IBM

Mellanox – IBM SRIOV enablement guide

Version 0.0.17
For IBM System-X/Mellanox OFED 2.0 drivers
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Table of Contents

Introduction

This document outlines the supported procedure to enable and configure SR-IOV using:

- Mellanox Connect-X3 adapters on
- Supported Linux Distribution (
    - Red Hat Enterprise Linux Server version 6 quarterly update 4 or higher
    - SLES 11 Service Pack 2 or higher
- IBM System-X:
    - M4, M5 or X6 class servers (ie: servers with either Sandy Bridge or Ivy Bridge Processor Families)

RHEL 6.4 preparation:

OS install

Recommend changing disk partitioning to maximize the size of root partition

Recommend installing groups/packages:

Software Development Workstation Group with following customizations:
Base System: Compatibility Libraries
Base System: Legacy UNIX compatibility
Servers: System administration tools
Virtualization: Virtualization Tools

Enable iommu:

After reboot:

```
vi /etc/grub.conf
```

copy lines starting with:

title
    root
    kernel
    initrd

paste to end of file, then modify the appended copied lines

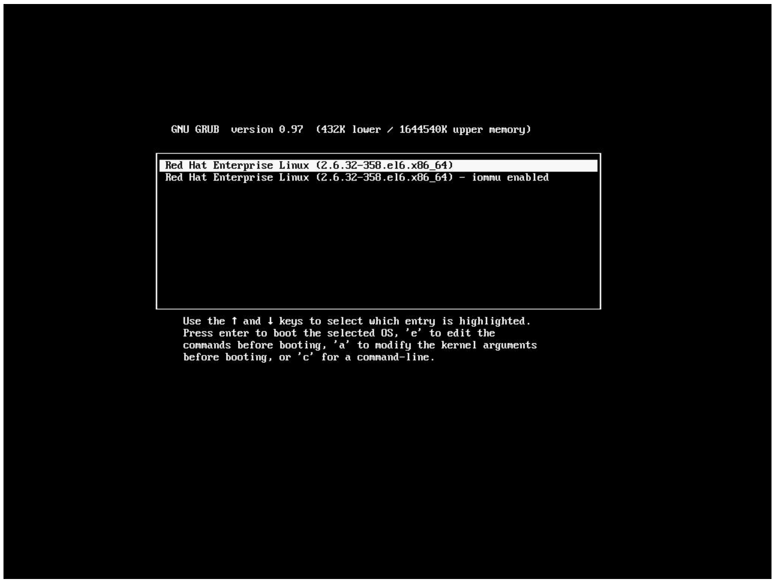
1) append to end of title line: “ - iommu enabled”
2) append to end of kernel line: “ intel_iommu=on iommu=pt”

Here's an example of edited /etc/grub.conf (every server's file will be slightly differenet, do not copy the output directly

```
# grub.conf generated by anaconda
#
# Note that you do not have to rerun grub after making changes to this file
# NOTICE:  You have a /boot partition.  This means that
#          all kernel and initrd paths are relative to /boot/,
eg.
#          root (hd0,1)
#          kernel /vmlinuz-version ro
root=/dev/mapper/VolGroup-lv_root
#          initrd /initrd-[generic-]version.img
#boot=/dev/sda1
device (hd0) HD(1,800,64000,4968f356-f168-4420-86df-
82ec92ba1387)
default=0
timeout=5
splashimage=(hd0,1)/grub/splash.xpm.gz
hiddenmenu
title Red Hat Enterprise Linux (2.6.32-358.el6.x86_64)
        root (hd0,1)
        kernel /vmlinuz-2.6.32-358.el6.x86_64 ro
root=/dev/mapper/VolGroup-lv_root rd_NO_LUKS LANG=en_US.UTF-8
rd_NO_MD rd_LVM_LV=VolGroup/lv_swap SYSFONT=latarcyrheb-sun16
crashkernel=128M rd_LVM_LV=VolGroup/lv_root  KEYBOARDTYPE=pc
KEYTABLE=us rd_NO_DM rhgb quiet
        initrd /initramfs-2.6.32-358.el6.x86_64.img

title Red Hat Enterprise Linux (2.6.32-358.el6.x86_64) - iommu
enabled
        root (hd0,1)
        kernel /vmlinuz-2.6.32-358.el6.x86_64 ro
root=/dev/mapper/VolGroup-lv_root rd_NO_LUKS LANG=en_US.UTF-8
rd_NO_MD rd_LVM_LV=VolGroup/lv_swap SYSFONT=latarcyrheb-sun16
crashkernel=128M rd_LVM_LV=VolGroup/lv_root  KEYBOARDTYPE=pc
KEYTABLE=us rd_NO_DM rhgb quiet intel_iommu=on iommu=pt
        initrd /initramfs-2.6.32-358.el6.x86_64.img
```

