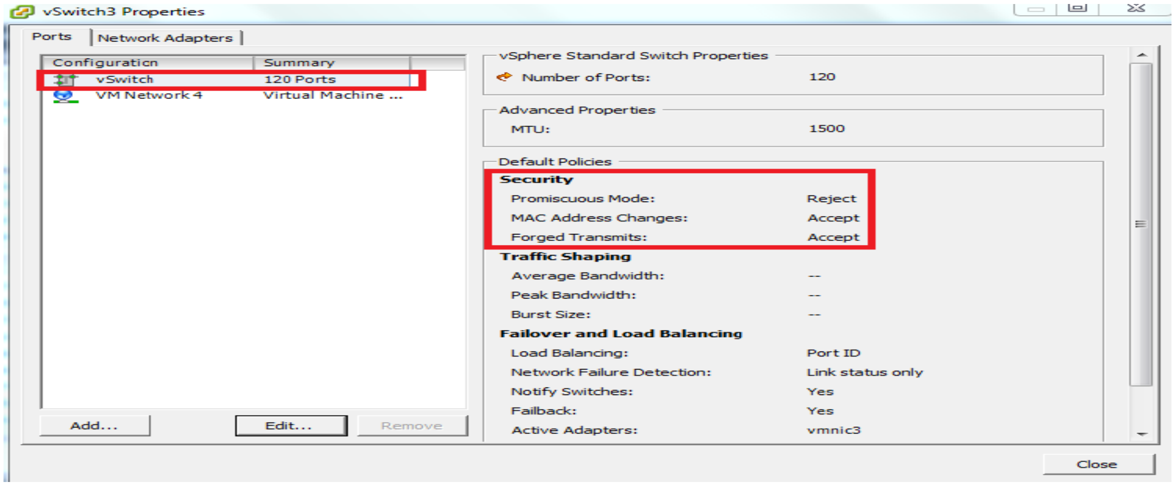
6. Under the **Security** tab, select the **PromiscuousMode** and select **Accept** from the drop menu and click **OK** to apply the changes.



Policy Exceptions

Promiscuous Mode:	☑	Accept
MAC Address Changes:	☑	Accept
Forged Transmits:	☑	Accept

Note: The vSwitch main configuration is set to reject the Promiscuous mode, but the virtual machine port group overwrites the vSwitch configuration and operates in a Promiscuous Mode for the **VM Network 4** port group.



Configuration	Summary
vSwitch	120 Ports
VM Network 4	Virtual Machine ...

vSphere Standard Switch Properties
Number of Ports: 120

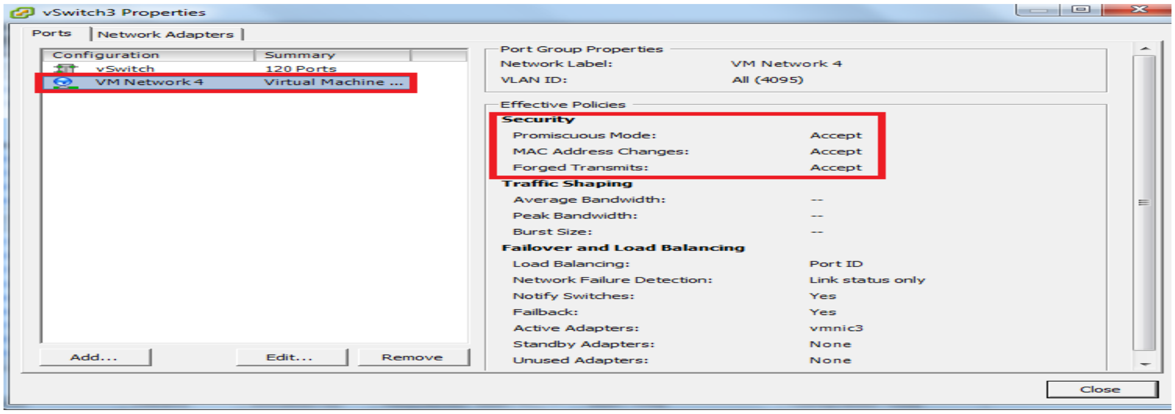
Advanced Properties
MTU: 1500

Default Policies

Security
Promiscuous Mode: Reject
MAC Address Changes: Accept
Forged Transmits: Accept

Traffic Shaping
Average Bandwidth: --
Peak Bandwidth: --
Burst Size: --

Failover and Load Balancing
Load Balancing: Port ID
Network Failure Detection: Link status only
Notify Switches: Yes
Failback: Yes
Active Adapters: vmnic3



Configuration	Summary
vSwitch	120 Ports
VM Network 4	Virtual Machine ...

Port Group Properties
Network Label: VM Network 4
VLAN ID: All (4095)

Effective Policies

Security
Promiscuous Mode: Accept
MAC Address Changes: Accept
Forged Transmits: Accept

Traffic Shaping
Average Bandwidth: --
Peak Bandwidth: --
Burst Size: --

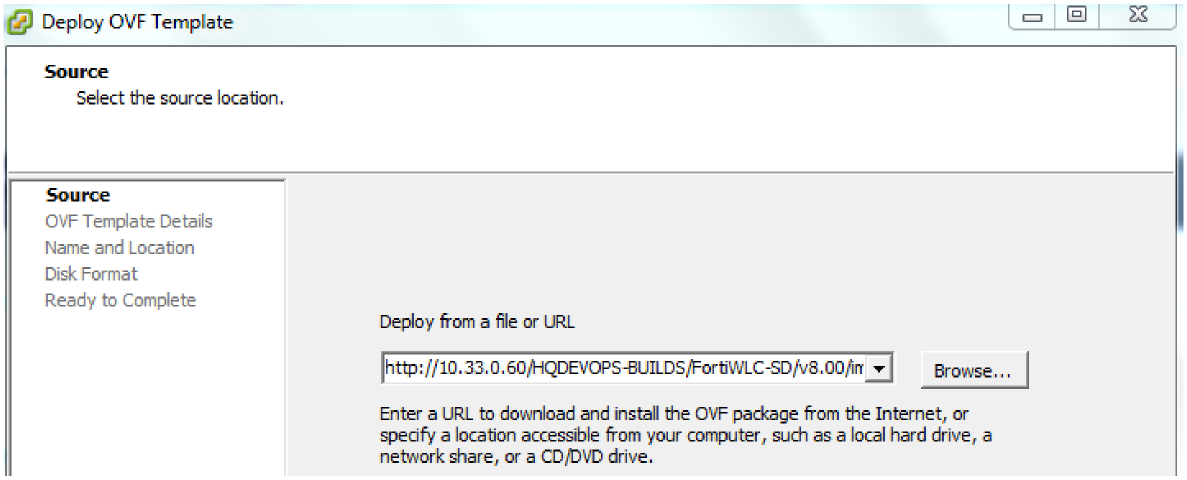
Failover and Load Balancing
Load Balancing: Port ID
Network Failure Detection: Link status only
Notify Switches: Yes
Failback: Yes
Active Adapters: vmnic3
Standby Adapters: None
Unused Adapters: None

Each vNIC has to be a part of a different Vswitch connected to different physical ports. Now that the structure is ready, start installing the OVA template into the VMware host.

Installing the Virtual Controller

1. Go to **File** and click **Deploy OVF Template…**in order to start the installation.

2. Browse to the location of the OVA template that you downloaded from *Fortinet Support* page and click **Next**.



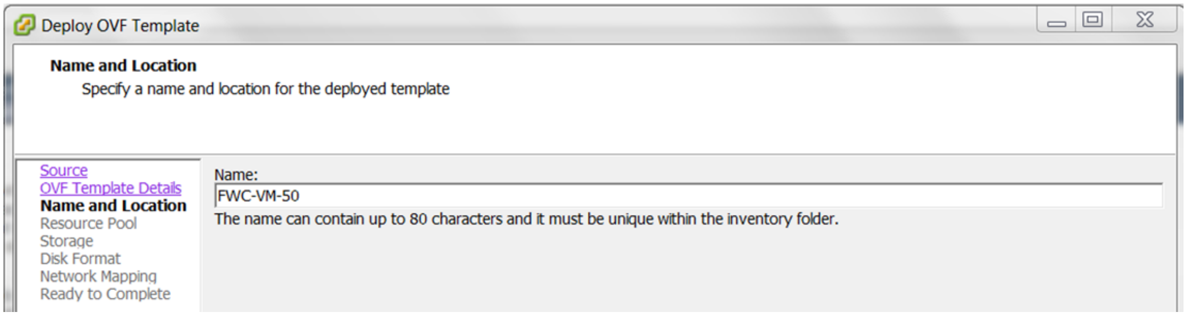
Source
Select the source location.

Deploy from a file or URL

http://10.33.0.60/HQDEVOPS-BUILDS/FortiWLC-SD/v8.00/im

Enter a URL to download and install the OVF package from the Internet, or specify a location accessible from your computer, such as a local hard drive, a network share, or a CD/DVD drive.

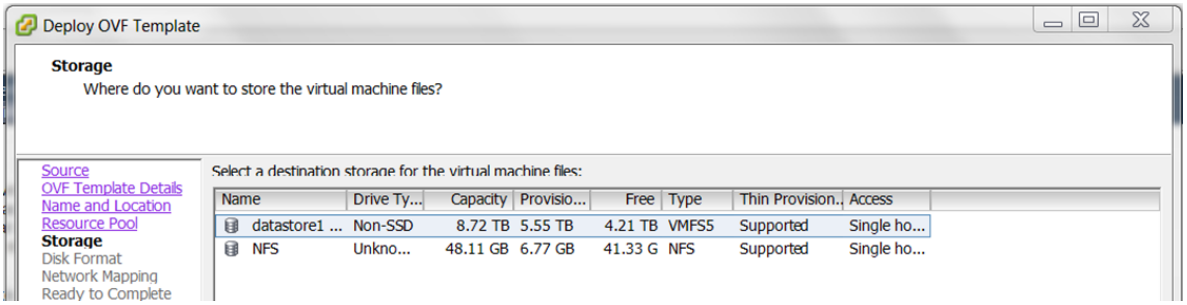
3. Click **Next** and enter a **Name** for the Virtual Controller, for example, **FWC-VM-50** is created as depicted in this image.



Name and Location
Specify a name and location for the deployed template

Name:
FWC-VM-50
The name can contain up to 80 characters and it must be unique within the inventory folder.

4. Configure the **Resource Pool** and **Storage**.

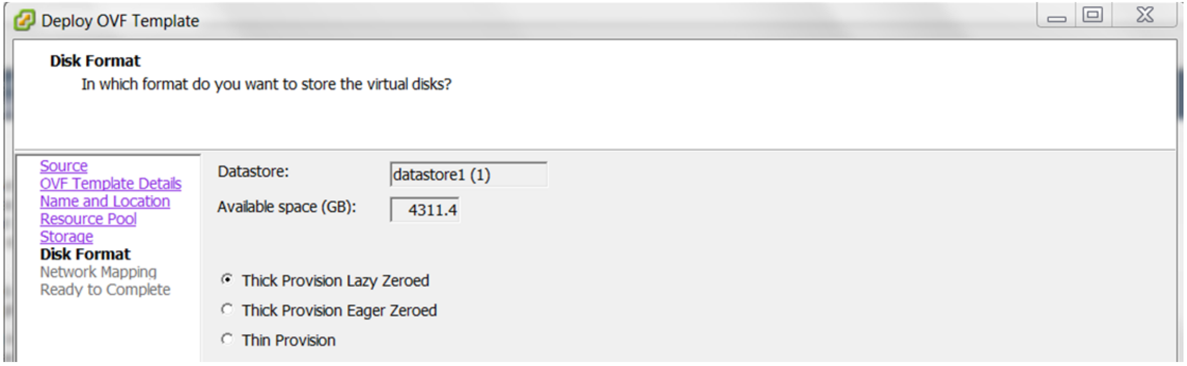


Storage
Where do you want to store the virtual machine files?

Select a destination storage for the virtual machine files:

Name	Drive Ty...	Capacity	Provisio...	Free	Type	Thin Provision...	Access
datastore1 ...	Non-SSD	8.72 TB	5.55 TB	4.21 TB	VMFS5	Supported	Single ho...
NFS	Unkno...	48.11 GB	6.77 GB	41.33 G	NFS	Supported	Single ho...

