SR-IOV Live Migration

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Figure 11. Image2020 7 26 14 39 27 Version 1 Modificationdate 1717696904392 Api V2

ⓘ **Note**

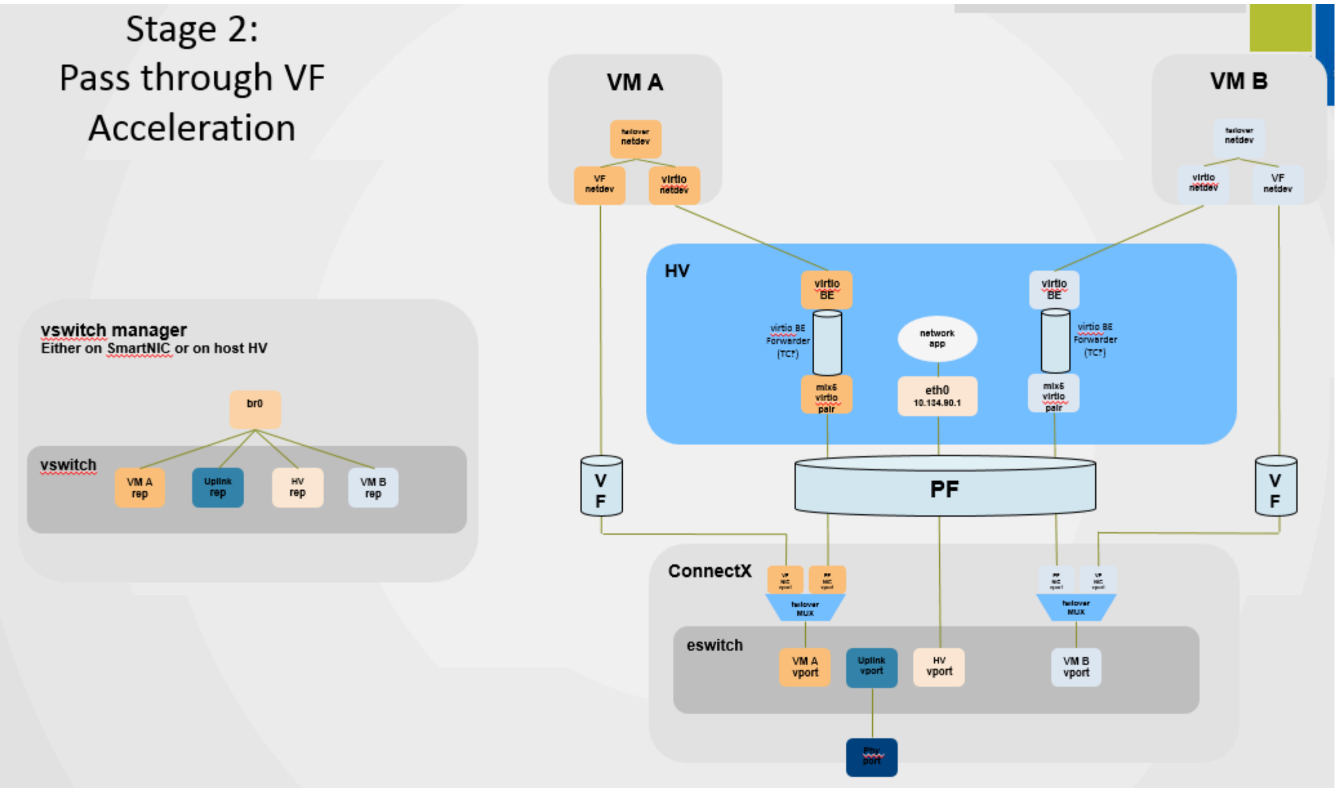
Support for this feature is at beta level.

Overview

This section describes how to set up and perform live migration on VMs with SR-IOV and with actively running traffic.

The below are the requirements for working with SR-IOV Live Migration.

- VM network persistency for applications - VM's applications must survive the migration process
- No internal VM admin configuration
- Support for ASAP^2 solution (kernel OVS hardware offload)
- No use of physical function (PF) network device in Paravirtual (PV) path for failover network traffic
- Use of sub-function (SF) in HyperVisor as failover PV path



Stage 2:
Pass through VF
Acceleration

Prerequisites

- ConnectX-5 or higher adapter cards
- Hypervisor host with RedHat/CentOS minimal version of 8.0 with MLNX_OFED minimal version of 5.4
- VMs that run on CentOS v8.0 or higher
- Hypervisor host with latest libvirt from hhttps://libvirt.org/news.html#v6-1-0-2020-03-03
- Hypervisor host with latest QEMU from https://www.qemu.org/2021/04/30/qemu-6-0-0/

This section consists of the following steps.

1. Host Servers Configuration.
2. VM OS Installation Using "virt-manager".
3. VFs to VMs Deployment.

4. ASAP^2 with OVS Deployment.

5. Live Migration with Paravirtual Path and Traffic.

Host Servers Configuration

The following steps should be performed in both host servers.

1. Install RedHat/CentOS v8.0 on the host server.
   The CentOS 8.0 ISO image can be downloaded via this link.

2. Connect the host servers to the Ethernet switch.
   Two host servers HV1 (eth0: 10.20.1.118) and HV2 (eth0: 10.20.1.119) connected via an Ethernet switch with switch ports configured/enabled VLAN. For example, vlan=100

3. Install the latest MLNX_OFED version.
   Download and install NVIDIA MLNX_OFED driver for distribution RHEL/CentOS 8.0.

   ```
   # mount -o loop MLNX_OFED_LINIx-5.4-rhel8.0-x86_64.iso /mnt
   # cd /mnt
   # ./mlnxofedinstall
   # reboot
   ```

4. Configure the host server and NVIDIA NIC with SR-IOV as instructed here.

5. Configure the host server and NVIDIA NIC with sub-function as instructed here (github.com/Mellanox/scalablefunctions/wiki).