Reboot, server... pressing enter “Booting Red Hat Linux banner, then selecting iommu enabled kernel



```
 GNU GRUB  version 0.97  (432K lower / 1644540K upper memory)

 Red Hat Enterprise Linux (2.6.32-358.el6.x86_64)
 Red Hat Enterprise Linux (2.6.32-358.el6.x86_64) - iommu enabled

    Use the ↑ and ↓ keys to select which entry is highlighted.
    Press enter to boot the selected OS, 'e' to edit the
    commands before booting, 'a' to modify the kernel arguments
    before booting, or 'c' for a command-line.
```

If boot was successful,
A) Double check iommu is enabled:

```
[root@localhost Packages]# dmesg | grep -e DMAR -e IOMMU
ACPI: DMAR 000000006340c000 00328 (v01 IBM    SERMEGAL 00000001
MSFT 01000021)
Intel-IOMMU: enabled
```

B) modify the /etc/grub.conf again to change the default kernel to load from 0 to 1

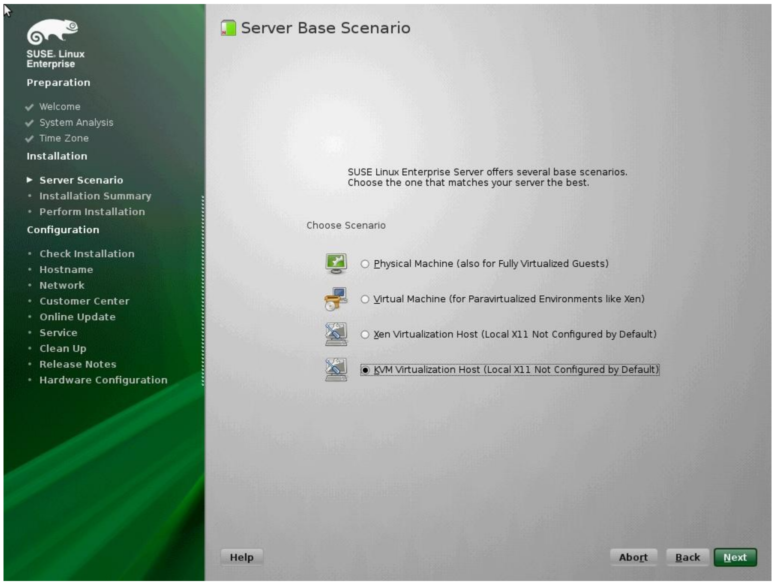
change “default=0” to “default=1”

SLES 11 SP3 preparation:

OS install

Recommend changing disk partitioning to maximize the size of root partition

Recommended “Server Base Scenario” = KVM Virtualization Host



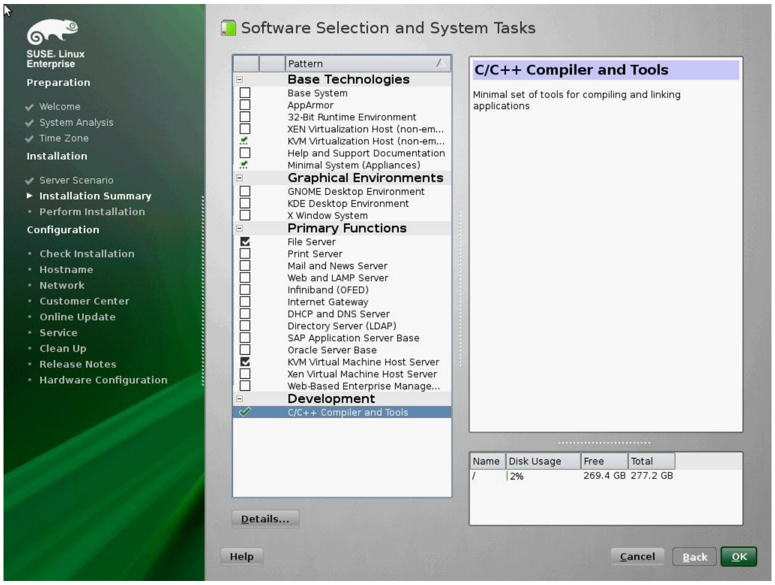
Server Base Scenario

SUSE Linux Enterprise Server offers several base scenarios.
Choose the one that matches your server the best.

Choose Scenario

○ Physical Machine (also for Fully Virtualized Guests)
○ Virtual Machine (for Paravirtualized Environments like Xen)
○ Xen Virtualization Host (Local X11 Not Configured by Default)
● KVM Virtualization Host (Local X11 Not Configured by Default)

Recommended “Software Selection and System Tasks”
add: C/C++ Compiler and Tools



Software Selection and System Tasks

Pattern

Base Technologies
- □ Base System
- □ AppArmor
- □ 32-Bit Runtime Environment
- □ XEN Virtualization Host (non-em...
- ✓ KVM Virtualization Host (non-em...
- □ Help and Support Documentation
- ✓ Minimal System (Appliances)

Graphical Environments
- □ GNOME Desktop Environment
- □ KDE Desktop Environment
- □ X Window System

Primary Functions
- ☑ File Server
- □ Print Server
- □ Mail and News Server
- □ Web and LAMP Server
- □ Infiniband (OFED)
- □ Internet Gateway
- □ DHCP and DNS Server
- □ Directory Server (LDAP)
- □ SAP Application Server Base
- □ Oracle Server Base
- ☑ KVM Virtual Machine Host Server
- □ Xen Virtual Machine Host Server
- □ Web-Based Enterprise Manage...

Development
- ✓ C/C++ Compiler and Tools

C/C++ Compiler and Tools

Minimal set of tools for compiling and linking applications

Name	Disk Usage	Free	Total
/	2%	269.4 GB	277.2 GB

Enable iommu:

After reboot:

```
linux-3f2i:~ # vi /boot/efi/efi/SuSE/elilo.conf
```

copy lines starting with:

image
        label
        append
        description
        initrd
        root

paste to end of file, then modify the appended copied lines

1) append to end of label line: “ - iommu enabled”
2) append to end of append line: “ intel_iommu=on iommu=pt”

Here's an example of edited /boot/efi/efi/SuSE/elilo.conf (every server's file will be slightly different, do not copy the output directly