Use the default **Disk Format - Thick Provisioning Lazy Zereod**.



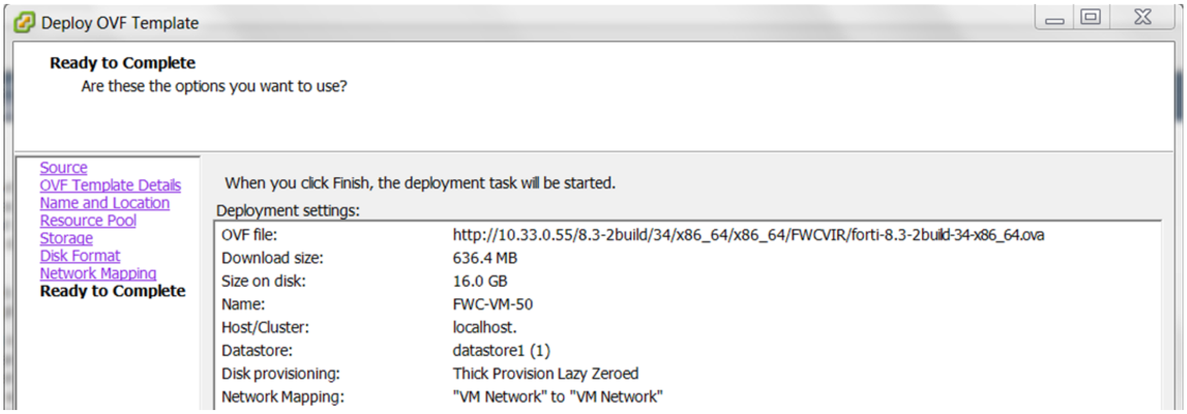
Disk Format
In which format do you want to store the virtual disks?

Datastore: datastore1 (1)
Available space (GB): 4311.4

● Thick Provision Lazy Zeroed
○ Thick Provision Eager Zeroed
○ Thin Provision

Configure **Network Mapping**.

5. Click**Finish** in the**Ready to Complete**wizard.



Ready to Complete

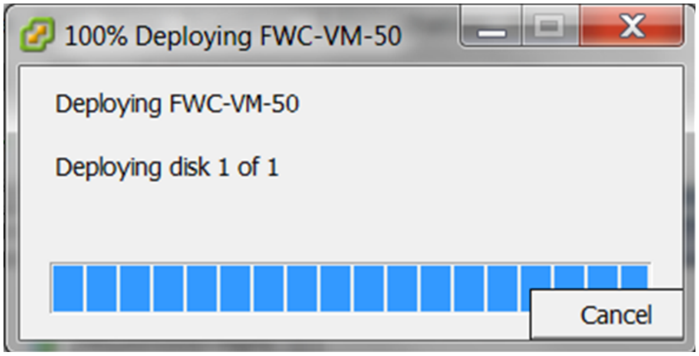
Are these the options you want to use?

When you click Finish, the deployment task will be started.

Deployment settings:

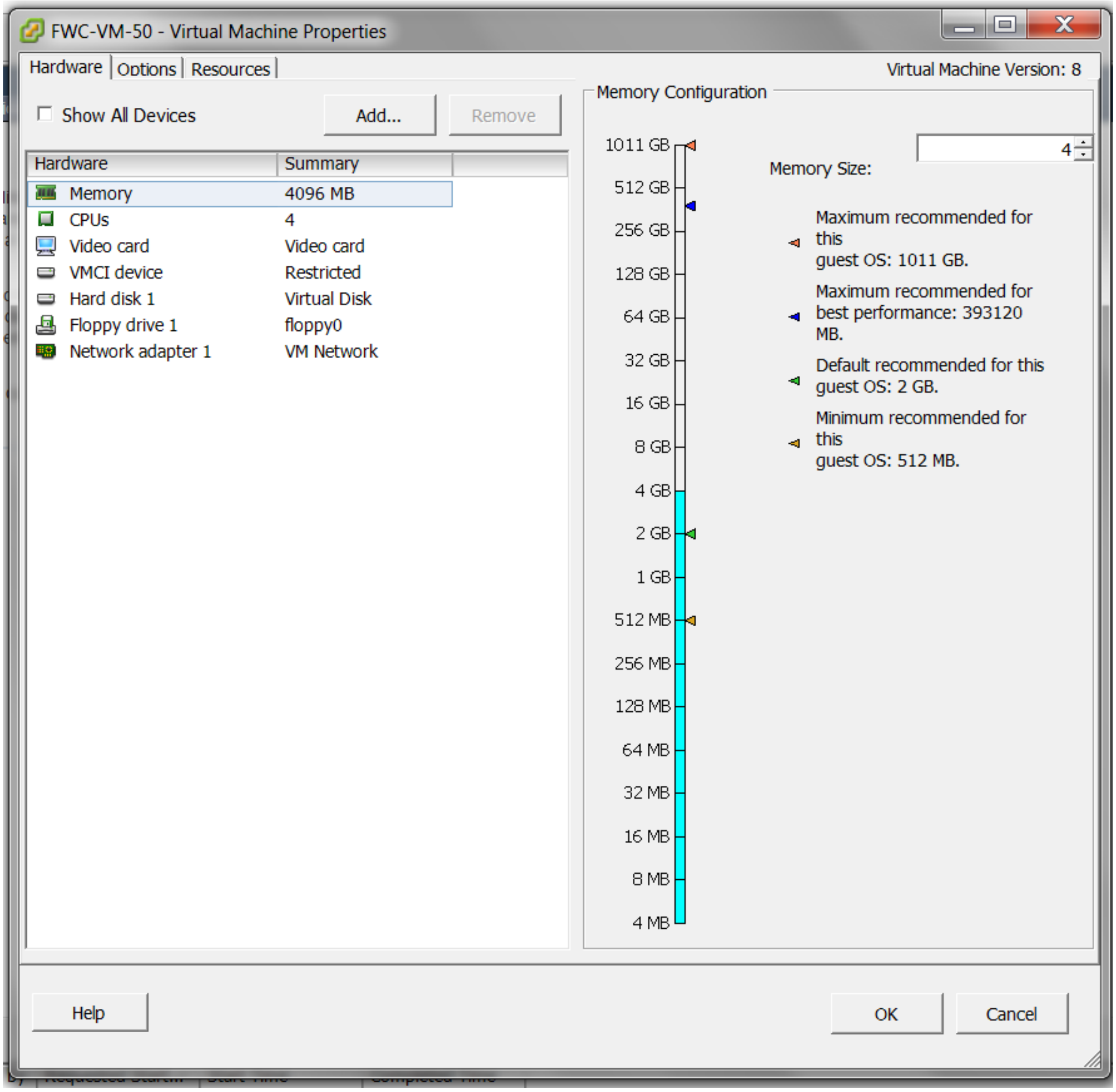
OVF file:	http://10.33.0.55/8.3-2build/34/x86_64/x86_64/FWCVIR/forti-8.3-2build-34-x86_64.ova
Download size:	636.4 MB
Size on disk:	16.0 GB
Name:	FWC-VM-50
Host/Cluster:	localhost.
Datastore:	datastore1 (1)
Disk provisioning:	Thick Provision Lazy Zeroed
Network Mapping:	"VM Network" to "VM Network"

The upload and installation of the Virtual Controller will start, the time varies according to the network bandwidth between the vSphere Client and the ESXi Host. You should get aCompleted Successfully message at the end.



Deploying FWC-VM-50

Deploying disk 1 of 1



FWC-VM-50 - Virtual Machine Properties

Virtual Machine Version: 8

□ Show All Devices

Hardware	Summary
Memory	4096 MB
CPUs	4
Video card	Video card
VMCI device	Restricted
Hard disk 1	Virtual Disk
Floppy drive 1	floppy0
Network adapter 1	VM Network

Memory Size: 4

Maximum recommended for this guest OS: 1011 GB.

Maximum recommended for best performance: 393120 MB.

Default recommended for this guest OS: 2 GB.

Minimum recommended for this guest OS: 512 MB.

Starting the Virtual Controller

Select the Controller and go to the **Console** Tab and Start the VM by clicking on the Power On button or (Ctrl+b). The Virtual Controller will start and you will see the entire startup message that you will typically found in a Hardware Controller.

The first boot might take few minutes longer to boot up if no DHCP server is available as the controller will try to get an IP address from the DHCP server. Please refer to the Controller SD documentation to complete the controller installation.

Recommended VMware ESXi Host Settings

Fortinet recommends the following VM configurations and global host settings for enhanced Controller performance.

VM Configuration Settings

- **CPU affinity** - In servers where the available physical cores (i.e. half of HT CPUs) are more than the required cores for Controllers, set the CPU affinity such that no two vCPUs are scheduled on the same physical core by the VMKernel.
  To set the CPU range, go to **Edit Settings ->Virtual Hardware -> CPU -> Scheduling Affinity**.
- **Latency Sensitivity** - Set the Latency sensitivity to High, to do so, go to **Edit Settings -> VM Options -> Advanced -> Latency Sensitivity**.
- **Virtual NIC settings** - Disable virtual interrupt coalescing, to do so, go to **Edit Settings -> Options tab -> Advanced -> Configuration Parameters** and add an entry for **ethernetX.coalescingScheme** with the value **disabled**.

Global Host Settings

- **Physical NIC settings** – Disable the interrupt moderation/coalescing. Run the **esxcli system module parameters set -m ixgbe -p "InterruptThrottleRate=0"** CLI command.
  This is applicable to Intel 10G with ixgbe driver, that is, chipsets Intel 82599 and is not applicable or i40en based drivers. Run the **esxcli network nic list** CLI command to find the list of drivers.
- Set the **/Net/MaxNetifTxQueueLen** global parameter to 10000 (default is 2000). Run the **esxcli system settings advanced set -o /Net/MaxNetifTxQueueLen -i=10000** CLI command.
- Set the **/Net/NetVMTxType** global parameter to 3 (applicable only for ESXi 6.5). Run the **esxcli system settings advanced set -o /Net/NetVMTxType -i=3** CLI command.
  This allocates multiple Tx world, that is, 1 per queue.

These are the parameters for different Controller models.

Parameters	FWC-VM-50	FWC-VM-200	FWC-VM-500 (10G)	FWC-VM-1000	FWC-VM-3000	FWC-VM-500-(1G)
CPU affinity	Yes	Yes	Yes	Yes	No (Applicable only if the number of physical cores on the host are more than 48.)	Yes

Parameters	FWC-VM-50	FWC-VM-200	FWC-VM-500 (10G)	FWC-VM-1000	FWC-VM-3000	FWC-VM-500-(1G)
Latency Sensitivity	High	High	High	High	High	High
Virtual NIC settings (Disable interrupt coalescing)	Yes	Yes	Yes	Yes	No	Yes
/Net/MaxNetifTxQueueLen	1000	1000	10000	10000	10000	1000
/Net/NetVMTxType (for ESXi 6.5 and above)	1	1	3	3	3	1

Deploying FortiWLC Virtual Controllers with Linux KVM

This section describes the virtual controller deplyoment procedure on Linux KVM. This section includes the following topics:

Pre-requisites

For deployment and management of the Virtual Controller on Linux KVM, install the following 3rd party software.

- Install Ubuntu v16.04 LTS server.
- Install KVM on the Ubuntu LTS server.
- Create an open Vswitch with KVM.
- Install Virtual Machine Manage (virt-manager) to create and manage guest virtual machines.

Note: To accomplish the pre-requisites refer to the respective 3rd party documentation.

Downloading the Virtual Controller Package File

You can download the virtual controller packages from the *Fortinet Customer Support* website. To access the support website you need a *Fortinet Customer Support* account.

The file name is, *forti-x.x-xbuild-0-x86_64.img.KVM.zip*, where x.x-x is the release version number. For example, 8.6.0.

Installing Linux KVM

Install Ubuntu 16.04.2 64-bit Desktop version.

1. Run the **apt-get install openssh-server** command to install openssh utility.
   Now, you should be able to ssh to the machine.