   ```
   mlxconfig -d 0000:03:00.0 s PF_BAR2_ENABLE=0 \
   PER_PF_NUM_SF=1 PF_TOTAL_SF=64 PF_SF_BAR_SIZE=8

   Set the number of SFs same as that of VFs, as one SF-VF pair is used to attach
   to one VM.
   ```

6. Configure storage for VMs' images as shared.
   The default location for VMs' images is /var/lib/libvirt/images, which is a shared location that is set up as an NFS directory in this PoC. For example:

```
# mount <nfs-server>:/opt/nfs/images /var/lib/libvirt/images
```

7. Set up the network bridge "installation" for VMs to enable external communication. VMs must be able to download and install extra required packages for external sources.

```
# cd /etc/sysconfig/network-scripts
# vim ifcfg-installation

DEVICE=installation
TYPE=Bridge
BOOTPROTO=dhcp
ONBOOT=yes
# vim ifcfg-eth0
BRIDGE=installation
# systemctl network restart
```

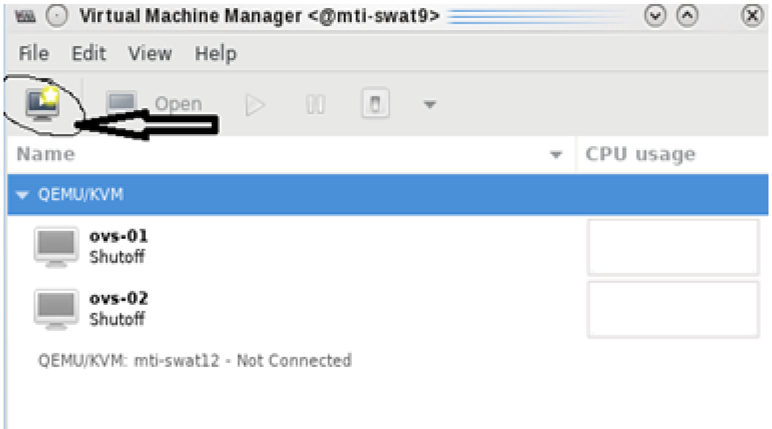
8. Download CentOS v8.0 ISO image for VM installation.
   Download CentOS v8.0 ISO image from one of the mirror sites to the local host.

```
# wget
http://isoredirect.centos.org/centos/8/isos/x86_64/CentOS-8-x86_64-1905-dvd1.iso
```

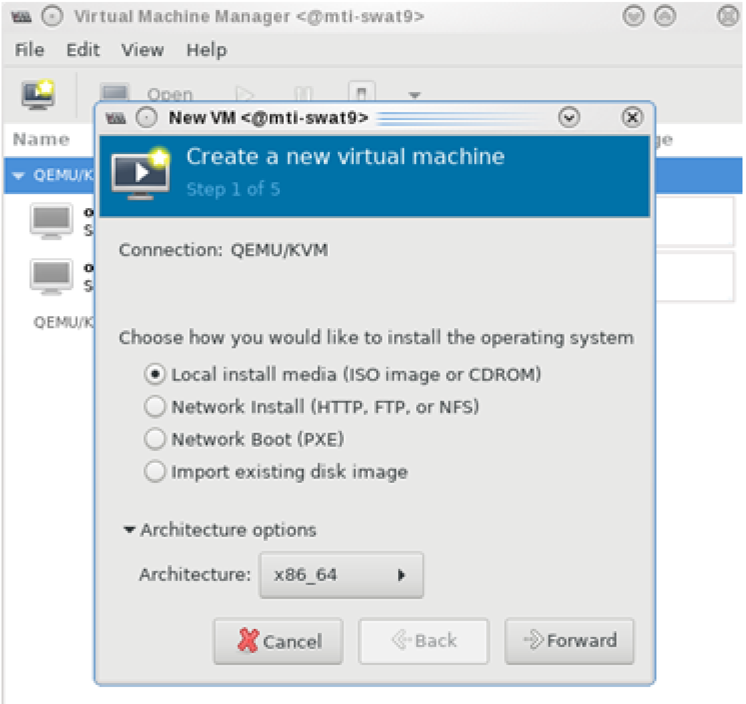
VM OS installation Using "virt-manager"

1. Launch "virt-manager" to create a new VM. Click the icon as shown below.

```
# virt-manager
```


Virtual Machine Manager <@mti-swat9>
File
Edit
View
Help
Open
Name
CPU usage
QEMU/KVM
ovs-01
Shutoff
ovs-02
Shutoff
QEMU/KVM: mti-swat12 - Not Connected

2. Choose “Local install media (ISO images or CDROM)”.



Create a new virtual machine
Step 1 of 5

Connection: QEMU/KVM

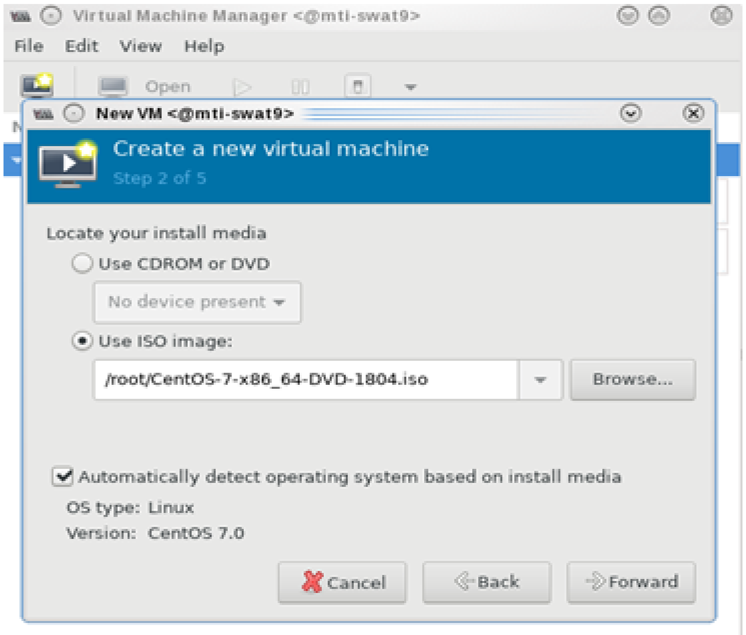
Choose how you would like to install the operating system

- ● Local install media (ISO image or CDROM)
- ○ Network Install (HTTP, FTP, or NFS)
- ○ Network Boot (PXE)
- ○ Import existing disk image