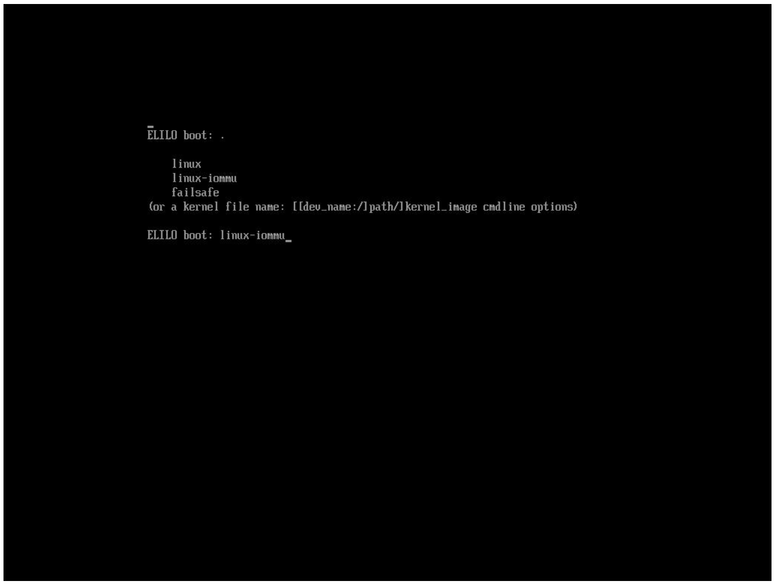
```
# This file has been transformed by /sbin/elilo.
# Please do NOT edit here -- edit /etc/elilo.conf instead!
# Otherwise your changes will be lost e.g. during kernel-update.
#
# Modified by YaST2. Last modification on Mon Jan  6 12:52:45 EST 2014
timeout = 80
##YaST - boot_efilabel = "SUSE Linux Enterprise Server 11 SP3"
default = linux
prompt

image = vmlinuz-3.0.76-0.11-default
###Don't change this comment - YaST2 identifier: Original name: linux###
    label = linux
    append = "resume=/dev/disk/by-id/scsi-350000393d848b10c-part2 splash=silent crashkernel=256M-:128M showopts "
    description = "Linux (3.0.76-0.11-default)"
    initrd = initrd-3.0.76-0.11-default
    root = /dev/disk/by-id/scsi-350000393d848b10c-part3

image = vmlinuz-3.0.76-0.11-default
###Don't change this comment - YaST2 identifier: Original name: linux###
    label = linux-iommu
    append = "resume=/dev/disk/by-id/scsi-350000393d848b10c-part2 splash=silent crashkernel=256M-:128M showopts intel_iommu=on iommu=pt "
    description = "Linux (3.0.76-0.11-default)"
    initrd = initrd-3.0.76-0.11-default
    root = /dev/disk/by-id/scsi-350000393d848b10c-part3

image = vmlinuz-3.0.76-0.11-default
###Don't change this comment - YaST2 identifier: Original name: failsafe###
    label = failsafe
    append = "showopts ide=nodma apm=off noresume edd=off powersaved=off nohz=off highres=off processor.max_cstate=1 nomodeset x11failsafe   "
    description = "Failsafe (3.0.76-0.11-default)"
    initrd = initrd-3.0.76-0.11-default
    root = /dev/disk/by-id/scsi-350000393d848b10c-part3
```

Reboot, server... pressing **tab** key at “ELILO boot:” banner, then typing linux-iommu



```
ELILO boot: .

    linux
    linux-iommu
    failsafe
(or a kernel file name: [[dev_name:/]path/]kernel_image cmdline options)

ELILO boot: linux-iommu_
```

If boot was successful,
A) Double check iommu is enabled:

```
linux-3f2i:~ # dmesg | grep -e DMAR -e IOMMU
[    0.000000] ACPI: DMAR 0000000067801000 000B4 (v01 IBM
SERMEGAL 00000001 MSFT 01000021)
[    0.000000] Intel-IOMMU: enabled
```

B) modify the /etc/grub.conf again to change the default kernel to load from “linux” to “linux-iommu”

change “default=linux” to “default=linux-iommu”

Installing Mellanox Drivers/Firmware

Procedure for RHEL6 and SLES 11 KVM servers are identical. Just ensure the correct driver/firmware/tool file being used matches Linux distro!

A) Using IBM standalone update express image.

Executing update payload by itself (easiest method, if other system updates not required). In this example, the server is running Red Hat 6 and the maximum number of virtual functions to be created by the operating system is 16.

```
./mlnx_fw_nic_2.0.3.0.0.4_rhel6_x86-64.bin -s --enable-sriov
--total-vfs 16
```

B) Using IBM's Update Express Tool

If desired, the Mellanox SR-IOV enabled driver install/adapter firmware can be a element of a general update express server update. A small modification of the payload's .xml is required to execute the Mellanox update properly. Download all the update express payloads, .xml files and uxspi tool into a single directory. Modify the Mellanox .xml file with the following two commands. In this example, the server is running Red Hat 6 and the maximum number of virtual functions to be created by the operating system is 16.

```
[root@localhost ~]#  sed -i -e 's/.bin -s/.bin -s --enable-
sriov --total-vfs 16/' mlnx_fw_nic_2.0.3.0.0.4_rhel6_x86-64.xml
[root@localhost ~]# sed -i -e 's/x86_64/x86_64 with SR-IOV
enablement/' mlnx_fw_nic_2.0.3.0.0.4_rhel6_x86-64.xml
```