2. Run the egrep -c '(vmx|svm)' /proc/cpuinfo command to check whether the system supports Virtualization or not.
   If the output is 0, then the system does not support Virtualization. If the output is greater than 0 it means your system is set and ready to go for KVM installation.
3. Run the **apt-get install openvswitch openvswitch-common openvswitch-switch** and **/etc/init.d/openvswitch-switch start** commands to install openvswitch which is used for tagging and untagging the vlans created.
4. Run the following commands to create a virtual-bridge.
   - **ovs-vsctl add-br <bridge-name:(user-defined)>**
   - **ovs-vsctl port <port-name:(user-defined) <eth-intf: name of the physical Ethernet port>**
   - **ovs-vsctl set port vnet0 trunks=0,168,169**
     In this command 168 and 169 are tagged vlans and 0 is a mandatory argument which specifies the native-vlan.
   - **dhclient <<bridge-name:(user-defined)>**
5. Run the **ovs-vsctl show** command to see the virtual switch created. This is a sample command output:

```
root@automation-HP-406-G1-MT:~# ovs-vsctl show
52690264-a2da-4a63-86e9-c8ceabf9be72
      Bridge "N164-T168-T169" (N164-T168-T169:Bridge-name)
         Port "N164-T168-T169" (N164-T168-T169:port--name)
            Interface "N164-T168-T169"
            type: internal
         Port "enp3s0" (enp3s0:physical Ethernet port name)
             Interface "enp3s0"
        Port "vnet0"
            trunks: [0, 168, 169]
             Interface "vnet0"
ovs_version: "2.5.0"
```

6. Run the **sudo apt-get install qemu-kvm libvirt-bin ubuntu-vm-builder bridge-utils** command to install KVM.
7. Run the **sudo adduser `id -username` libvirtd** command to ensure that your Ubuntu username is added to the group libvirtd.
8. Run the **sudo apt-get install virt-manager** command to install graphical user interface for KVM.
9. After the virt-manager is installed, type **virt-manager** to start the virtual manager application.
10. You can create a virtual Instance using GUI. In one of the window, you have to select **bridge interface vnet0**.
11. Create a virtual network:
    - Create a directory for storing the virtual network xml file, for example, *mkdir vmswitch-xml*.
    - Let the name of the xml file stored in the directory be *N164-T168-T169.xml*.
    - Contents of the xml file are as follows:

```
<network>
 <name>N164</name>
<forward mode='bridge'/>
 <bridge name='N164-T168-T169' />  #Created Bridge name
 <virtualport type='openvswitch'/>
 <portgroup name='N164-T168-T169'> #Created Port name
   <vlan trunk='yes'>
     <tag id='164' nativeMode='untagged'/>
     <tag id='168'/>  #tagged vlan
     <tag id='169'/> #tagged vlan
```

```
          </vlan>
        </portgroup>
      </network>
```

12. Run the following commands to activate the created virtual network.
    - **virsh net-define N164-T168-T169.xml**
    - **virsh net-start N164**
13. Copy the image in the specified path and run the VM through virt-manager(GUI).
    - cd /var/lib/libvirt/images/
    - *wget -c http://10.34.224.254/release/8.6-0build/11/x86_64/x86_64/FWCVIR/forti-8.6-0build-11-x86_64.img.KVM.zip***(this is a sample file)**.
    - Unzip *forti-8.6-0build-11-x86_64.img.KVM.zip*

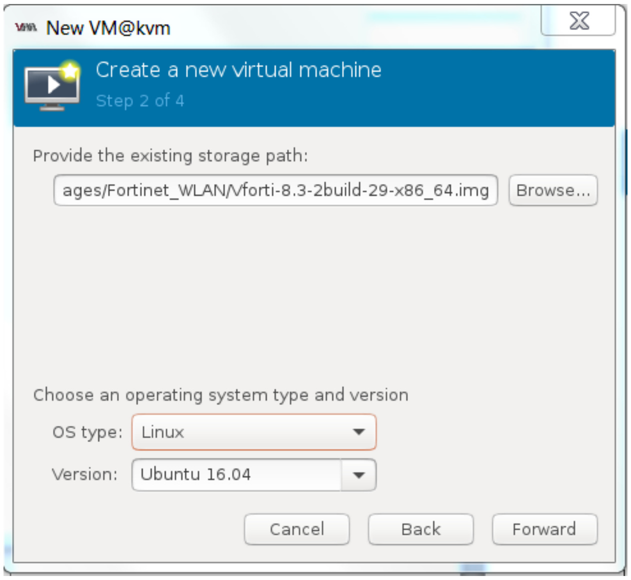
Configuring the Virtual Controller

Perform these steps to configure a virtual controller.

a. Open the virt-manager and select **Import Existing Disk Image**.

b. Browse to the location of the downloaded package file and specify the **OS type** as **Linux** and **Version** as **Ubuntu 16.04**.

c. Click **Forward**.



New VM@kvm

Create a new virtual machine

Step 2 of 4

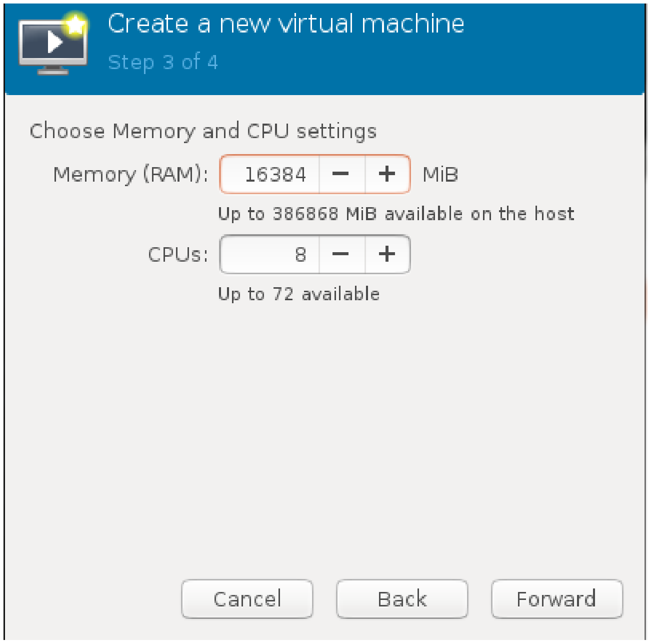
Provide the existing storage path: ages/Fortinet_WLAN/Vforti-8.3-2build-29-x86_64.img

Choose an operating system type and version

OS type: Linux

Version: Ubuntu 16.04

d. Specify the memory and CPU setting as per the deployed virtual controller model.



Create a new virtual machine

Step 3 of 4

Choose Memory and CPU settings

Memory (RAM): 16384 MiB

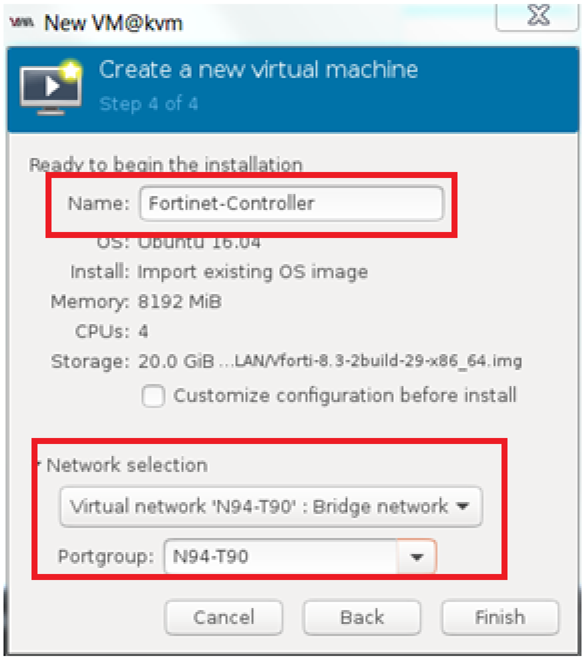
Up to 386868 MiB available on the host

CPUs: 8

Up to 72 available

e. Click **Forward**.

f. Specify the hostname, select the network adapter from the **Network Selection** drop down, and specify the **Portgroup**.



New VM@kvm

Create a new virtual machine

Step 4 of 4

Ready to begin the installation

Name: Fortinet-Controller

OS: Ubuntu 16.04

Install: Import existing OS image

Memory: 8192 MiB

CPUs: 4

Storage: 20.0 GiB ...LAN/Vforti-8.3-2build-29-x86_64.img

□ Customize configuration before install

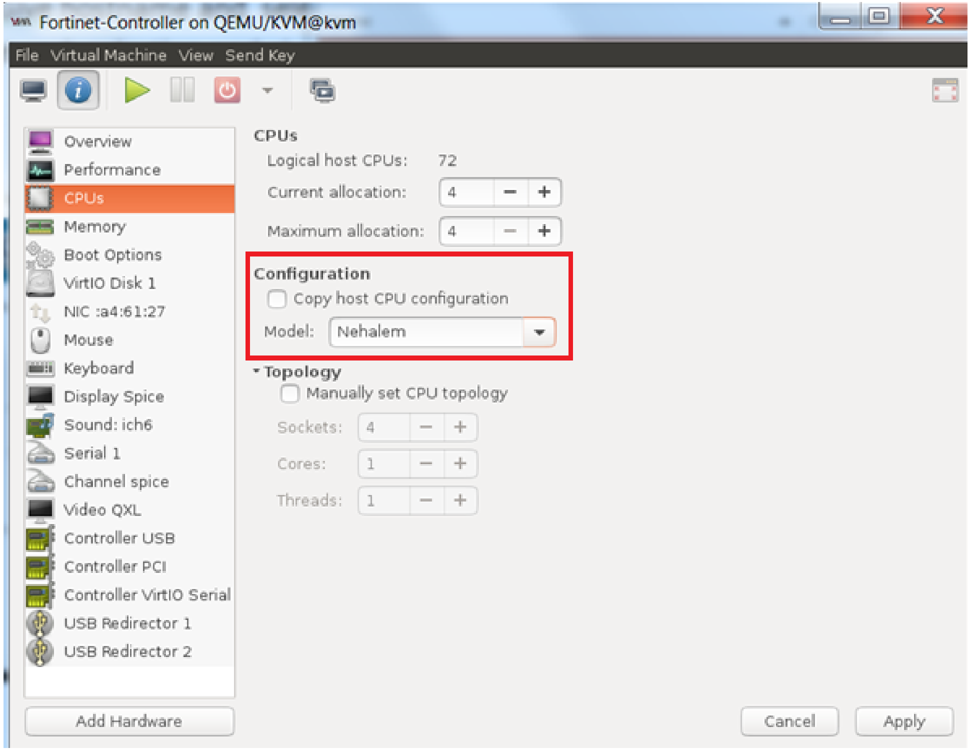
Network selection

Virtual network 'N94-T90' : Bridge network

Portgroup: N94-T90

g. Click **Finish**.

h. In the **CPUs** settings, configure the **Model** as **Nehalem**. Click**Apply**.



CPUs

Logical host CPUs: 72

Current allocation: 4

Maximum allocation: 4

Configuration

□ Copy host CPU configuration

Model: Nehalem

Topology

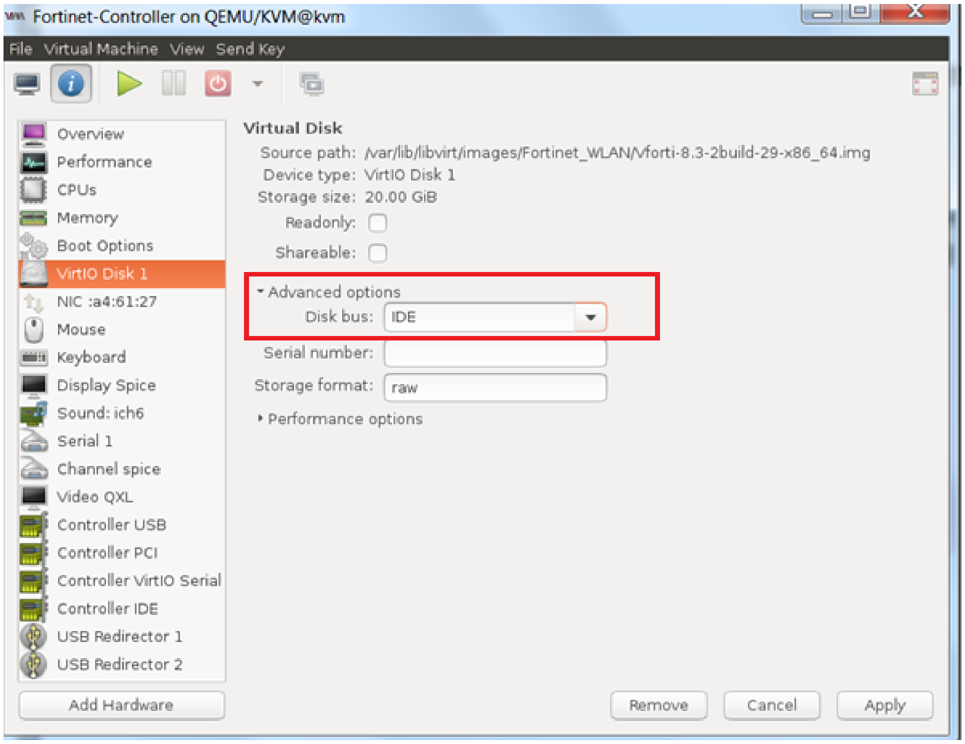
□ Manually set CPU topology

Sockets: 4

Cores: 1

Threads: 1

i. In the **VirtIO Disk1**, under **Advanced options**, select the **Disk bus** as **IDE**. Click**Apply**.