Architecture options

Architecture: x86_64

3. Specify the location of the downloaded CentOS 8.0 ISO image.



Locate your install media

○ Use CDROM or DVD

No device present

● Use ISO image:

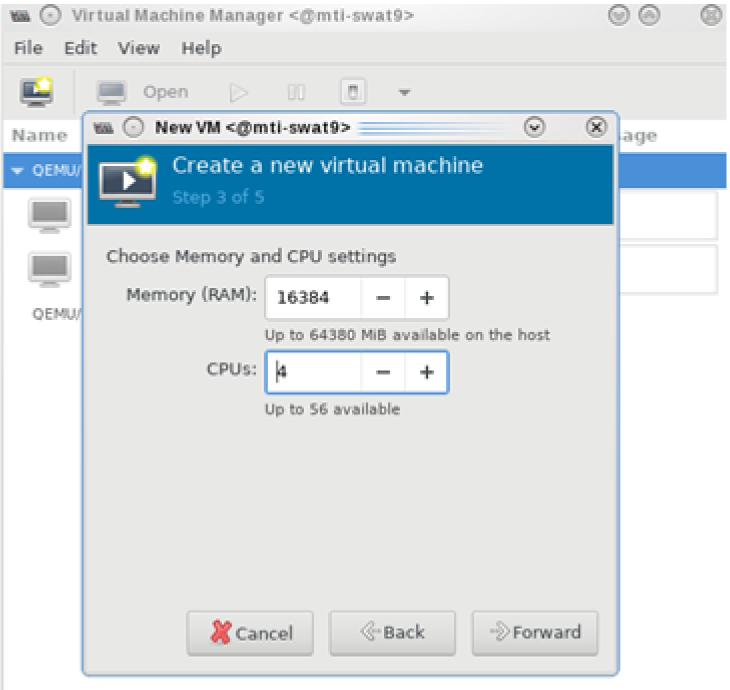
/root/CentOS-7-x86_64-DVD-1804.iso

☑ Automatically detect operating system based on install media

OS type: Linux

Version: CentOS 7.0

4. Fill in the fields under "Choose Memory and CPU settings" for the VM.



Choose Memory and CPU settings

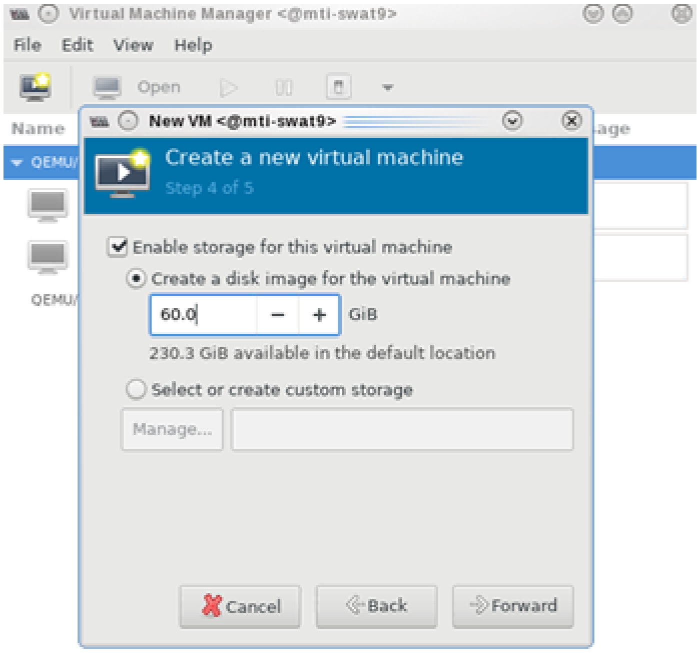
Memory (RAM): 16384

Up to 64380 MiB available on the host

CPUs: 4

Up to 56 available

5. Create the disk image at the default root user location, for example: /var/lib/libvirt/images (NFS mount point). Make sure the storage is higher than 120GB and the virtual disk image is 60GB.



