



Cisco vWAAS on RHEL KVM, KVM on CentOS, and KVM in SUSE Linux

This chapter describes how to use Cisco vWAAS on RHEL KVM, KVM on CentOS, and KVM in SUSE Linux, and contains the following sections:

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- [Supported Host Platforms, Software Versions, and Disk Type, on page 2](#)
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About vWAAS on RHEL KVM, KVM on CentOS, and KVM in SUSE Linux

Cisco vWAAS on RHEL KVM is a virtual WAAS appliance that runs on a KVM Hypervisor. The Cisco vWAAS on RHEL KVM solution extends the capabilities of Cisco ISR-WAAS and Cisco vWAAS running on the Cisco UCS-E Series and the Cisco Enterprise Network Compute System (Cisco ENCS) 5400-W Series.

Consider the following interoperability guidelines for Cisco vWAAS on the KVM hypervisor platforms:

- **Cisco vWAAS on RHEL KVM:** Supported for Cisco vWAAS in WAAS Version 6.2.x and later.



Note Cisco vWAAS on RHEL KVM can also be deployed as a TAR archive (tar.gz) to deploy Cisco vWAAS on Cisco Network Functions Virtualization Infrastructure Software (Cisco NFVIS). The Cisco NFVIS portal is used to select the tar.gz file to deploy vWAAS.

- **Cisco vWAAS on KVM on CentOS:** Supported for Cisco vWAAS in WAAS version 6.2.3b and later.
- **Cisco vWAAS on KVM in SUSE Linux:** Supported for all Cisco vWAAS and Cisco vCM models that are supported on KVM on CentOS, for Cisco vWAAS in Cisco WAAS Version 6.4.1b and later.

Supported Host Platforms, Software Versions, and Disk Type

The following table shows the platforms and software versions supported for Cisco vWAAS on RHEL KVM, for the PID **OE-VWAAS-KVM** and the device type: **OE-VWAAS-KVM**.

Table 1: Platforms and Software Versions Supported for Cisco vWAAS on RHEL KVM

Earliest Cisco WAAS Version Supported	Cisco Host Platforms	Earliest RHEL and CentOS Host Version Supported	Disk Type
6.2x	<ul style="list-style-type: none"> • UCS • UCS E-Series 	<ul style="list-style-type: none"> • RHEL Server 7.1 • CentOS Linux 7.2.1511 (Core) 	<ul style="list-style-type: none"> • virtio
6.4.3d	<ul style="list-style-type: none"> • UCS • UCS E-Series 	<ul style="list-style-type: none"> • RHEL Server 7.5 • RHEL Server 7.6 • CentOS Linux 7.5.1804 (Core) • CentOS Linux 7.6.1810 (Core) 	<ul style="list-style-type: none"> • virtio

Cisco vWAAS on RHEL KVM System Requirements

Cisco vWAAS on RHEL KVM has a predefined configuration with specific requirements for CPU and memory. However, there are some features that are customizable. Table 6-2 shows the supported configuration for Cisco vWAAS on RHEL KVM, and, where applicable, highlights the customizable features.



Note Data disk size varies according to the model shown in the following table. While deploying RHEL KVM, Cisco vWAAS and Cisco vCM should verify that enough disk space is available in the respective partition.

Table 2: Cisco vWAAS on RHEL KVM Supported Configuration

Feature or Component	Description
Platform	Three-disk platform of: <ul style="list-style-type: none"> • 10 GB system • 4 GB flash • Data disk (customizable, depending on number of connections)
RHEL version for vWAAS on KVM	RHEL 7.2

Feature or Component	Description
Cisco vWAAS Memory Requirements	<ul style="list-style-type: none"> • vWAAS-150: 4 GB • vWAAS-200: 4 GB • vWAAS-750: 4 GB • vWAAS-1300: 6 GB • vWAAS-2500: 8 GB • vWAAS-6000: 11 GB • vWAAS-12000: 18 GB • vWAAS-50000: 48 GB
Interception Method	WCCP (Web Cache Communication Protocol) or Cisco Appnav
Device Emulation	Cisco vWAAS on RHEL KVM uses Quick Emulator-KVM (QEMU-KVM).
Management	Cisco WAAS Central Manager and serial console
Licensing	For information on Cisco vWAAS licensing, contract your Cisco account representative.
MAC address	Customizable

Cisco vWAAS on RHEL KVM in WAAS Version 6.4.1 and Later

This section contains the following topics:

Unified OVA Package for Cisco vWAAS on KVM in WAAS Version 6.4.1 and Later

For Cisco vWAAS on RHEL KVM in Cisco WAAS Version 6.4.x and later, Cisco provides a single, unified OVA or NPE OVA package for each hypervisor type, which can be used with all Cisco vWAAS models for that hypervisor.