Assuming the IBM uxspi executable, Mellanox payload and .xml files are in the current directory

```
[root@localhost ~]# ./ibm_utl_uxspi_9.50_rhel6_32-64.bin up -L
Extracting...
Executing...


This Program is licensed under the terms of the agreement
available by invoking
this utility with the --license option. By extracting, copying,
accessing, or
using the Program, you agree to the terms of this agreement. If
you do not
agree to the terms, please uninstall the software and return it
to IBM or the
reseller from whom you acquired the software for a refund, if
any.
Initializing, Please wait...

UpdateXpress System Pack Installer Version 9.50.05
(C) Copyright IBM Corp. 2004-2013. All Rights Reserved.
Active Machine Type: 7917, OS: RHEL 6 (64 bit)
Gathering Inventory .................................. done
Querying Updates done
Comparing Updates
(1) [ ] Mellanox OFED update for Red Hat Enterprise Linux 6
x86_64 with SR-IOV enablement
     Category          : Network
     Severity          : Not Required
     Reboot            : Reboot Required to take effect
     Update ID         : mlnx_fw_nic_2.0-2.6.7.1_rhel6_x86-64
     Requisites        : None

     Update            : IBM1060110017 Firmware
     New Version       : 2.30.2010
     Installed Version : 2.30.2010

     Update            : mlx4_core.ko Device Driver
     New Version       : 2.0-2.6.7.1
     Installed Version : 2.0.3.0.0.4

     Update            : IBM0FD0140019 Firmware
     New Version       : 2.30.2010
     Installed Version : 2.30.2010

Legend:
Type the item number to toggle selected [*] or not selected [ ]
Type 'a' to accept the menu
Type 'f' to select all entries
Type 'q' to quit without processing the entries
[1-1,a,q,f]>
```

C) Using a Mellanox created .iso and firmware update install CD

mount Mellanox .iso image and run installation script

```
[root@localhost ~]# mount -o loop MLNX_OFED_LINUX-2.0-3.0.0-
rhel6.4-x86_64.iso /mnt
[root@localhost ~]# /mnt/mlnxofedinstall --enable-sriov
--total-vfs 16This program will install the MLNX_OFED_LINUX
package on your machine.
Note that all other Mellanox, OEM, OFED, or Distribution IB
packages will be removed.
Do you want to continue?[y/N]:y
.
.
```

using server's remote access tool, mount the firmware image and boot server in legacy mode to update firmware

Post driver install modprobe configuration file creation. The maximum number vfs (virtual functions supported is 16)

```
root@localhost Packages]#echo options mlx4_core
port_type_array=2,2 num_vfs=16 > /etc/modprobe.d/mlx4_core.conf
```

Post firmware installation confirmation (installation of Mellanox drivers/tools required to perform this test):

Example (commands work any number of adapters in server, results in example for two adapters)

```
[root@localhost Packages]# mst start
Starting MST (Mellanox Software Tools) driver set
[warn] mst_pci is already loaded, skipping
[warn] mst_pciconf is already loaded, skipping
Create devices
[root@localhost Packages]# for i in `mst status | grep _pciconf
| cut -c 1-24`; do echo $i; flint -d $i dc | grep -e sriov -e
vfs; done
/dev/mst/mt4099_pciconf0
total_vfs = 16
sriov_en = true
/dev/mst/mt4099_pciconf1
```

```
total_vfs = 16
sriov_en = true
[root@localhost Packages]#
```

Reboot server

SRIOV Customization

Confirming Mellanox adapter(s) are virtualizied

Example (commands work any number of adapters in server, results in example for two adapters, 16 virtual ports)

```
[root@localhost ~]# lspci | grep -c Mellanox
34
```

Result of command should be equal to (1 physical port + virtual posts defined in modprobe configuration file above) times number of adapters.