Create a new virtual machine

Step 4 of 5

☑ Enable storage for this virtual machine

● Create a disk image for the virtual machine

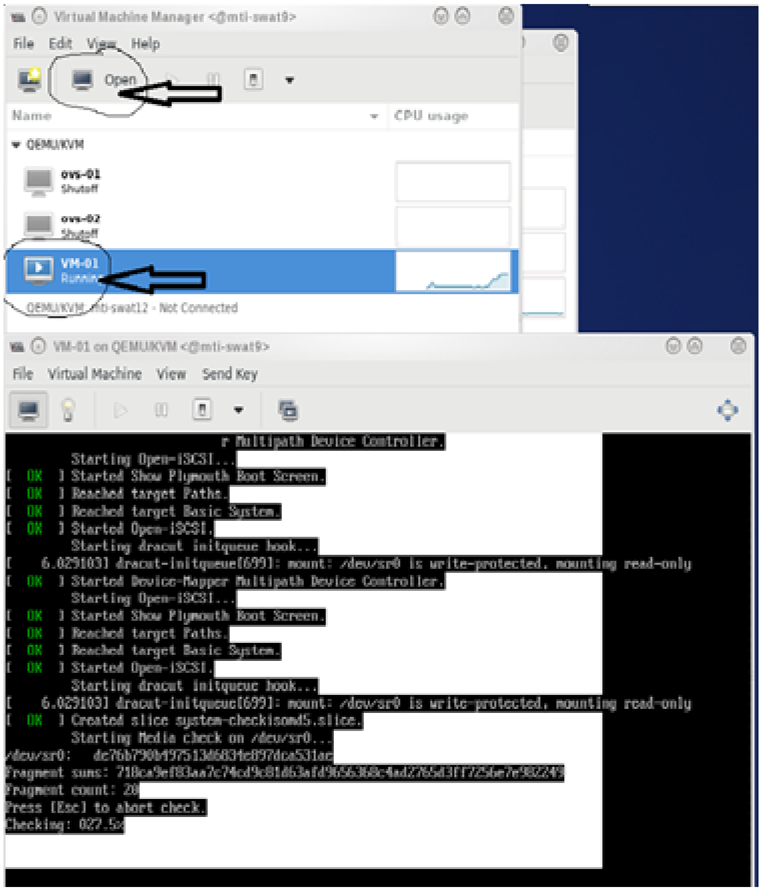
60.0 GiB

230.3 GiB available in the default location

○ Select or create custom storage

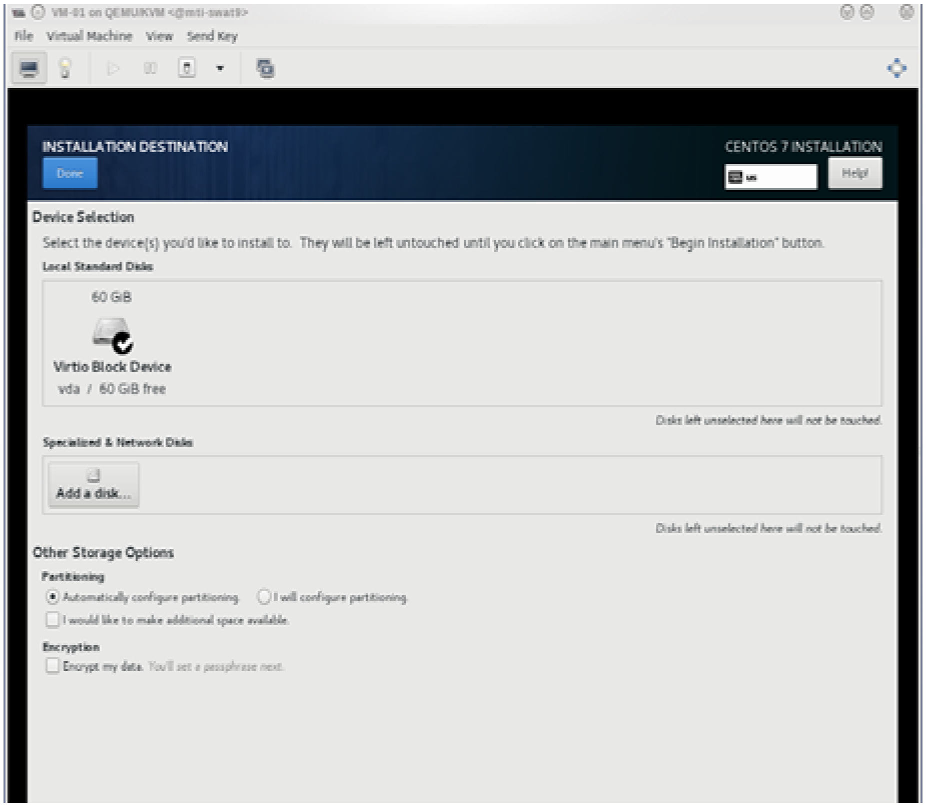
6. In the VM Name field, add "vm-01", and for the network selection, choose "Bridge installation: Host device eth0".

7. Click "vm-01", then "Open".


Virtual Machine Manager <@mti-swat9>
File Edit View Help
Open
Name
CPU usage
QEMU/KVM
ovs-01
Shutoff
ovs-02
Shutoff
VM-01
Running
QEMU/KVM: mti-swat12 - Not Connected
VM-01 on QEMU/KVM <@mti-swat9>
File Virtual Machine View Send Key

```
                 r Multipath Device Controller.
         Starting Open-iSCSI...
[  OK  ] Started Show Plymouth Boot Screen.
[  OK  ] Reached target Paths.
[  OK  ] Reached target Basic System.
[  OK  ] Started Open-iSCSI.
         Starting dracut initqueue hook...
[    6.029103] dracut-initqueue[699]: mount: /dev/sr0 is write-protected, mounting read-only
[  OK  ] Started Device-Mapper Multipath Device Controller.
         Starting Open-iSCSI...
[  OK  ] Started Show Plymouth Boot Screen.
[  OK  ] Reached target Paths.
[  OK  ] Reached target Basic System.
[  OK  ] Started Open-iSCSI.
         Starting dracut initqueue hook...
[    6.029103] dracut-initqueue[699]: mount: /dev/sr0 is write-protected, mounting read-only
[  OK  ] Created slice system-checkisomd5.slice.
         Starting Media check on /dev/sr0...
/dev/sr0:   de76b790b4975134684e897dca531ae
Fragment sums: 718ca9ef83aa7c74cd9c81d63afd9656368c4ad2765d3ff725be7e982249
Fragment count: 20
Press [Esc] to abort check.
Checking: 027.5%
```

8. Follow the installation with “Minimal Install” and “Virtual Block Device” selection.



Device Selection

Select the device(s) you'd like to install to. They will be left untouched until you click on the main menu's "Begin Installation" button.

Local Standard Disks

60 GiB

Virtio Block Device

vda / 60 GiB free

Disks left unselected here will not be touched.

Specialized & Network Disks

Disks left unselected here will not be touched.

Other Storage Options

Partitioning

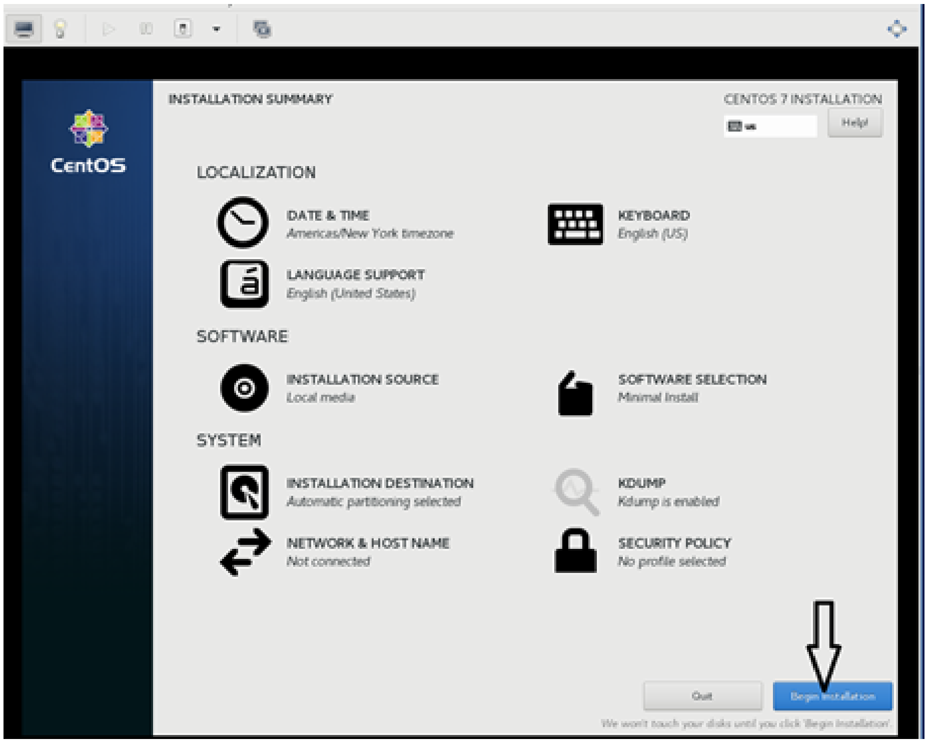
● Automatically configure partitioning. ○ I will configure partitioning.