Each unified OVA package file is a preconfigured VM image that is ready to run on a particular hypervisor. The launch script for each unified OVA package provides the model and other required parameters to launch vWAAS with WAAS in the required configuration.

The following are examples of the unified OVA and NPE OVA package filenames for vWAAS on RHEL KVM:

- OVA: Cisco-KVM-vWAAS-Unified-6.4.5-b-69.tar
- NPE OVA: Cisco-KVM-vWAAS-Unified-6.4.5-b-69-npe.tar

The unified OVA package for vWAAS on RHEL KVM and KVM on CentOS contains the following files:

- Flash disk image
- Data system disk
- Akamai disk
- INSTRUCTIONS.TXT: Describes the procedure for deploying the virtual instance and using the launch.sh file.
- **package.mf** template file and **bootstrap-cfg.xml**: These two files work together on the Cisco NFVIS platform with the image_properties.xml file as Day-0 configuration template.
- **ezdeploy.sh**: The script used to deploy vWAAS on UCS-E.
- **exdeploy_qstatus.exp**: The dependent file for ezdeploy.sh script image_properties.xml A VM configuration template file used on the Cisco NFVIS platform.
- **launch.sh**: The launch script to deploy Cisco vWAAS on Linux KVM.
- **vm_macvtap.xml**: Configuration file for vWAAS deployment using host machine interfaces with the help of the macvtap driver.
- **vm_tap.xml**: Configuration file for vWAAS deployment using virtual bridge or OVS (Open Virtual Switch) present in the host machine.

Installing Cisco vWAAS on KVM in WAAS Version 6.4.1 and Later

This section contains the following topics:



Note

For how to install Cisco vWAAS with Cisco NFVIS on the Cisco ENCS 5400-W Series, see the [Cisco vWAAS Bundled Image Upgrade for ENCS 5400 Series, with RMA Process for Cisco EOS/EOL WAVE Devices](#).

- Using the Launch Script to Deploy Cisco vWAAS on RHEL KVM on CentOS in WAAS Version 6.4.1 and Later
- Using the EzDeploy Script to Deploy Cisco vWAAS on RHEL KVM on CentOS in WAAS Version 6.4.1 and Later

Using the Launch Script to Deploy Cisco vWAAS on RHEL KVM on CentOS in WAAS Version 6.4.1 and Later

Procedure

Step 1 At [root@localhost hostname] enter the following:

Example:

```
[root@localhost hostname]# ./launch.sh unified mactap enp1s0f0 enp1s0f0
```

The **Model Menu** is displayed:

```
--- Model Menu ---
1. vWAAS-150
2. vWAAS-200
3. vWAAS-750
4. vWAAS-1300
5. vWAAS-2500
6. vWAAS-6000R
7. vWAAS-6000
8. vWAAS-12000
9. vWAAS-50000
10. vCM-100N
11. vCM-500N
12. vCM-1000N
13. vCM-2000N
Select the model type :
```

- Step 2** After you select the vWAAS or vCM model type, the launch script completes the RHEL CentOS KVM deployment.
-

Using the EzDeploy Script to Deploy Cisco vWAAS on RHEL KVM on CentOS in WAAS Version 6.4.1 and Later

Before you begin

Use the EzDeploy script (**ezdeploy.sh**) to deploy Cisco vWAAS or vCM on RHEL KVM on CentOS, for vWAAS models up to 6,000 connections.

Procedure

- Step 1** At [root@localhost ezdeploy] enter the following:

```
[root@localhost ezdeploy]# ./ezdeploy.sh
```

The **Model Menu** is displayed:

- Step 2** After you select the vWAAS model type, the EzDeploy script completes the RHEL KVM/KVM on CentOS deployment.
-

Cisco vWAAS on RHEL KVM in WAAS Version 5.x to 6.2.x

This section contains the following topics:

Tar Archive Package for Cisco vWAAS on KVM in WAAS Version 5.x to 6.2.x

For Cisco vWAAS on RHEL KVM in Cisco WAAS Version 5.x through 6.2.x, Cisco provides a TAR archive or No Payload Encryption (NPE) TAR archive package for each Cisco vWAAS connection profile and for each Cisco vCM connection profile.