Virtual Disk

Source path: /var/lib/libvirt/images/Fortinet_WLAN/vforti-8.3-2build-29-x86_64.img

Device type: VirtIO Disk 1

Storage size: 20.00 GiB

Readonly: □

Shareable: □

Advanced options

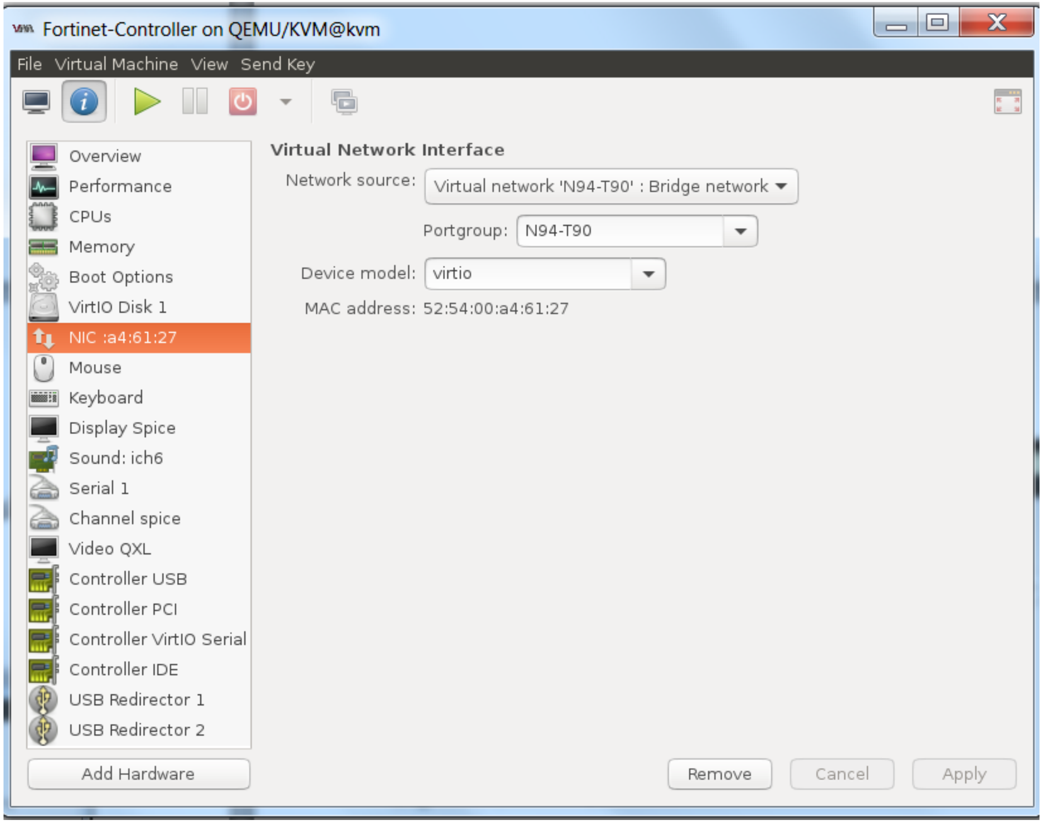
Disk bus: IDE

Serial number:

Storage format: raw

Performance options

j. In the NIC settings, specify the **Network source**, **Portgroup**, and **Device model** as **virtio**. Click**Apply**.



Virtual Network Interface

Network source: Virtual network 'N94-T90' : Bridge network

Portgroup: N94-T90

Device model: virtio

MAC address: 52:54:00:a4:61:27

k. The Virtual Controller deployment is complete.

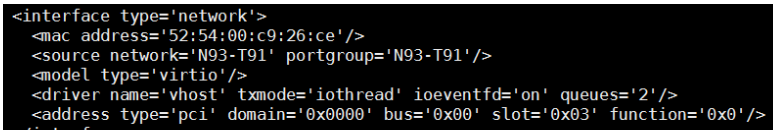
Recommended Linux KVM Host Settings

Fortinet recommends the following host settings for enhanced Controller performance.

- Disable the offload settings like GSO, GRO, TSO, and UFO for all ports. Run the **ethtool -K <eth dev> gso off lro off tso off ufo off** command.
- Set the ring descriptor size (**ethtool -G <eth dev> 4096**) to the maximum limit (4096) for all ports.
- Set **net.core.netdev_budget** to 600 and **net.core.netdev_max_backlog** to 60000.
  The commands in the above steps could be set in */etc/rc.local* so that configuration is retained on a reboot of the host. Based on the VM model, modify the guest xml file and add below line in each interface in xml file.as follows:
  - FWC-VM-50: <driver name='vhost' txmode='iothread' ioeventfd='on' queues='2'/>
  - FWC-VM-200: <driver name='vhost' txmode='iothread' ioeventfd='on' queues='2'/>
  - FWC-VM-500: <driver name='vhost' txmode='iothread' ioeventfd='on' queues='4'/>
  - FWC-VM-1000: <driver name='vhost' txmode='iothread' ioeventfd='on' queues='8'/>

- FWC-VM-3000: <driver queues=‘16'/>

  This is an example of FWC-VM-200 configuration.

  ```
  <interface type='network'>
    <mac address='52:54:00:c9:26:ce'/>
    <source network='N93-T91' portgroup='N93-T91'/>
    <model type='virtio'/>
    <driver name='vhost' txmode='iothread' ioeventfd='on' queues='2'/>
    <address type='pci' domain='0x0000' bus='0x00' slot='0x03' function='0x0'/>
  ```

- In servers where the available physical cores, that is, half of HT CPUs, are more than the number of vhost kernel threads, set the IRQ affinity for vhost kernel threads. For example, in 1000D each port has 8 queues, hence, there are 32 total vhost threads. Use this script to set the affinity for vhost kernel threads for 1000D VM on Dell PowerEdge R730 (for other hosts, the configuration would be different).

```
#!/bin/bash
cpids=`ps -ef | grep [v]host- | awk '{ print $2 }' | xargs`
echo $cpids
for cpid in $cpids;
do
    taskset -pc 36-71 $cpid
    echo $cpid]
done
```

This script sets the CPU affinity for vhost kernel threads from CPUs 36-71.

Parameters	FWC-VM-50	FWC-VM-200	FWC-VM-500	FWC-VM-1000	FWC-VM-3000
CPU affinity	Yes	Yes	Yes	Yes	No (Applicable only if the number of physical cores on the host are more than 48.)
Offload settings	Yes	Yes	Yes	Yes	Yes
Ring Descriptor size	4096	4096	4096	4096	4096
Net.core sysctl parameters	Yes	Yes	Yes	Yes	Yes

Parameters	FWC-VM-50	FWC-VM-200	FWC-VM-500	FWC-VM-1000	FWC-VM-3000
Guest Network configuration	<drivername=‘vhost’ txmode=’iothread’ ioeventfd=’on’ queues=’2’/>	<drivername=‘vhost’ txmode=’iothread’ ioeventfd=’on’ queues=’2’/>	<drivername=‘vhost’ txmode=’iothread’ ioeventfd=’on’ queues=’2’/>	<drivername=‘vhost’ txmode=’iothread’ ioeventfd=’on’ queues=’2’/>	<driver queues=’16’/>

Deploying FortiWLC Virtual Controllers on Hyper-V

This section describes the virtual controller deplyoment procedure on Hyper-V. This section includes the following topics:

- Pre-requisites on page 27
- Downloading the Virtual Controller Package File on page 27]
- Configuring the Virtual Controller on page 27
- Recommended Hyper-V Settings on page 33

Note:
FWC-VM-1000 & FWC-VM-3000 are not supported on the Windows Hyper-V platform.

Pre-requisites

For deployment and management of the Virtual Controller on Hyper-V, install the following 3rd party software.

- Install Windows server 2016/Windows server 2019.
- Install the Hyper-V role.
- Create a Hyper-V Vswitch.

Note: To accomplish the pre-requisites refer to the respective 3rd party documentation.

Downloading the Virtual Controller Package File

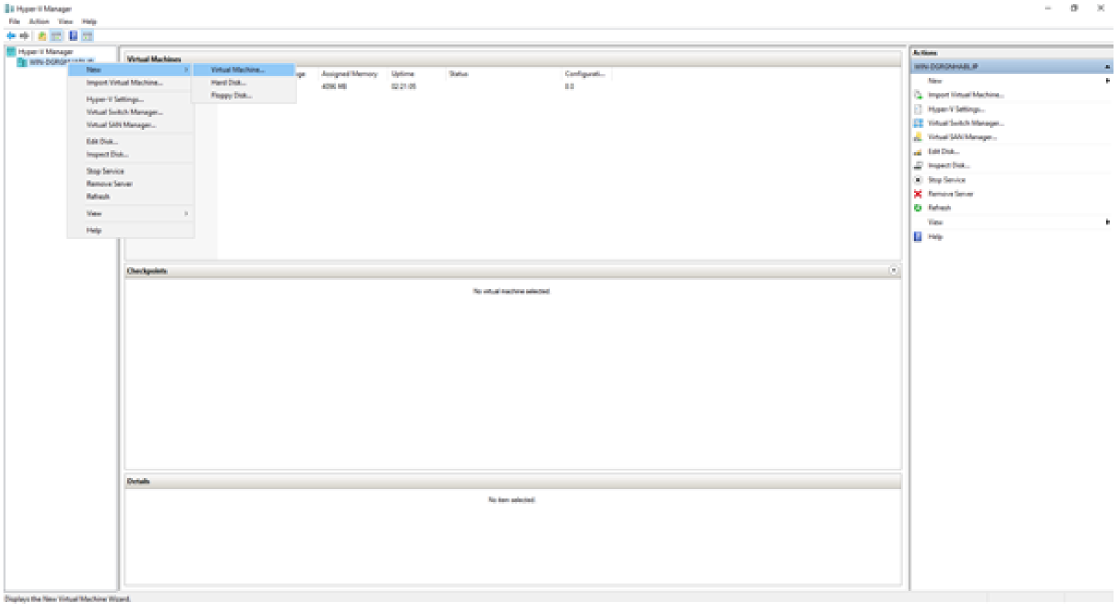
You can download the virtual controller packages from the *Fortinet Customer Support* website. To access the support website you need a *Fortinet Customer Support* account.

The file name is, *forti-x.x-xbuild-0-x86_64.vhd.hv.zip*, where x.x-x is the release version number. For example, 8.6.0.

Configuring the Virtual Controller

1. Download the package file to *C:\Users\Public\Documents\Hyper-V\Virtual hard disks* and unzip it. The file should have a unique name and one file is used to create only one instance.