□ I would like to make additional space available.

Encryption

□ Encrypt my data. You'll set a passphrase next.

9. Click "Begin Installation".



INSTALLATION SUMMARY

CENTOS 7 INSTALLATION

LOCALIZATION

DATE & TIME
Americas/New York timezone

KEYBOARD
English (US)

LANGUAGE SUPPORT
English (United States)

SOFTWARE

INSTALLATION SOURCE
Local media

SOFTWARE SELECTION
Minimal Install

SYSTEM

INSTALLATION DESTINATION
Automatic partitioning selected

KDUMP
Kdump is enabled

NETWORK & HOST NAME
Not connected

SECURITY POLICY
No profile selected

We won't touch your disks until you click 'Begin Installation'.

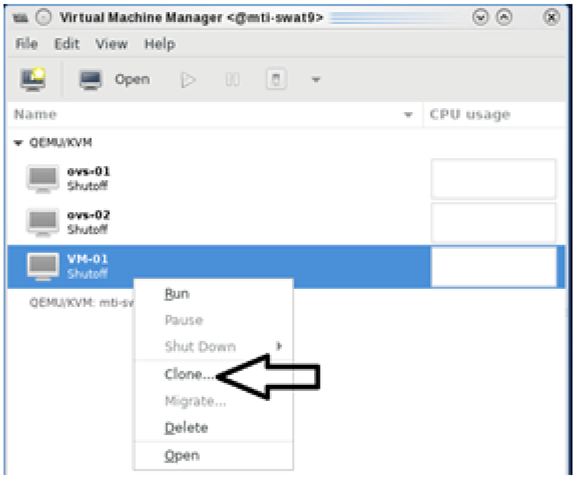
10. Reboot VM "vm-01" after installation is completed.

11. Use the VM's console terminal to enable external communication.

```
# [~]$ vi /etc/sysconfig/network-scripts/ifcfg-eth0
ONBOOT=yes
BOOTPROTO=dhcp

# systemctl network restart
```

12. Shut down VM "vm-01" and clone it to VM "vm-02".

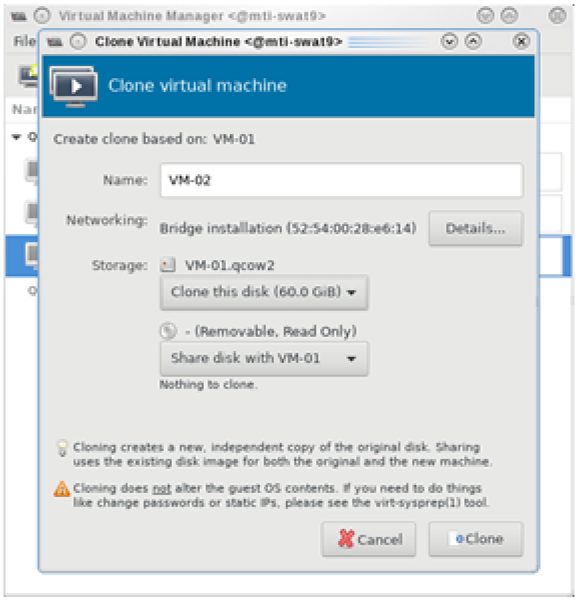


ovs-01
Shutoff

ovs-02
Shutoff

VM-01
Shutoff

13. Clone the virtual disk VM-01.qcow to VM-02.qcow.


Virtual Machine Manager <@mti-swat9>
Clone Virtual Machine <@mti-swat9>
Clone virtual machine
Details...
Cancel
Clone

Create clone based on: VM-01

Name: VM-02

Networking: Bridge installation (52:54:00:28:e6:14)

Storage: VM-01.qcow2

Clone this disk (60.0 GiB)

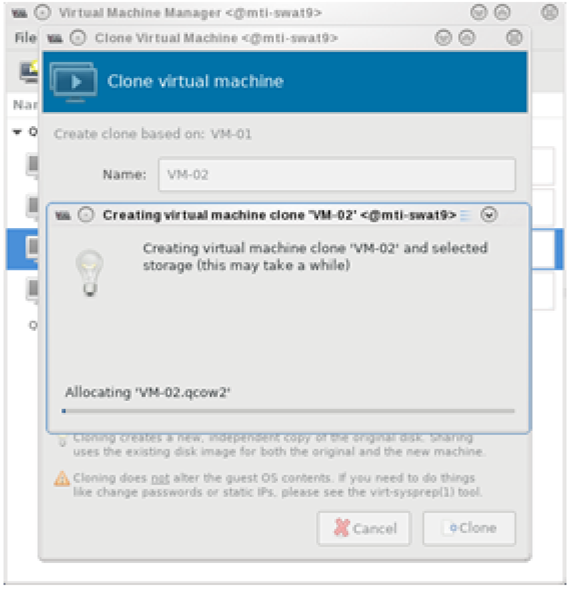
- (Removable, Read Only)

Share disk with VM-01

Nothing to clone.

Cloning creates a new, independent copy of the original disk. Sharing uses the existing disk image for both the original and the new machine.