The table shows the files included for deploying Cisco vWAAS on RHEL KVM, and for deploying Cisco vWAAS with Cisco Network Functions Virtualization Infrastructure Software (Cisco NFVIS). For more information, see the [Cisco Network Function Virtualization Infrastructure Software Getting Started Guide](#) and see the chapter "Cisco vWAAS with Cisco Enterprise NFVIS."



Note For a listing of hypervisor OVA, zip, and **tar.gz** files for Cisco vWAAS, see the [Cisco Wide Area Application Services \(WAAS\) Download Software page](#) and select the Cisco WAAS software version used with your Cisco vWAAS instance.

Table 3: OVA Package Format Examples for Cisco vWAAS on RHEL KVM in WAAS Version 5.x to 6.2.x

Package Format	File Format Example
<ol style="list-style-type: none"> 1. Cisco KVM 150 package file 2. Cisco KVM 150 package file for NPE 	<ol style="list-style-type: none"> 1. Cisco-KVM-vWAAS-150-6.2.3d-b-68.tar.gz 2. Cisco-KVM-vWAAS-150-6.2.3d-b-68-npe.tar.gz
<ol style="list-style-type: none"> 1. Cisco KVM 200 package file 2. Cisco KVM 200 package file for NPE 	<ol style="list-style-type: none"> 1. Cisco-KVM-vWAAS-200-6.2.3d-b-68.tar.gz 2. Cisco-KVM-vWAAS-200-6.2.3d-b-68-npe.tar.gz
<ol style="list-style-type: none"> 1. Cisco KVM 750 package file 2. Cisco KVM 750 package file for NPE 	<ol style="list-style-type: none"> 1. Cisco-KVM-vWAAS-750-6.2.3d-b-68.tar.gz 2. Cisco-KVM-vWAAS-750-6.2.3d-b-68-npe.tar.gz
<ol style="list-style-type: none"> 1. Cisco KVM 1300 package file 2. Cisco KVM 1300 package file for NPE 	<ol style="list-style-type: none"> 1. Cisco-KVM-vWAAS-1300-6.2.3d-b-68.tar.gz 2. Cisco-KVM-vWAAS-1300-6.2.3d-b-68-npe.tar.gz
<ol style="list-style-type: none"> 1. Cisco KVM 2500 package file 2. Cisco KVM 2500 package file for NPE 	<ol style="list-style-type: none"> 1. Cisco-KVM-vWAAS-2500-6.2.3d-b-68.tar.gz 2. Cisco-KVM-vWAAS-2500-6.2.3d-b-68-npe.tar.gz
<ol style="list-style-type: none"> 1. Cisco KVM 6000 package file 2. Cisco KVM 6000 package file for NPE 	<ol style="list-style-type: none"> 1. Cisco-KVM-vWAAS-6000-6.2.3d-b-68.tar.gz 2. Cisco-KVM-vWAAS-6000-6.2.3d-b-68-npe.tar.gz

Table 4: OVA Package Format for Cisco vCM in WAAS Version 5.x to 6.2.x

Package Format	File Format Example
<ol style="list-style-type: none"> 1. Cisco KVM 100N package file 2. Cisco KVM 100N package file for NPE 	<ol style="list-style-type: none"> 1. Cisco-KVN-vCN-100N-6.2.3d-npe-b-68.tar.gz 2. Cisco-KVN-vCN-100N-6.2.3d-npe-b-68-npe.tar.gz

Table 5: Installation Files for Cisco vWAAS on RHEL KVM and Cisco vWAAS with Cisco NFVIS in WAAS 5.x to 6.2.x