Associating physical NIC ports to virtual PCI functions

Use Mellanox “ibdev2netdev” command to associate adapters to linux “eth” ports

Example (commands work any number of adapters in server, results in example for two adapters)

```
[root@localhost ~]# ibdev2netdev
mlx4_0 port 1 ==> eth4 (Up)
mlx4_0 port 2 ==> eth5 (Down)
mlx4_1 port 1 ==> eth2 (Up)
mlx4_1 port 2 ==> eth3 (Up)
```

Then use “ethtool” command to associate a “eth” to a pci function

```
[root@localhost ~]# ethtool -i eth4
driver: mlx4_en
version: 2.1.6 (Aug 27 2013)
firmware-version: 2.30.2010
bus-info: 0000:16:00.0
supports-statistics: yes
supports-test: yes
supports-eeprom-access: no
supports-register-dump: no
supports-priv-flags: no
```

Example combining the two commands to produce required data:(commands work any number of adapters in server, results in example for two adapters)

```
[root@localhost ~]# ibdev2netdev > /tmp/tmp; cat /tmp/tmp |
while read eth; do echo $eth connected PCI function `ethtool -i
${eth:18:4} | grep bus`; done
mlx4_0 port 1 ==> eth4 (Up) connected PCI function bus-info:
0000:16:00.0
mlx4_0 port 2 ==> eth5 (Down) connected PCI function bus-info:
0000:16:00.0
mlx4_1 port 1 ==> eth2 (Up) connected PCI function bus-info:
0000:4b:00.0
mlx4_1 port 2 ==> eth3 (Up) connected PCI function bus-info:
0000:4b:00.0
```

Associating virtual functions (vf) to virtual PCI functions

The following table is handy to associate virtual function numbers to virtual PCI functions

virtual functions (vf)	PCI functions	virtual functions (vf)	PCI functions
0	X:00.1	8	X:01.1
1	X:00.2	9	X:01.2
2	X:00.3	10	X:01.3
3	X:00.4	11	X:01.4
4	X:00.5	12	X:01.5
5	X:00.6	13	X:01.6
6	X:00.7	14	X:01.7
7	X:01.0	15	X:02.0

(Optional) Assigning MAC addresses to virtual functions.

Optional, however very useful if you would like to use a dhcpd server to IP addresses to your guest virtual machines.

Basic command: “ip link set <p-dev> vf <vf> mac xx:xx:xx:xx:xx:xx”

Basic example, using data collected above... setting MAC 00:02:03:00:00:15 address for 3 vf on port 2 of the first Mellanox adapter (mlx4_0):

```
[root@localhost ~]#ip link set eth5 vf 3 mac 00:02:03:00:00:15
```

suggest bash loop to config all the vf for a specific port at one time.

example, using data collected above. For second Mellanox Adapter, Port 2, assign MAC address to each vf as 00:01:02:03:04:vf#

```
[root@localhost ~]# for i in {0..15}; do ip link set eth3 vf $i
mac 00:01:02:03:04:$i; done
```

(Optional) Assignment of CPU NUMA to virtual function

On computers that have many CPUs, nonuniform memory access (NUMA) hardware can significantly improve performance by pairing dedicated memory with CPUs. For best networking performance (bandwidth and latency) providing the virtual machine direct access to the server's CPU directly connected to the adapter is required.

First determine what mlx device the virtual machine(s) will be using with the Mellanox “ibdev2netdev” command to associate adapters to linux “eth” ports

Example (commands work any number of adapters in server, results in example for two adapters)

```
[root@localhost ~]# ibdev2netdev
mlx4_0 port 1 ==> eth4 (Up)
mlx4_0 port 2 ==> eth5 (Down)
mlx4_1 port 1 ==> eth2 (Up)
mlx4_1 port 2 ==> eth3 (Up)
```

Assuming the eth2 is being used, then query the file /sys/class/infiniband/mlx4_1/numa_node to determine the CPU associated with the adapter.

```
[root@localhost ~]# cat
/sys/class/infiniband/mlx4_1/device/numa_node
1
```

In the example above, eth2 is a port on Mellanox Adapter mlx4_1 which is physically connected to CPU 1.