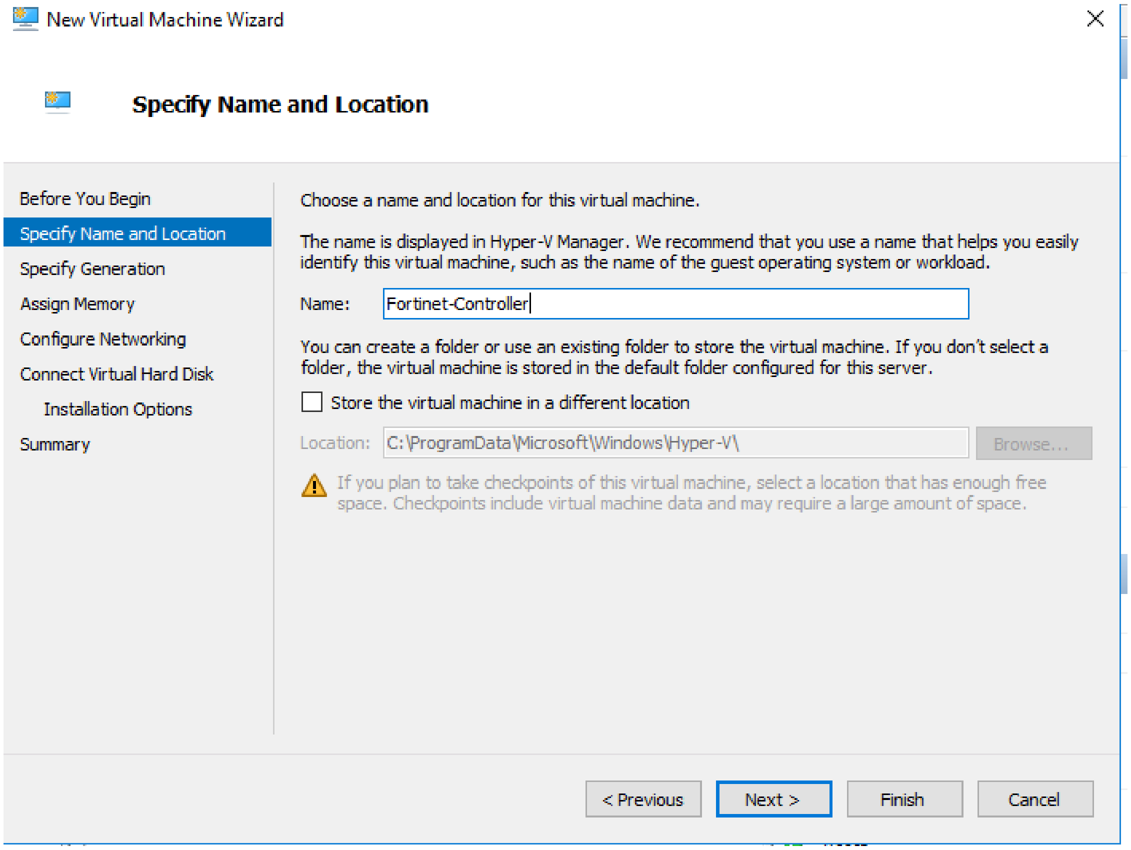
2. Open the HYPER-V manager and select **New > Virtual Machine**.



The **Virtual Machine** wizard is displayed.

3. Configure the following settings in the **Virtual Machine**wizard:

- **Name and Location**



New Virtual Machine Wizard

Specify Name and Location

Choose a name and location for this virtual machine.

The name is displayed in Hyper-V Manager. We recommend that you use a name that helps you easily identify this virtual machine, such as the name of the guest operating system or workload.

Name: Fortinet-Controller

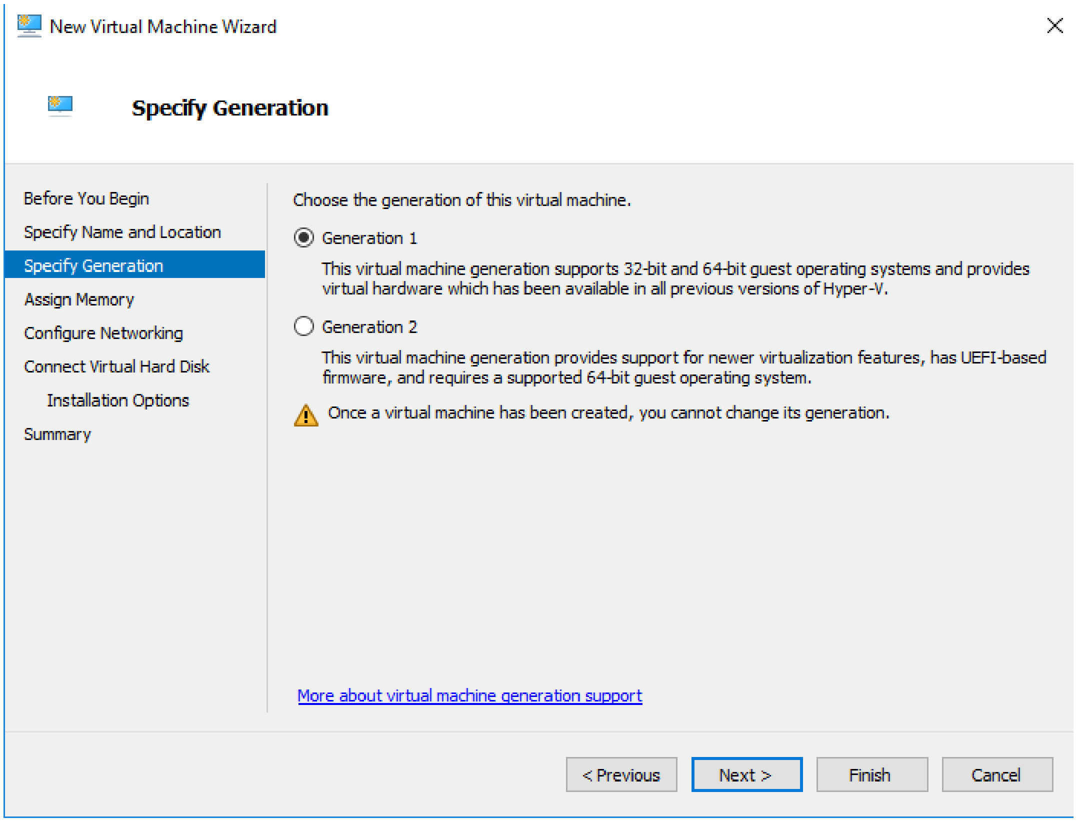
You can create a folder or use an existing folder to store the virtual machine. If you don't select a folder, the virtual machine is stored in the default folder configured for this server.

□ Store the virtual machine in a different location

Location: C:\ProgramData\Microsoft\Windows\Hyper-V\

If you plan to take checkpoints of this virtual machine, select a location that has enough free space. Checkpoints include virtual machine data and may require a large amount of space.

- **Specify Generation** – Select **Generation 1**.



Choose the generation of this virtual machine.

● Generation 1

This virtual machine generation supports 32-bit and 64-bit guest operating systems and provides virtual hardware which has been available in all previous versions of Hyper-V.

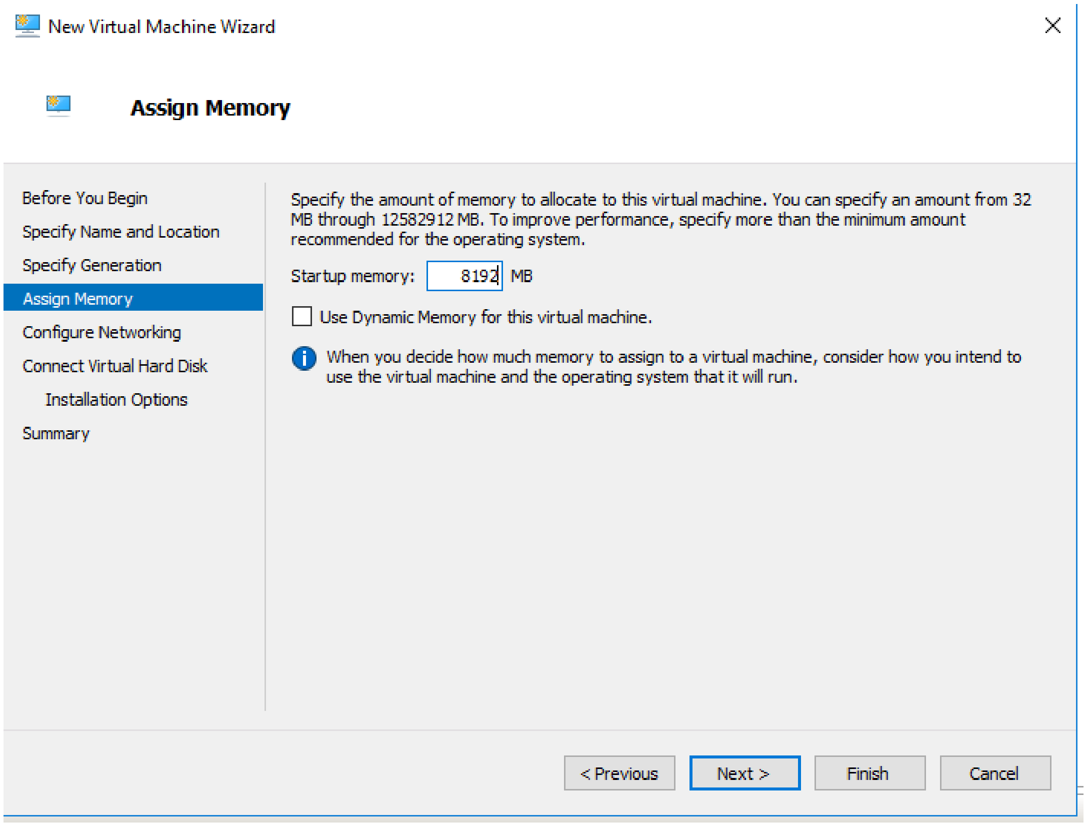
○ Generation 2

This virtual machine generation provides support for newer virtualization features, has UEFI-based firmware, and requires a supported 64-bit guest operating system.

⚠ Once a virtual machine has been created, you cannot change its generation.

More about virtual machine generation support

- **Assign Memory** (Supported Hardware Configuration)



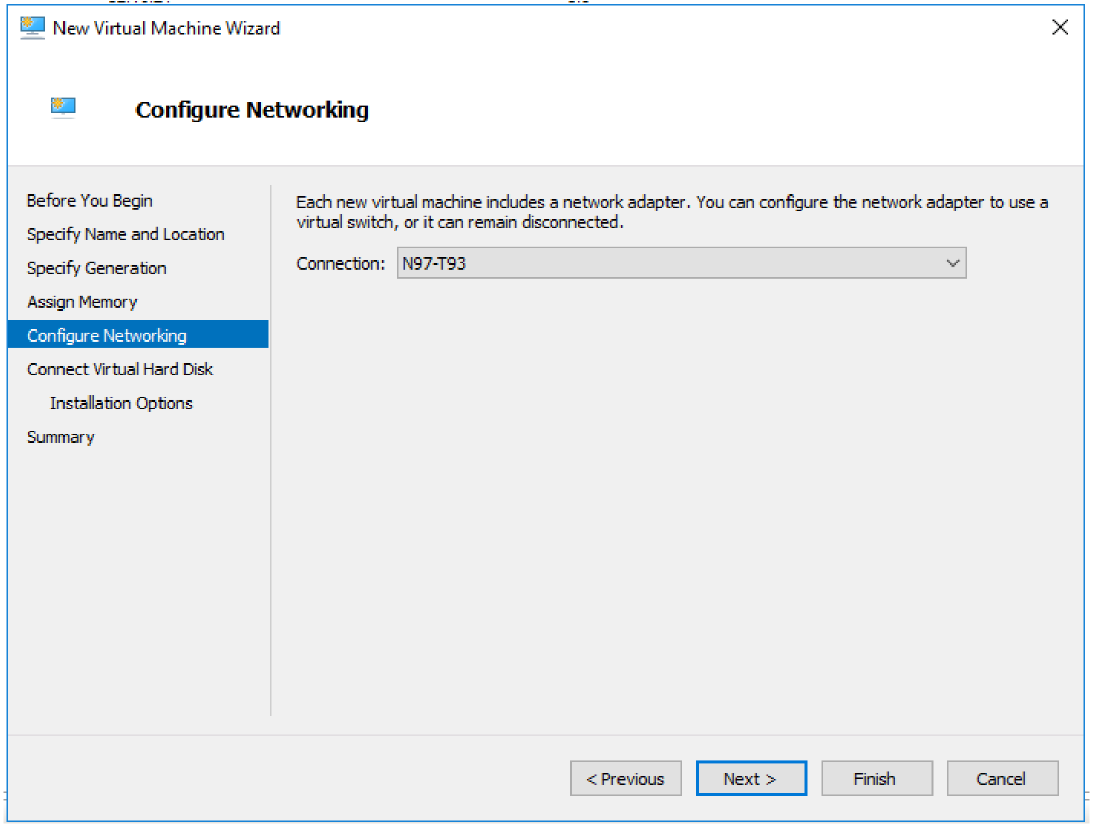
Specify the amount of memory to allocate to this virtual machine. You can specify an amount from 32 MB through 12582912 MB. To improve performance, specify more than the minimum amount recommended for the operating system.