Cloning does not alter the guest OS contents. If you need to do things like change passwords or static IPs, please see the virt-sysprep(1) tool.


Virtual Machine Manager <@mti-swat9>
File
Clone Virtual Machine <@mti-swat9>
Clone virtual machine
Creating virtual machine clone 'VM-02' <@mti-swat9>
Cancel
Clone

Create clone based on: VM-01

Name: VM-02

Creating virtual machine clone 'VM-02' and selected storage (this may take a while)

Allocating 'VM-02.qcow2'

Cloning creates a new, independent copy of the original disk. Sharing uses the existing disk image for both the original and the new machine.

Cloning does not alter the guest OS contents. If you need to do things like change passwords or static IPs, please see the virt-sysprep(1) tool.

14. Test the VM installation and migration without VFs.

    1. Boot both VMs and run ping to each other.

       ```
       [root@vm-01]# ping 10.20.4.8

       [root@vm-02]# ping 10.20.4.20
       ```

    2. Perform live migration using the "virsh" command line on HV1 where VM "vm-01" resides.

       ```
       [root@HV1]# virsh list --all
       Id Name State
       ----------------------------------------------------
        24 VM-01 running
       ```

    3. Perform live migration.

       ```
       [root@HV1]# virsh migrate --live --unsafe --persistent --verbose VM-01
       qemu+ssh://HV2/system
       ```

    4. Verify that vm-01 is migrated and resides at HV2.

```
[root@HV2]# virsh list --all
Id Name State
----------------------------------------------------
 1 VM-01 running
 2 VM-02 running
```

VFs to VMs Deployment

1. Make sure SR-IOV is enabled and VFs are available.

```
[root@HV2]# lspci -D | grep Mellanox
0000:06:00.0 Ethernet controller: Mellanox Technologies MT27800 Family
[ConnectX-5]
0000:06:00.1 Ethernet controller: Mellanox Technologies MT27800 Family
[ConnectX-5 Virtual Function]
0000:06:00.2 Ethernet controller: Mellanox Technologies MT27800 Family
[ConnectX-5 Virtual Function]
0000:06:00.3 Ethernet controller: Mellanox Technologies MT27800 Family
[ConnectX-5 Virtual Function]
0000:06:00.4 Ethernet controller: Mellanox Technologies MT27800 Family
[ConnectX-5 Virtual Function]
```

Enable the usage of VF2 "0000:06:00.3" and VF3 "0000:06:00.4" to assign to VM-01 and VM-02 respectively.

2. Attach VF to VM with XML file using "virsh" command line.

   1. Create VM-01-vf.xml and VM-02-vf.xml files to assign VF1 to VM-01 and VF2 to VM-02 as "hostdev" with MAC-address assigned.

```
root@HV1]# cat VM-01-vf.xml
<interface type='hostdev' managed='yes'>
<mac address='52:54:00:53:53:53'/>
<source>
<address type='pci' domain='0x0000' bus='0x06' slot='0x00' function='0x1'/>
</source>
<address type='pci' domain='0x0000' bus='0x00' slot='0x0c' function='0x0'/>
</interface>
```

```
[root@HV2]# cat VM-02-vf.xml
<interface type='hostdev' managed='yes'>
<mac address='52:54:00:54:54:54'/>
<source>
<address type='pci' domain='0x0000' bus='0x06' slot='0x00' function='0x2'/>
</source>
<address type='pci' domain='0x0000' bus='0x00' slot='0x0c' function='0x0'/>
</interface>
```

2. Assign the VF to the VM by running the "virsh" command line.

    1. Before attaching the VF, VM-01 and VM-02 should have a single network interface.

    ```
    [root@VM-02]# ip link show
    1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state
    UNKNOWN mode DEFAULT group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    2: ens3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc
    noqueue state UP mode DEFAULT group default qlen 1000
    link/ether 52:54:00:06:83:8a brd ff:ff:ff:ff:ff:ff
    ```

    2. On HV1 host, assign VF1 to VM-01.

    ```
    [root@HV1]# virsh attach-device VM-01 VM-01-vf.xml
    Device attached successfully
    ```

3. On HV2 host, assign VF2 to VM-02.

```
[root@HV2]# virsh attach-device VM-02 VM-02-vf.xml
Device attached successfully
```

4. After attaching the VFs, VM-01 and VM-02 should have two network interfaces. The second interface "ens12" is the VF with the MAC-address assigned.

```
[root@VM-02]# ip link show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state
UNKNOWN mode DEFAULT group default qlen 1000
link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: ens3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc
noqueue state UP mode DEFAULT group default qlen 1000
link/ether 52:54:00:06:83:8a brd ff:ff:ff:ff:ff:ff
3: ens12: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc
mq state UP mode DEFAULT group default qlen 1000
link/ether 52:54:00:54:54:54 brd ff:ff:ff:ff:ff:ff
```

3. Connect to VMs console, configure the IP address of the VF network interface and run traffic.
Install iperf, configure the IP address and run traffic between them on both VMs.

```
[root@VM-01]# yum -y install iperf3
...
Resolving Dependencies
--> Running transaction check
---> Package iperf3.x86_64 0:3.1.7-2.el7 will be installed
...

[root@VM-01]# ip addr add 11.11.11.1 dev ens12
```

```
[root@VM-02]# yum -y install iperf3
...
Resolving Dependencies
--> Running transaction check
---> Package iperf3.x86_64 0:3.1.7-2.el7 will be installed
...

[root@VM-02]# ip addr add 11.11.11.2 dev ens12

[root@VM-02]# ping 11.11.11.1
64 bytes from 11.11.11.1: icmp_seq=1 ttl=64 time=0.046 ms
64 bytes from 11.11.11.1: icmp_seq=2 ttl=64 time=0.039 ms

[root@VM-02]# iperf3 -s -f m
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
```

```
[root@VM-01]# iperf3 -c 11.11.11.2 -P 4 -t 600 -i 1
```

NVIDIA ASAP2 with OVS Deployment

Perform the NVIDIA ASAP^2 installation and configuration on both HV1 and HV2.