Next determine what NUMAs are used by that CPU. The lscpu command provides the associated between NUMAs and physical CPUs

```
[root@localhost ~]# lscpu
Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Little Endian
CPU(s):                48
On-line CPU(s) list:   0-47
Thread(s) per core:    2
Core(s) per socket:    6
Socket(s):             4
NUMA node(s):          4
Vendor ID:             GenuineIntel
CPU family:            6
Model:                 62
Stepping:              2
CPU MHz:               2100.000
BogoMIPS:              4199.45
Virtualization:        VT-x
L1d cache:             32K
L1i cache:             32K
L2 cache:              256K
L3 cache:              15360K
NUMA node0 CPU(s):     0-5,24-29
NUMA node1 CPU(s):     6-11,30-35
NUMA node2 CPU(s):     12-17,36-41
NUMA node3 CPU(s):     18-23,42-47
```

Going back to the example where eth2 is associated with mlx4_1 which is physically connected to CPU 1. The NUMAs of interest are 6-11 and 30-35. The number of NUMAs for each CPU should equal the number of CPU cores available (in this example 12 cores = 12 NUMAs)

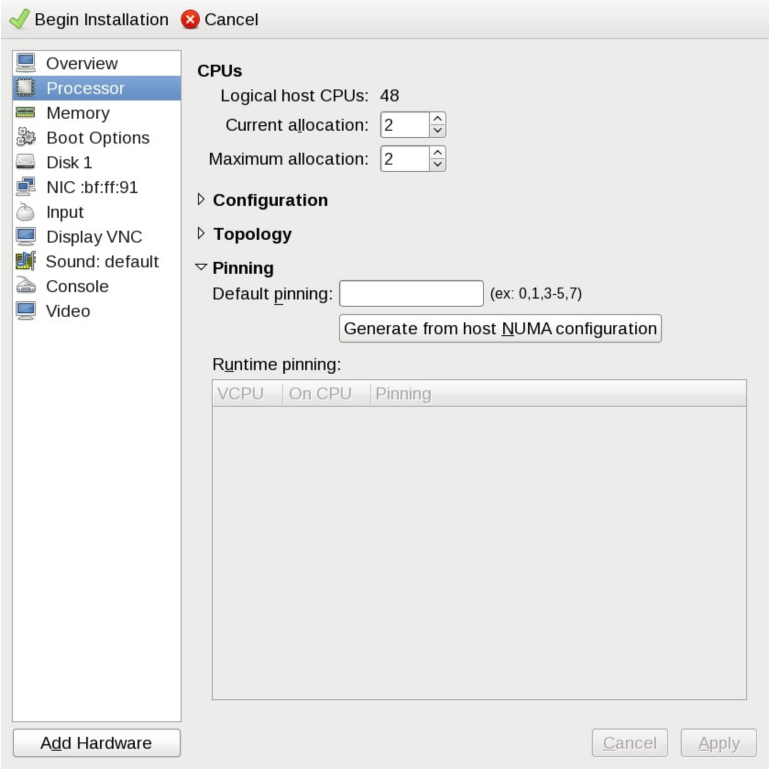
For best performance one and only one of the NUMAs associated with the CPU attached to the adapter should be used by a single virtual machine. The virtual machine's xml file defines what NUMAs are used by the virtual machine. Specifically the cpuset element of the vcpu tag defines what NUMAs are used. The example below lists out the vcpu tage for 16 virtual machines defined on a server. Notice that VM 0 to VM 11 each are defined to be using 1 single NUMA from the set associated with CPU 1 (6-11, 30-35). VM 12 to VM 15 do not have NUMAs that are part of CPU 1. Performance of these Vms will be significantly LOWER than VM 0 to VM11

```
[root@localhost ~]# for i in {0..15}; do echo -n "VM $i:  ";cat
```

```
/etc/libvirt/qemu/vm-$i.xml | grep vcpu; done
VM 0:   <vcpu placement='static' cpuset='0,6'>2</vcpu>
VM 1:   <vcpu placement='static' cpuset='1,7'>2</vcpu>
VM 2:   <vcpu placement='static' cpuset='2,8'>2</vcpu>
VM 3:   <vcpu placement='static' cpuset='3,9'>2</vcpu>
VM 4:   <vcpu placement='static' cpuset='4,10'>2</vcpu>
VM 5:   <vcpu placement='static' cpuset='5,11'>2</vcpu>
VM 6:   <vcpu placement='static' cpuset='24,30'>2</vcpu>
VM 7:   <vcpu placement='static' cpuset='25,31'>2</vcpu>
VM 8:   <vcpu placement='static' cpuset='26,32'>2</vcpu>
VM 9:   <vcpu placement='static' cpuset='27,33'>2</vcpu>
VM 10:   <vcpu placement='static' cpuset='28,34'>2</vcpu>
VM 11:   <vcpu placement='static' cpuset='29,35'>2</vcpu>
VM 12:   <vcpu placement='static' cpuset='12,18'>2</vcpu>
VM 13:   <vcpu placement='static' cpuset='13,19'>2</vcpu>
VM 14:   <vcpu placement='static' cpuset='14,20'>2</vcpu>
VM 15:   <vcpu placement='static' cpuset='15,21'>2</vcpu>
[root@localhost ~]#
```