Installation Files	RHEL KVM Installation	NFVIS Installation
<ul style="list-style-type: none"> • Cisco signature envelope file Verifies that this deployment is from Cisco. 	Yes	Yes
<ul style="list-style-type: none"> • Manifest file with checksums 	Yes	Yes
<ul style="list-style-type: none"> • image_properties.xml A VM configuration template file used on the Cisco NFVIS platform. 	No	Yes
<ul style="list-style-type: none"> • package.mf template file and bootstrap-cfg.xml These two files work together on the Cisco NFVIS platform with the image_properties.xml file as Day-0 configuration template. 	No	Yes
<ul style="list-style-type: none"> • INSTRUCTIONS.TXT Describes the procedure for deploying the virtual instance and for using the launch.sh file. 	Yes	No
<ul style="list-style-type: none"> • launch.sh file For more information, see Using the Launch Script to Deploy Cisco vWAAS on RHEL KVM in WAAS Version 5.x to 6.2.x, on page 8. 	Yes	No
<ul style="list-style-type: none"> • vm.xml Configuration file needed for Cisco vWAAS deployment using virtual bridge or Open Virtual Switch (OVS) present in host mac. 	Yes	No
<ul style="list-style-type: none"> • VM disk images A 4 GB flash disk, 10 GB system disk, and data disk (data disk size is dependent on your connection profile). 	Yes	Yes
<ul style="list-style-type: none"> • ezdeploy.sh file The script used to deploy Cisco vWAAS on UCS-E. For more information, see Using the EzDeploy Script to Deploy Cisco vWAAS on KVM on UCS-E in WAAS Version 5.x to 6.2.x, on page 9 and Using the EzDeploy Script to Deploy Cisco vWAAS on RHEL KVM on CentOS in WAAS Version 6.4.1 and Later, on page 5. 	Yes	No

Installing Cisco vWAAS on KVM in WAAS Version 5.x to 6.2.x

This section contains the following topics:

Using the Launch Script to Deploy Cisco vWAAS on RHEL KVM in WAAS Version 5.x to 6.2.x

Procedure

Step 1 Launch the Cisco vWAAS VM. (You must have root permissions to launch the vWAAS VM.)

Step 2 Create a new directory to hold the extracted contents of **tar.gz**.

Step 3 Copy **tar.gz** into the specified directory.

Step 4 To extract the **tar.gz** file, use the command:

```
tar -zxvf Cisco-KVM-vWAAS-ModelNumber-Version-BuildNumber.tar.gz
```

Example:

```
tar -zxvf Cisco-KVM-vWAAS-200-6.2.3d.b-68.tar.gz
```

The contents of the **tar.gz** file are:

- INSTRUCTIONS.TXT
- Disk-0.qcow
- Disk-1.qcow
- Disk-2.qcow
- vm_tap.xml
- vm_macvtap.xml
- launch.sh
- ezdeploy.sh
- ezdeploy.qstatus.exp

Step 5 To launch the Cisco vWAAS, run the **launch.sh** script:

- To check the prerequisite conditions, run the **./launch.sh check** command.
- To launch Cisco vWAAS using the OVS bridge, run the **./launch.sh vm-name bridge bridge1-name bridge2-name** command.
 - *bridge1-name* and *bridge2-name*: The OVS bridges already created in the host.

Note Before using the **./launch.sh vm-name bridge bridge1-name bridge2-name** command, verify that the OVS bridges are created and are in working state.

- To launch Cisco vWAAS using macvtap, run the **./launch.sh vm-name macvtap interface1-name interface2-name** command.
 - *vm-name*: The specified name of the Cisco vWAAS VM.

- *interface1-name* and *interface2-name*: The specified Ethernet interfaces of the host machine.

- Step 6** The Cisco vWAAS is launched
- Step 7** To view the Cisco vWAAS, use the VM GUI or run the **virsh list** command.
- Step 8** To connect to the console, use the VM GUI or run the **virsh console *vm-name*** command.
- Step 9** To power down the Cisco vWAAS, run the **virsh destroy *vm-name*** command.
- Step 10** To undefine the Cisco vWAAS:
- a) Run the **virsh undefine *vm-name*** command.
 - b) Remove the directory with the specified *vm-name*.

Note If you want to create another Cisco vWAAS of the same model, repeat this procedure. The specified directory, for example, **Basic**, will then have two VMs, **Basic1** and **Basic2**. Disks for these VMs will be stored in the subdirectories **Basic1** and **Basic2**, respectively.

Using the EzDeploy Script to Deploy Cisco vWAAS on KVM on UCS-E in WAAS Version 5.x to 6.2.x

Before you begin

Use the EzDeploy script (**ezdeploy.sh**) for simplified deployment of a Cisco vWAAS.