1. Download, build and install OpenvSwitch-2.12.0.

```
root@HV1]# wget https://www.openvswitch.org/releases/openvswitch-2.15.0.tar.gz
[root@HV1]# tar -xzf openvswitch-2.15.0.tar.gz
[root@HV1]# cd openvswitch-2.15.0
[root@HV1]# ./boot.sh
[root@HV1]# ./configure
[root@HV1]# make -j32; make install
```

```
[root@HV1]# export PATH=$PATH:/usr/local/share/openvswitch/scripts
```

2. Configure OVS with a single vSwitch "ovs-sriov" with hw-offload=true and tc-policy=verbose.

    1. Create OVS "ovs-sriov" and set hw-offload=true and tc-policy=verbose

    ```
    [root@HV1]# export PATH=$PATH:/usr/local/share/openvswitch/scripts
    [root@HV1]# ovs-ctl start

    [root@HV1]# ovs-vsctl add-br ovs-sriov
    [root@HV1]# ovs-vsctl set Open_vSwitch . other_config:hw-offload=true
    [root@HV1]# ovs-vsctl set Open_vSwitch . other_config:tc-policy=verbose
    [root@HV1]# ovs-vsctl set Open_vSwitch . other_config:max-idle=100000
    [root@HV1]# ovs-ctl restart
    [root@HV1]# ovs-vsctl get Open_vSwitch . other_config
    {hw-offload="true", tc-policy=verbose}
    ```

    2. Enable SR-IOV and SWITCHDEV mode by executing "asap_config.sh" script for PF port 1.

    ```
    [root@HV1] cat asap_config.sh
    echo "Configure ASAP & VSWITCH OFFLOAD"
    devlink dev eswitch set pci/0000:${pci}.0 mode switchdev
    ethtool -K $pf hw-tc-offload on
    ip link set dev $pf up
    # Number of Virtual Functions NUM_VFS=2

    # Mellanox NIC ID
    HCA=MT27800

    pci=$(lspci |grep Mellanox|grep $HCA |head -n1|awk '{print $1}'| sed s/\.0\$//g)
    pf=$(ls -l /sys/class/net/| grep $pci|awk '{print $9}'| head -n1)
    echo "pci=$pci pf=$pf HCA=$HCA"
    sh -c "echo $NUM_VFS > /sys/class/net/${pf}/device/sriov_numvfs"
    ```

```
lspci|grep Mell
ls -l /sys/class/net/
ovs-vsctl show
ovs-dpctl show
```

3. Create a sub-function on PF port 1 with the script "create_sf.sh".

```
[root@HV1] cat create_sf.sh

# Number of Sub-Functions
NUM_SFS=2

HCA=MT27800

pci=$(lspci |grep Mellanox|grep "$HCA" |head -n1|awk '{print $1}'| sed
s/\.0\$//g)
DEV=0000:$pci.0

 for ((i=1; i<=$NUM_SFS; i++)); do
/opt/mellanox/iproute2/sbin/mlxdevm port add pci/0000:${pci}.0 \
flavour pcisf pfnum 0 sfnum $i
/opt/mellanox/iproute2/sbin/mlxdevm port function set en6s0f0pf0sf$i
state active
done

[root@HV1] ./create_sf.sh
[root@HV1] ip link
...
 47: en6s0f0pf0sf0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500
qdisc mq state UP mode DEFAULT group default qlen 1000
link/ether 7e:94:e9:79:48:0b brd ff:ff:ff:ff:ff:ff
 48: enp6s0f0s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc
mq state UP mode DEFAULT group default qlen 1000
link/ether 36:76:c1:f9:3e:5d brd ff:ff:ff:ff:ff:ff
```

```
 49: en6s0f0pf0sf1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500
qdisc mq state UP mode DEFAULT group default qlen 1000
link/ether 96:03:d2:f1:27:f6 brd ff:ff:ff:ff:ff:ff
 50: enp6s0f0s1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc
mq state UP mode DEFAULT group default qlen 1000
link/ether 62:f0:68:a5:79:cb brd ff:ff:ff:ff:ff:ff

NOTES:
======
There are 2 new SF netdevices (enp6s0f0s0, enp6s0f0s1) and their
representors netdevices (en6s0f0pf0sf0, en6s0f0pf0sf1) created
```

4. Rename the sub-function's netdevices.

```
Rename sub function's netdevices so that both source and destination
systems can have same name.

[root@HV1]
$ ip link set eth0 down
$ ip link set eth0 name meth0
$ ip link set meth0 up

$ ip link set eth1 down
$ ip link set eth1 name meth1
$ ip link set meth1 up

$ ip link set eth2 down
$ ip link set eth2 name meth2
$ ip link set meth2 up

$ ip link set eth3 down
$ ip link set eth3 name meth3
$ ip link set meth3 up
```

Live Migration with Paravirtual Path and Traffic

1. Create bonding devices of VF and sub-function (SF) representors.

```
NOTES:
=======
bond0 is bond device of sf1's representor (primary slave) and vf0's representor
bond1 is bond device of sf2's representor (primary slave) and vf1's representor

[root@HV1]# ./bond_setup.sh bond0 en6s0f0pf0sf0 ens2_0
[root@HV1]# ./bond_setup.sh bond1 en6s0f0pf0sf1 ens2_1

[root@HV1]# cat ./bond_setup.sh

BOND=$1

# put here two SF/VF reps for which you want to share the block
SFR1=$2
VFR2=$3

tc qdisc del dev $BOND ingress
tc qdisc del dev $SFR1 ingress
tc qdisc del dev $VFR2 ingress

ip link set dev $SFR1 nomaster
ip link set dev $VFR2 nomaster
ip link del $BOND

ip link add name $BOND type bond

ip link set dev $SFR1 down
ip link set dev $VFR2 down

ip link set dev $BOND type bond mode active-backup
ip link set dev $SFR1 master $BOND
ip link set dev $VFR2 master $BOND

# make SFR1 the primary - this is paravirtual path
```

```
echo $SFR1 > /sys/class/net/$BOND/bonding/primary

ip link set dev $SFR1 up
ip link set dev $VFR2 up
ip link set dev $BOND up
```

2. Add Uplink "ens2" and bonding devices to "ovs-sriov" bridge.

   ```
   [root@HV1]# ovs-vsctl add-port ovs-sriov ens2
   [root@HV1]# ovs-vsctl add-port ovs-sriov bond0 tag=100
   [root@HV1]# ovs-vsctl add-port ovs-sriov bond1 tag=100
   ```

3. Modify the VM-01's xml file to have the default SF's macvtap-based virtio netdevice.

   1. Edit VM-01 configuration with the same MAC address assigned to VF-1.

   2. Make sure the alias name has the prefix "ua-".

      ```
      Insert below configuration to VM-01.