Startup memory: 8192 MB

□ Use Dynamic Memory for this virtual machine.

When you decide how much memory to assign to a virtual machine, consider how you intend to use the virtual machine and the operating system that it will run.

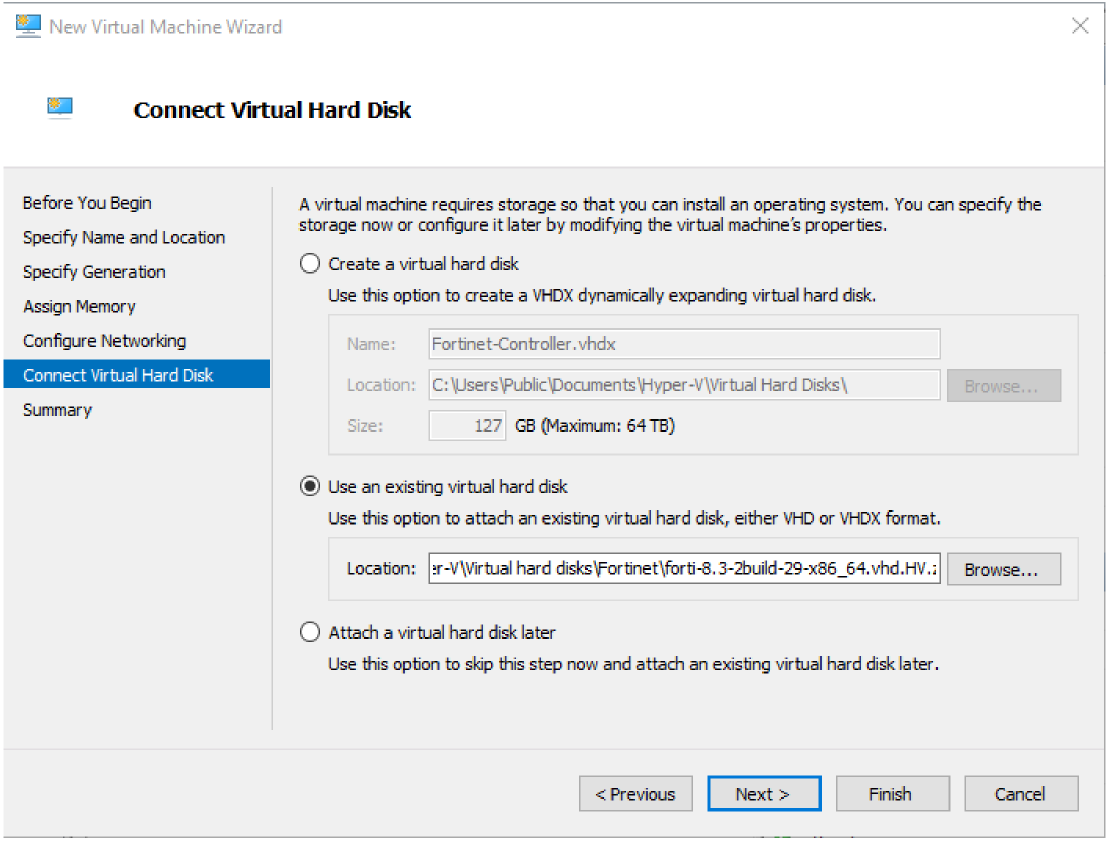
- **Configure Networking**



Each new virtual machine includes a network adapter. You can configure the network adapter to use a virtual switch, or it can remain disconnected.

Connection: N97-T93

- **Connect Virtual Hard Disk** – Select **Use an existing virtual hard disk**



A virtual machine requires storage so that you can install an operating system. You can specify the storage now or configure it later by modifying the virtual machine's properties.

○ Create a virtual hard disk

Use this option to create a VHDX dynamically expanding virtual hard disk.

Name: Fortinet-Controller.vhdx

Location: C:\Users\Public\Documents\Hyper-V\Virtual Hard Disks\

Size: 127 GB (Maximum: 64 TB)

● Use an existing virtual hard disk

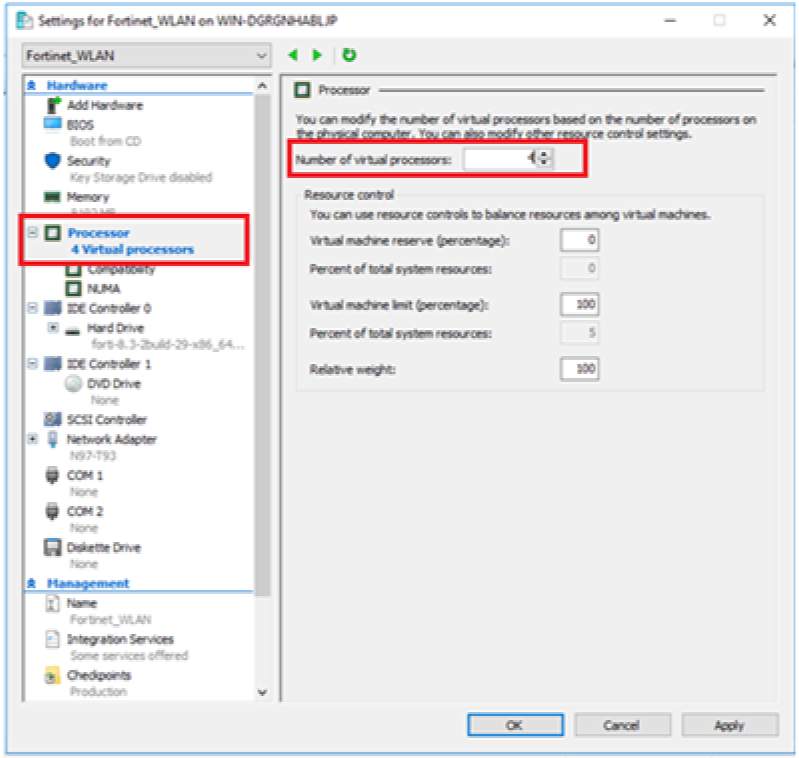
Use this option to attach an existing virtual hard disk, either VHD or VHDX format.

Location: :r-V\Virtual hard disks\Fortinet\forti-8.3-2build-29-x86_64.vhd.HV.:

○ Attach a virtual hard disk later

Use this option to skip this step now and attach an existing virtual hard disk later.

4. Click **Finish**. The virtual machine is listed.
5. Select the newly created virtual machine and double-click. The settings are displayed.
6. Specify the **Number of virtual processors** in the **Processor** settings.



Settings for Fortinet_WLAN on WIN-DGRGNHABLJP

Processor

You can modify the number of virtual processors based on the number of processors on the physical computer. You can also modify other resource control settings.

Number of virtual processors:

Resource control

You can use resource controls to balance resources among virtual machines.

Virtual machine reserve (percentage): 0

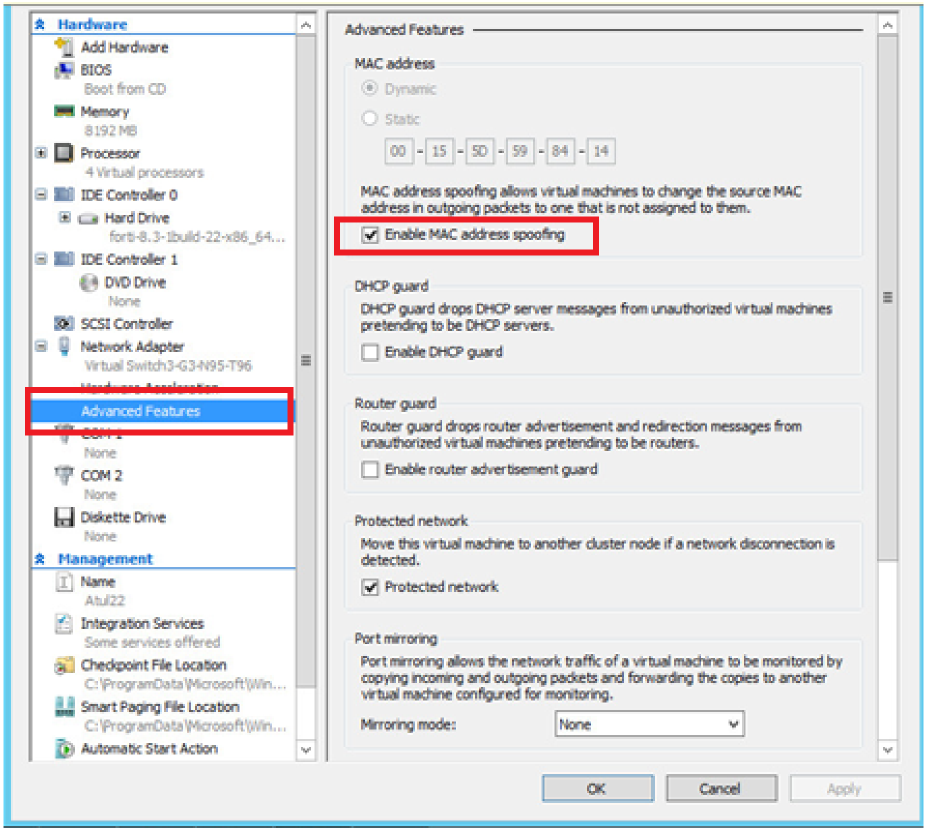
Percent of total system resources: 0

Virtual machine limit (percentage): 100

Percent of total system resources: 5

Relative weight: 100

7. Select **Enable MAC address spoofing** in the **Advanced Features** settings to establish wireless connectivity.



Advanced Features

MAC address

● Dynamic

○ Static

00 - 15 - 5D - 59 - 84 - 14

MAC address spoofing allows virtual machines to change the source MAC address in outgoing packets to one that is not assigned to them.

☑ Enable MAC address spoofing

DHCP guard

DHCP guard drops DHCP server messages from unauthorized virtual machines pretending to be DHCP servers.

□ Enable DHCP guard

Router guard

Router guard drops router advertisement and redirection messages from unauthorized virtual machines pretending to be routers.

□ Enable router advertisement guard

Protected network

Move this virtual machine to another cluster node if a network disconnection is detected.

☑ Protected network

Port mirroring

Port mirroring allows the network traffic of a virtual machine to be monitored by copying incoming and outgoing packets and forwarding the copies to another virtual machine configured for monitoring.

Mirroring mode: None

The Virtual Controller deployment is complete.

8. Run the following command in secure shell on each instance to get the configured VLAN working. This is a sample command:
9. **Set-VMNetworkAdapterVlan -Trunk -AllowedVlanIdList "96" -VMName "Forti22" -VMNetworkAdapterName "Network Adapter" -NativeVlanId 0**

Recommended Hyper-V Settings

Fortinet recommends the following settings for enhanced Controller performance.

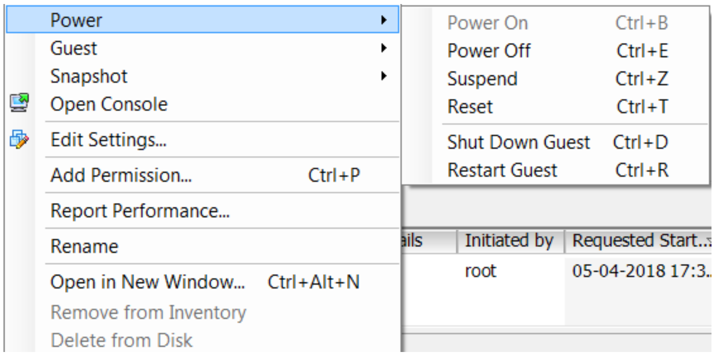
- Disable the default VMQ.
- Enable RSS on all the adapters.
- Tx and Rx buffers set to 4096.