Note The EzDeploy script is not used for the Cisco vCM.

The following are the prerequisites for launching the EzDeploy script:

- To launch the Cisco vWAAS VM, you must have root permission.
- The following software and utility packages must be installed before using the EzDeploy script:
 - QEMU
 - Libvirt
 - Genisoimage
 - Expect script (required only if you choose to run EzDeploy's capability for auto-monitoring Cisco WAAS Central Manager registration status)
- Verify the following:
 - There is sufficient disk and RAM memory to deploy another Cisco vWAAS.
 - Compatibility of software versions.
 - Availability and readiness of network connectivity.



Note Because EzDeploy leverages the **launch.sh** script to launch a Cisco vWAAS, the **launch.sh** script, as well as all the necessary files associated with it, must be present, intact, and not manually removed or manually moved elsewhere.

Procedure

Step 1 Launch the Cisco vWAAS VM.

Step 2 Create a new directory to hold the extracted contents of **tar.gz**.

Step 3 Copy **tar.gz** into the specified directory.

Step 4 To extract the **tar.gz** gzip file, run the **tar -zxvf Cisco-KVM-vWAAS-200-6.2.0.b-80.tar.gz** command.

The contents of the **tar.gz** file are:

- INSTRUCTIONS.TXT
- Disk-0.qcow
- Disk-1.qcow
- Disk-2.qcow
- vm_tap.xml
- vm_macvtap.xml
- launch.sh
- ezdeploy.sh
- ezdeploy.qstatus.exp

Step 5 Run the **ezdeploy.sh** script:

a) During execution of the **ezdeploy.sh**, you are prompted for bootstrap configuration parameters:

- vWAAS KVM name: The name is dependent on whether or not you provide the Cisco vWAAS' bootstrap configuration.

If you have not provided the Cisco vWAAS' bootstrap configuration: the name is set as the name of the guest KVM to be created. not the Cisco vWAAS' host name.

If you have provided the vWAAS' bootstrap configuration: the Cisco vWAAS' host name is set and used in both instances.

- Cisco vWAAS local IP address and mask
- Default GW IP address: An address on the ISR-4000 series RP that is reachable by the Cisco vWAAS and has external network connectivity
- IP address of the Cisco WAAS Central Manager with which the Cisco vWAAS will register
- One NTP server address, without authentication. If you want to have authentication or multiple NTP servers, use the Cisco WAAS Central Manager to configure these after the Cisco vWAAS is powered up.

- (Optional) DNS server address
- b) After input collection is completed, the following information is saved:
- The bootstrap configuration is saved in the **bootstrap-cfg.xml** file in the directory created for this KVM.
 - The execution log and error log of the script are saved in the **ezdeploy-log.txt** file in the directory created for this KVM.
 - For the Cisco vWAAS in this KVM, the error log is saved in **errorlog/ezdeploy-errorlog.txt**.
- Note** By default, all configuration and error logs saved in the specified KVM directory are *not* deleted, even if they have recorded errors, so allow for debugging. If you do not want to generate log files, you must confirm this choice at the end of the script execution, after input entry.
- c) After the EzDeploy script is run, the Cisco vWAAS is fully up and running. Registration with the specified Cisco WAAS Central Manager and the NTP server are automatically started after installation of their corresponding CLIs.
- (Optional) To view Cisco vWAAS, use the VM GUI or run the **virsh list** command.
 - (Optional) To connect to the console, use the VM GUI or run the **virsh console *vm-name*** command.
 - (Optional) To power down Cisco vWAAS, run the **virsh destroy *vm-name*** command.
 - (Optional) To undefine the Cisco vWAAS:
- d) To undefine the vWAAS:
- 1.Run the **virsh undefine *vm-name*** command.
 - 2.Remove the directory with the specified *vm-name*.

Operating Guidelines for Cisco vWAAS on KVM and KVM on CentOS

This section contains the following topics:

Interoperability Guidelines for Cisco vWAAS on KVM and KVM on CentOS

Consider the following interoperability guidelines for Cisco vWAAS on KVM:

Interoperability guidelines for Cisco WAAS versions and Cisco vWAAS on KVM:

- Cisco vWAAS on RHEL KVM is available for vWAAS in WAAS Version 6.2.1 and later.
- Cisco vWAAS on KVM on CentOS (Linux Community Enterprise Operating System) is available for vWAAS in WAAS Version 6.2.3x and later.