      [root@HV1]# virsh edit VM-01

      <interface type='direct'>
      <mac address='52:54:00:53:53:53'/>
      <source dev='enp6s0f0s0' mode='passthrough'/>
      <target dev='macvtap0'/>
      <model type='virtio'/>
      <teaming type='persistent'/>
      <alias name='ua-net0'/>
      <address type='pci' domain='0x0000' bus='0x05' slot='0x00' function='0x0'/>
      </interface>
      ```

   3. Edit VM-02 configuration with the same MAC address assigned to VF-2.

   4. Make sure the alias name has the prefix "ua-".

```
Insert below configuration to VM-01.

[root@HV1]# virsh edit VM-02

<interface type='direct'>
<mac address='52:54:00:54:54:54'/>
<source dev='enp6s0f0s1' mode='passthrough'/>
<target dev='macvtap1'/>
<model type='virtio'/>
<alias name='ua-net1'/>
<address type='pci' domain='0x0000' bus='0x06' slot='0x00' function='0x0'/>
</interface>
```

4. Restart the VMs and verify that the PV path exists in both VMs and that it is accessible.
   Each VM should have two extra netdevs, such as: eth0, eth1 where eth0 is master and eth1 is automatically enslaved to eth0.

   ```
   [root@VM-01] ip link show
   1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN
   mode DEFAULT qlen 1000
   link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
   2: ens3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast
   state UP mode DEFAULT qlen 1000
   link/ether 52:54:00:1c:91:0a brd ff:ff:ff:ff:ff:ff
   3: eth0: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN mode
   DEFAULT qlen 1000
   link/ether 52:54:00:53:53:53 brd ff:ff:ff:ff:ff:ff
   4: eth1: <BROADCAST,MULTICAST> mtu 1500 qdisc noop master eth0 state
   DOWN mode DEFAULT qlen 1000
   link/ether 52:54:00:53:53:53 brd ff:ff:ff:ff:ff:ff
   ```

1. Configure the IP address and run iperf on VMs over SF PF path.

```
[root@VM-01]# ip addr add 11.11.11.1 dev eth0
[root@VM-01]# iperf3 -s -f m
```

```
[root@VM-02]# ip addr add 11.11.11.2 dev eth0
[root@VM-02]# ping 11.11.11.1
[root@VM-02]# iperf3 -c 11.11.11.1 -P 4 -t 600 -i 1
```

2. Modify the XML file of the VFs to link to the persistent device of the SFs.

```
[root@HV1]# cat VM-01-vf.xml
<interface type='hostdev' managed='yes'>
<mac address='52:54:00:53:53:53'/>
<source>
<address type='pci' domain='0x0000' bus='0x06' slot='0x00' function='0x1'/>
</source>
<teaming type='transient' persistent='ua-net0'/>
<address type='pci' domain='0x0000' bus='0x00' slot='0x0c' function='0x0'/>
</interface>
```

```
[root@HV2]# cat VM-02-vf.xml
<interface type='hostdev' managed='yes'>
<mac address='52:54:00:54:54:54'/>
<source>
<address type='pci' domain='0x0000' bus='0x06' slot='0x00' function='0x2'/>
</source>
<teaming type='transient' persistent='ua-net1'/>
<address type='pci' domain='0x0000' bus='0x00' slot='0x0c' function='0x0'/>
</interface>
```

3. Attach VFs to VMs VM-01 and VM-02, and switch to the direct path in HyperVisors HV1 and HV2. I/O traffic should continue after the VFs have been successfully attached to the VMs.

```
[root@HV1] virsh attach-device VM-01 VM-01-vf.xml; echo ens2_0 >
/sys/class/net/bond0/bonding/active_slave
```

```
Device attached successfully

[root@HV2] virsh attach-device VM-02 VM-02-vf.xml; echo ens2_1 >
/sys/class/net/bond1/bonding/active_slave
Device attached successfully
```

Each VM should have one extra netdev from the attached VF that is automatically enslaved to eth0.

```
[root@VM-01] ip link show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state
UNKNOWN mode DEFAULT qlen 1000
link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: ens3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc
pfifo_fast state UP mode DEFAULT qlen 1000
link/ether 52:54:00:1c:91:0a brd ff:ff:ff:ff:ff:ff
3: eth0: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN
mode DEFAULT qlen 1000
link/ether 52:54:00:53:53:53 brd ff:ff:ff:ff:ff:ff
4: eth1: <BROADCAST,MULTICAST> mtu 1500 qdisc noop master eth0
state DOWN mode DEFAULT qlen 1000
link/ether 52:54:00:53:53:53 brd ff:ff:ff:ff:ff:ff
5: ens12: <BROADCAST,MULTICAST> mtu 1500 qdisc noop master eth0
state DOWN mode DEFAULT qlen 1000
link/ether 52:54:00:53:53:53 brd ff:ff:ff:ff:ff:ff
```

5. Detach VF from VM, switch to SF PV path in HyperVisors HV1 and HV2. I/O traffic should pause 0.5s and then resume.

```
root@HV1] virsh detach-device VM-01 VM-01-vf.xml; echo en6s0f0pf0sf0 >
/sys/class/net/bond0/bonding/active_slave
Device detached successfully
```

6. Perform Live Migration on VM-01. iperf traffic should run as usual.

```
[root@HV1] virsh migrate --live --unsafe --persistent --verbose VM-01
qemu+ssh://HV2/system
```

7. Attach VF to VM again and switch to the direct path in HyperVisor. I/O traffic should run as usual.

```
[root@HV2] virsh attach-device VM-01 VM-01-vf.xml; echo ens2_0 >
/sys/class/net/bond0/bonding/active_slave
Device attached successfully
```