VMWare Tools

Some utilities of the VMWare tool are supported on FortiWLC to improve managing of the virtual machines.

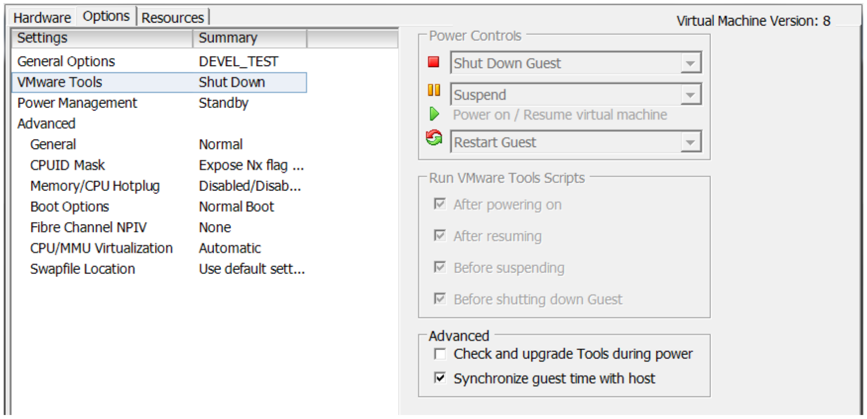
Graceful power shutdown

Right-click the virtual machine and click select **Power > Shut Down Guest** to shut down the guest operating system gracefully.



Clock/time synchronization between the guests and the hosts

Right-click the virtual machine and click **Edit Settings**. Click the **Options** tab and select **VMware Tools**. Enable **Synchronize guest time with host** to configure the guest operating system to synchronize time with the host.



Settings	Summary
General Options	DEVEL_TEST
VMware Tools	Shut Down
Power Management	Standby
Advanced	
General	Normal
CPUID Mask	Expose Nx flag ...
Memory/CPU Hotplug	Disabled/Disab...
Boot Options	Normal Boot
Fibre Channel NPIV	None
CPU/MMU Virtualization	Automatic
Swapfile Location	Use default sett...

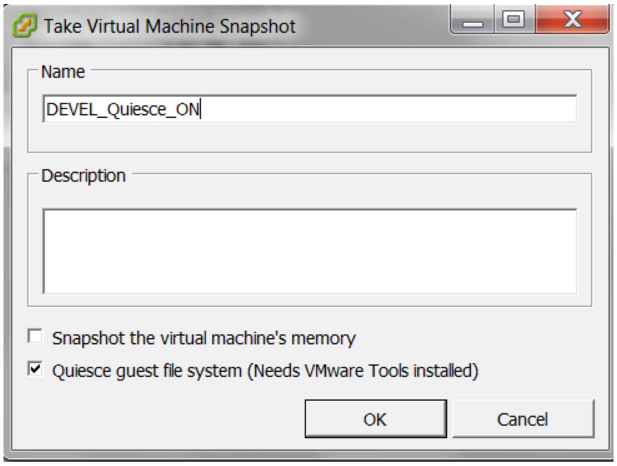
Power Controls
Shut Down Guest
Suspend
Power on / Resume virtual machine
Restart Guest

Run VMware Tools Scripts
☑ After powering on
☑ After resuming
☑ Before suspending
☑ Before shutting down Guest

Advanced
☐ Check and upgrade Tools during power
☑ Synchronize guest time with host

Quiescing guest file systems to allow hosts to capture file-system-consistent guest snapshots

Right-click the virtual machine and click Snapshot > Take Snapshot. Update the required fields and enable **Quiesce guest file system (Needs VMware Tools installed)** to pause running processes on the guest operating system so that file system contents are in a known consistent state when you take the snapshot.



Take Virtual Machine Snapshot

Name

DEVEL_Quiesce_ON

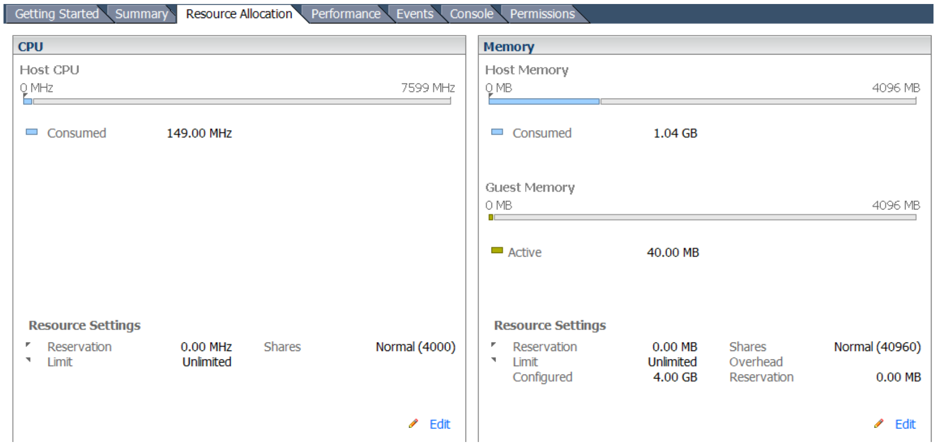
Description

□ Snapshot the virtual machine's memory

☑ Quiesce guest file system (Needs VMware Tools installed)

Note: Quiescing a file system can be done only on virtual machines that are powered on.

Network information and resource utilization of the guest is published to the host.
Select a virtual machine and click on the **Resource Allocation** tab to view the resource utilization details.



CPU

Host CPU

0 MHz — 7599 MHz

Consumed 149.00 MHz

Resource Settings

Reservation	0.00 MHz	Shares	Normal (4000)
Limit	Unlimited		

Memory

Host Memory

0 MB — 4096 MB

Consumed 1.04 GB

Guest Memory

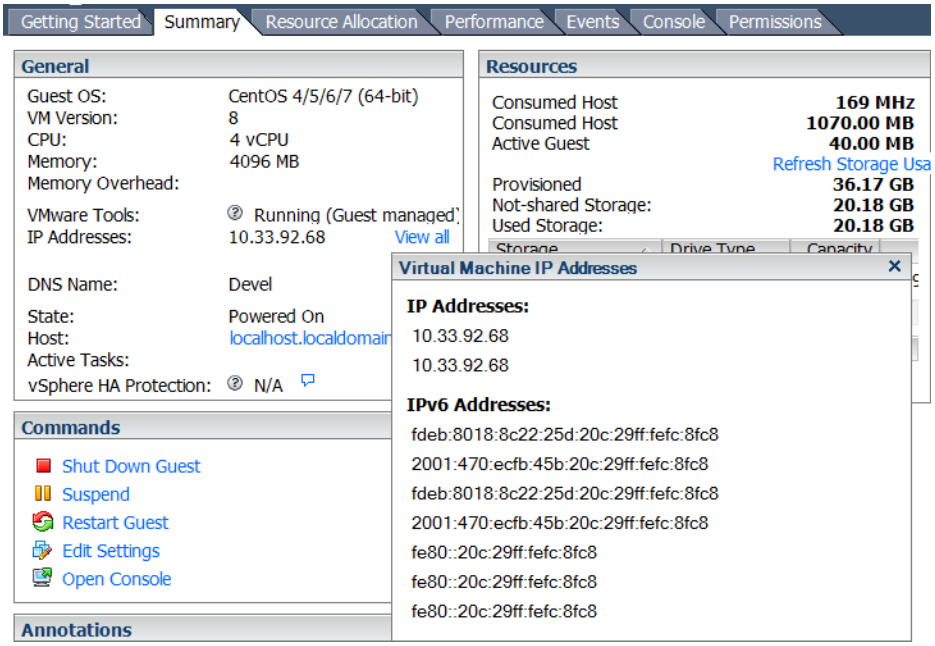
0 MB — 4096 MB

Active 40.00 MB

Resource Settings

Reservation	0.00 MB	Shares	Normal (40960)
Limit	Unlimited	Overhead	
Configured	4.00 GB	Reservation	0.00 MB

In the **Summary** tab, click **View All** against the IP addresses to view the virtual machine’s IP addresses (IPv4 and IPv6).



General

Guest OS: CentOS 4/5/6/7 (64-bit)
VM Version: 8
CPU: 4 vCPU
Memory: 4096 MB
Memory Overhead:

VMware Tools: Running (Guest managed)
IP Addresses: 10.33.92.68

DNS Name: Devel

State: Powered On
Host: localhost.localdomair
Active Tasks:
vSphere HA Protection: N/A

Commands

Annotations

Resources

Consumed Host 169 MHz
Consumed Host 1070.00 MB
Active Guest 40.00 MB

Provisioned 36.17 GB
Not-shared Storage: 20.18 GB
Used Storage: 20.18 GB

Storage | Drive Type | Capacity

Virtual Machine IP Addresses

IP Addresses:

10.33.92.68
10.33.92.68

IPv6 Addresses:

fdeb:8018:8c22:25d:20c:29ff:fefc:8fc8
2001:470:ecfb:45b:20c:29ff:fefc:8fc8
fdeb:8018:8c22:25d:20c:29ff:fefc:8fc8
2001:470:ecfb:45b:20c:29ff:fefc:8fc8
fe80::20c:29ff:fefc:8fc8
fe80::20c:29ff:fefc:8fc8
fe80::20c:29ff:fefc:8fc8

License Management for FortiWLC Virtual Controllers

This section assumes you have already received your entitlement for the FortiWLC Virtual Controller you ordered. Along with the entitlement that allows you to obtain the license for your instance, you would also have received instructions on where to download the right version of the software for the model you ordered. Register your product at the *Fortinet Customer Support* portaland use the registration key and system ID to obtain a license file.

Note: Obtain the license only after completing the installation of the Virtual Controller. Contact the Forticare Support with the details entailed in the following sections to obtain the license. This section includes the following topics:

FWC-VM Series Virtual Controllers

After completing installation of the Virtual Controller, login to the controller and run the **setup** command to generate the system-id. Perform the following steps to obtain the license.

1. Run the **setup** command on the Controller to generate the system-id, configure the hostname, and configure the static IP address of the Controller, to ensure that the IP address does not change as the system-id/license is mapped to the IP address of the Controller.
2. Save the configuration. The Controller restarts.
3. Run the **show system-id** command to obtain the system-id.
4. Share the Virtual Controller model details and system-id with the Forticare Support team.
5. Configure the Virtual Controller instance with the required resources (Supported Hardware Configuration on page 6) as per the model for which the license has been generated.
6. Install the license from the GUI (See section Importing and Installing a License on page 38) OR from the CLI (Configuration Terminal mode => **vm-license scp://username@<Your file server IP Address>:<license filename>**)
7. Reboot the Controller to apply the changes as per the generated license.

Note: A freshly installed system boots up as FWC-VM-50 with default license valid for 30 days.

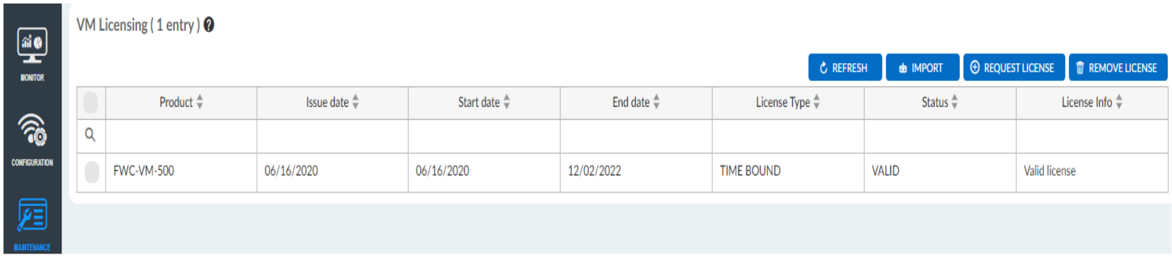
- System-id is not get generated until you run the **setup** command on a fresh instance.
- System-id is coupled with the IP address. Hence, any change in the IP address generates a new system-id thereby failing validation of the older license. In this case, a new license is required. Changing the IP address via CLI followed by a reboot to activate the new IP address does not generate a new system-id. Hence, license validation fails and the Controller is once again the FWC-VM-50 model. Therefore, use only the **setup** command to change the Controller IP address.