Interoperability guidelines for OVS and vWAAS on KVM:

- The Cisco Discovery Protocol (CDP) is not supported for Open Virtual Switch (OVS) on RHEL KVM on CentOS, therefore the show cdp command cannot be used for Cisco vWAAS on RHEL KVM on CentOS.
- For Cisco vWAAS in WAAS Version 6.2.3x and later, there is inline Cisco vWAAS support for the OVS switch, with additional settings in Cisco vWAAS.

To configure inline Cisco vWAAS support for the OVS switch:

1. Install CentOS 7.2 on UCS-C240.
2. Configure OVS switch on the KVM host.
3. Deploy the KVM vWAAS OVA's with the OVS switch on KVM host.
4. Power off the Cisco vWAAS.
5. Add two additional interfaces.
6. Using the virt-manager, map the bridge ID in Cisco vWAAS:

```
[root@localhost kvm]# virsh edit vwaas-name
```

The domain vWAAS XML configuration is changed.

7. Using the virt-manager, edit the virtual type:

```
virtualport type='openvswitch' /
```

8. Example:

```
<interface type='bridge'>
  <mac address='52:54:00:ea:3f:7b' />
  <source bridge='br2' />
  <virtualport type='openvswitch' />
  <model type='virtio' />
  <address type='pci' domain='0x0000' bus='0x00' slot='0x08' function='0x0' />
</interface>
<interface type='bridge'>
  <mac address='52:54:00:7f:7c:99' />
  <source bridge='br3' />
  <virtualport type='openvswitch' />
  <model type='virtio' />
  <address type='pci' domain='0x0000' bus='0x00' slot='0x0a' function='0x0' />
</interface>
```

Traffic Interception Methods for Cisco vWAAS on KVM

For traffic interception for Cisco vWAAS on KVM, you can use WCCP (WCCP GRE or WCCP L2) or Appnav.



Note When you use any of the traffic interception methods for Cisco vWAAS on RHEL KVM, you must disable Generic Receive Offload (GRO) on the Cisco UCS NIC. Run the **ethtool -K nic_interface_name gro off** command on the KVM host to disable GRO, for example: **ethtool -K enp3sof2 gro off**. If you do not disable GRO, traffic is not recognized, and packets are discarded.

If you upgrade the Cisco UCS NIC firmware to the latest version, you do not have to disable the GRO parameter.

For more information on configuring traffic interception methods, see the [Cisco Wide Area Application Services Configuration Guide](#).

Upgrade and Downgrade Guidelines for Cisco vWAAS on KVM

Consider the following guidelines when upgrading or downgrading your Cisco WAAS system with vWAAS on KVM

- Cisco vWAAS on KVM is used in Cisco WAAS Version 6.2.1 and later. You cannot downgrade Cisco vWAAS on KVM or vCM on KVM devices to a version earlier than Cisco WAAS Version 6.2.1.
- When upgrading Cisco vWAAS, do not upgrade more than five Cisco vWAAS nodes at the same time on a single Cisco UCS device. Upgrading more than five Cisco vWAAS nodes at the same time may cause the Cisco vWAAS devices to go offline and diskless mode.
- For a Cisco vCM-100 model used with the RHEL KVM or KVM on CentOS hypervisor, with the default memory size of 2 GB:

When you upgrade to Cisco WAAS Version 5.2.1 from an earlier version, or downgrade from Cisco WAAS Version 5.2.1 to an earlier version, and run either the **restore factory-default** command or run the **restore factory-default preserve basic-config** command, the vCM-100 may not come up due to GUID Partition Table (GPT) boot order errors.



Note The **restore factory-default** command erases user-specified configuration information stored in the flash image, including the starting configuration of the device, and also removes data from the disk, user-defined partitions, and the entire Central Manager database.

This upgrade-downgrade scenario does not occur for Cisco vCM-100 models whose memory size is upgraded to 4 GB.

To resolve this situation, follow these steps:

1. Power down the Cisco vWAAS: Run the **virsh destroy vmname** command or use the virt manager.
2. Power up the Cisco vWAAS: Run the **virsh start vmname** command or use the virt manager.