- After the license is invalidated due to a change in the system-id and the controller is once again a FWC-VM-50 model, ensure that you delete (License Monitoring on page 39) the invalid license for the Controller to function properly. Else, the Controller reboots after every one hour.

Importing and Installing a License

Perform these steps to obtain the license using the GUI.

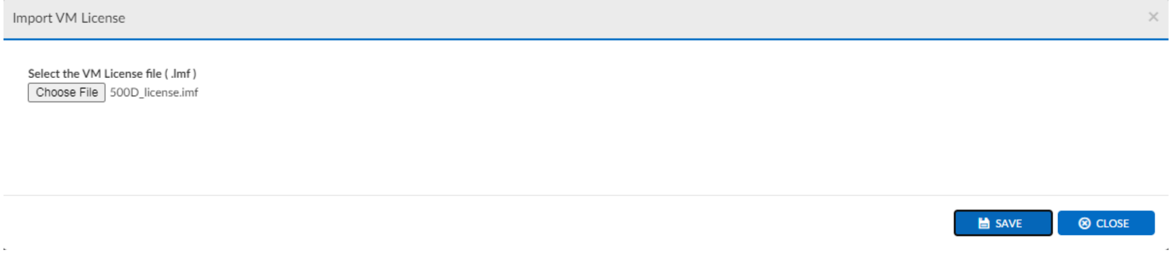
1. Navigate to **Maintenance > System > VM Licensing**
   This image displays a freshly installed system which has a default license (trial based) valid for 30 days from the license issued date.
2. In the **VM Licensing** wizard, click **Import** to add a license. By default, this page lists the license available on the system which includes details on the Virtual Controller model.



VM Licensing (1 entry)

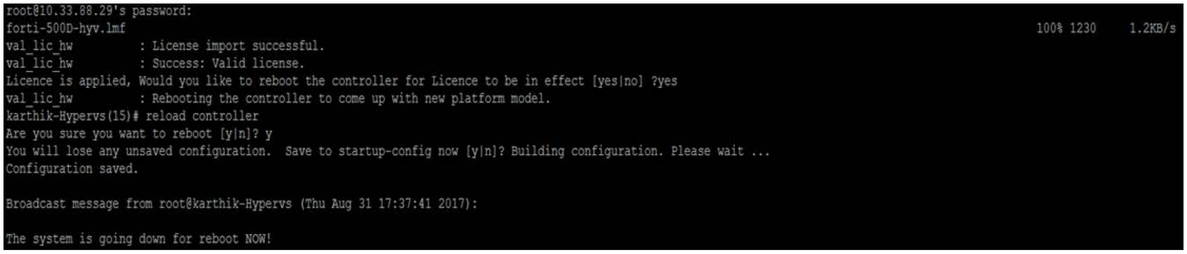
	Product	Issue date	Start date	End date	License Type	Status	License Info
	FWC-VM-500	06/16/2020	06/16/2020	12/02/2022	TIME BOUND	VALID	Valid license

Browse to the license file and click **Save**.



Select the VM License file (.lmf)
500D_license.imf

The license can be imported through the CLI as well.



```
root@10.33.88.29's password:
forti-500D-hyv.lmf                                                                                        100% 1230     1.2KB/s
val_lic_hw          : License import successful.
val_lic_hw          : Success: Valid license.
Licence is applied, Would you like to reboot the controller for Licence to be in effect [yes|no] ?yes
val_lic_hw          : Rebooting the controller to come up with new platform model.
karthik-Hypervs(15)# reload controller
Are you sure you want to reboot [y|n]? y
You will lose any unsaved configuration.  Save to startup-config now [y|n]? Building configuration. Please wait ...
Configuration saved.

Broadcast message from root@karthik-Hypervs (Thu Aug 31 17:37:41 2017):

The system is going down for reboot NOW!
```

Notes:

- The Controller reboots when you have uploaded the license file.
- The Controller does not support importing license files with spaces or brackets [()] in the filename.

License Validation

After the license is imported, validation is performed on the license parameters. If that validation succeeds and the appropriate hardware resources for the requested controller model are allocated, then the license is installed successfully. If either license validation or hardware resource validation fails, the system reverts to the default license. See section Supported Hardware Configuration on page 6 for further details.

Once the license is installed successfully, it replaces the default license. There are two types of licenses – Trial Based and Perpetual (Never ending).

License Monitoring

The license validation happens after every one hour at regular intervals. With 30 days to go for expiry, alarms are raised on the controller. The Software License Expired alarm is generated as per the configured severity. The default severity is critical.
In a fresh installation running on a default license (FWC-VM-50) which is valid for 30 days, you get 30 additional days within which to purchase and apply for a valid license. If a valid license is not imported, at the end of additional 30 days, the Controller will reboot and the APs will go to offline state.

To delete a **perpetual** license, select the license and click **Remove License** or run the **delete vm-license** CLI command. After the license is deleted, the Controller reboots and comes up as FWC-VM-50 with the default trial based license.

Note: Deletion of trial based license is not allowed.

Managing FortiWLC Virtual Controllers

Like any conventional Hardware Controller that Fortinet offers, the Virtual Controller can be managed by directly accessing the controller using the FortiWLC Web UI or FortiWLM.

Refer to *FortiWLC Configuration Guide* and the *FortiWLC Command Reference Guide* or configuring and managing your Virtual Controller. The term Controller refers to Physical appliance as well as your Virtual Controller.

This section includes the following topics:

- Upgrading FortiWLC Virtual Controllers on page 40
- FortiWLC Virtual Controller High Availability on page 41

Upgrading FortiWLC Virtual Controllers

Virtual Controllers can be upgraded the same way as the hardware controllers. Download the appropriate virtual controller image from Fortinet Customer Support website. Upgrading the controller can be done in the following ways:

- Using the FTP, TFTP, SCP, and SFTP protocols.
- Navigate to **Maintenance < File Management** in the FortiWLC GUI to import the downloaded package.

The following are sample commands for upgrading the virtual controllers using any of these protocols.

- **upgrade-image tftp://10.xx.xx.xx:forti-x.x-xbuild-x-x86_64-rpm.tar.fwlc both reboot**
- **upgrade-image sftp://build@10.xx.xxx.xxx:/home/forti-x.x-xbuild-xx-x86_64-vm-rpm.tar.fwlc both reboot**
- **upgrade-image scp://build@10.xx.xxx.xxx:/home /forti-x.x-xbuild-xx-x86_64-vm-rpm.tar.fwlc both reboot**
- **upgrade-image ftp://anonymous@10.xx.xx.xx:forti-x.x-xbuild-x-x86_64-rpm.tar.fwlc both reboot**

The **both** option upgrades the Fortinet binaries (rpm) as well as the Kernel (iso), the **apps** option upgrades only the Fortinet binaries (rpm).

After upgrade, the virtual controller should maintain the System-id of the system, unless there were some changes in the fields that are used to generate the system-id.

The international virtual controller can be installed, configured, licensed and upgraded the same way.

FortiWLC Virtual Controller High Availability

Virtual Controller are affordable and an easy way to achieve High Availability for your environment.

These are some highlights of the Virtual Controllers High Availability deployment:

- N+1 slave for controller appliances.
- **The FWC-VM Series Virtual Controllers** - Supports HW appliances of same model, for example,1000D-VM can act as N+1 slave for 1000D-VM only.
- When a controller slave becomes active, the slave model operates with the same capacity as that of the master controller it has taken over.

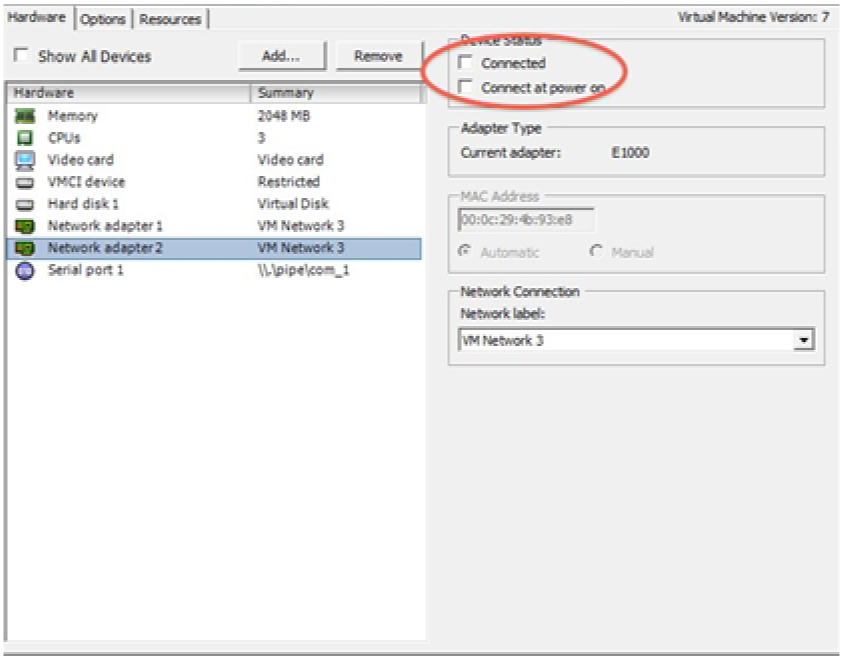
This table describes the NPlus1 compatibility with the FWC series.

	Master									
Slave	FWC-50D	FWC-VM-50	FWC-200D	FWC-VM-200	FWC-500D	FWC-VM-500	FWC-1000D	FWC-VM-1000	FWC-3000D	FWC-VM-3000
FWC-50D	✓	✓	x	x	x	x	x	x	x	x
FWC-VM-50	✓	✓	x	x	x	x	x	x	x	x
FWC-200D	x	x	✓	✓	x	x	x	x	x	x
FWC-VM-200	x	x	✓	✓	x	x	x	x	x	x
FWC-500D	x	x	x	x	✓	✓	x	x	x	x
FWC-VM-500	x	x	x	x	✓	✓	x	x	x	x
FWC-1000D	x	x	x	x	x	x	✓	✓	x	x
FWC-VM-1000	x	x	x	x	x	x	✓	✓	x	x
FWC-3000D	x	x	x	x	x	x	x	x	✓	✓
FWC-VM-3000	x	x	x	x	x	x	x	x	✓	✓

Troubleshooting Tips

APs not connecting to the controller & seeing duplicate responses for pings from the controller to an outside system.

The same vSwitch is being used for both vNICs, define separate vSwitches for each vNIC. Alternatively, you could disable one of the vNICs in the virtual machine. You can disable the 2nd vNIC, by un-checking the **Connected** and **Connect at Power On** options.



Virtual Machine Version: 7

□ Show All Devices

Hardware	Summary
Memory	2048 MB
CPUs	3
Video card	Video card
VMCI device	Restricted
Hard disk 1	Virtual Disk
Network adapter 1	VM Network 3
Network adapter 2	VM Network 3
Serial port 1	\\.\pipe\com_1

Device Status
□ Connected
□ Connect at power on

Adapter Type
Current adapter: E1000

MAC Address
00:0c:29:4b:93:e8
● Automatic ○ Manual

Network Connection
Network label:
VM Network 3

Clients not able to connect to the network

If you look at the station log and see “Client moved to wired side”. This is an indication that your vSwitches are not configured properly. Potentially vSwitch is not mapped to one physical vNIC or the physical resources is not bonded properly or multiple hosts are sharing the same vSwitch.

How To Capture Events leading to a Crash on Virtual Controller

1. Unlike physical controllers, virtual controllers may not generate a kernel-gather file if they crash.
2. It should generate a file Fortinet-kernel-diag similar to Physical controller unless you encounter silent reboot which can happen to both VM and Physical controller.
3. The output for a virtual controller crash may well look like a fault on VMWare.
4. To confirm, connect a PC to the serial port of the physical host (virtual blade).
5. Map the serial port resource on the host to the VMware image.
6. Try to connect via PuTTY (same serial settings as those set for a physical host) to virtual controller.
7. You will be able to catch the reboot reason / crash log, the next time the event occurs.

Does Fortinet Support Mesh on Virtual Controllers?

Yes, Fortinet supports Mesh on Virtual controllers as well.