Important note: Optimizing any server to favor a specific device may effort the performance of other devices the server. The changes suggested above may decrease the throughput of other network and storage functions.

NUMAs values can also be set when defining the VM from the virt-manager interface. In step 5 select “ Customize configuration before install” and then modify “Processor” entering the NUMAs into the “default pinning” rollout.



CPUs

Logical host CPUs: 48

Current allocation: 2

Maximum allocation: 2

Pinning

Default pinning: (ex: 0,1,3-5,7)

Runtime pinning:

VCPU	On CPU	Pinning

(Optional) Assignment of Transparent vLAN to a virtual function.

To add a transparent (to the guest OS) vLAN tag all packets on a virtualized interface, use the following command:

ip link set <p-dev> vf <vf> vlan <vlan-num>

example, using data collected above:

Setting a transparent vLAN on the First Port on the First adapter (eth4), virtual function 0 to 101

```
[root@localhost ~]# ip link set eth4 vf 0 vlan 101
```

The transparent vLAN will automatically apply a vLAN of 101 on every packet leaving the virtual function adapter port. Any vLAN applied by the VM's OS will be stripped away. All packets sent to the VM on this virtual interface must have the vLAN of 101 applied or it will be discard. The vLAN tag of 101 is removed from the packet before it's sent to the VM.

Applying a vLAN of 0, will allow remove this VLAN feature.

(Optional) Assignment of QOS rate limits to a virtual function

Assignment of QOS (Quality of Service) parameters is a two step process.

Step 1 – Defining the QOS levels for each interface. (using the mlnx_qos command)

Each interface can up to 8 predefined quality of service levels. Each of these levels allows refinement of the total adapter bandwidth capability any specific virtual function can use/consume.

Variables to consider when defining QOS levels.

Transmission Algorithm: (-s in mlnx_qos command)

> ets: Based on 802.1QAZ standards, attempts to provide as much bandwidth to each virtual function and then uses prioritizes when interface bandwidth becomes over-subscribed.
>
> strict: Caps available bandwidth at fixed level

guaranteed bandwidth. (-t in mlnx_qos command) Used in conjunction with ets algorithm to set the min level bandwidth to interfaces, when using ets, the sum of all the QOS levels guaranteed bandwidth must equal 100%

rate limit: (-r in mlnx_qos command) the rate cap for the interface when using the strict algorithm.

Suggested method to create QOS levels, create a table to define the levels, from the table compose mlnx_qos command. Here's a blank table:

Interface (-i):

QOS Level (-p)	Transmission Algorithm (-s) ets or strict	Guaranteed bandwidth (-t) The sum of this column must equal 100	Rate limit in Gb/s (-r) use 0 for est use 0 for unlimited rate
0			
1			
2			
3			

4			
5			
6			
7			

Two examples:

guaranteed bandwidth (ets) example. Will create 8 virtual machines, would like all the machines to share the same physical interface (eth2), with a guaranteed min bandwidth of 12% of the total bandwidth

Interface (-i): eth2

QOS Level (-p)	Transmission Algorithm (-s) ets or strict	Guaranteed bandwidth (-t) The sum of this column must equal 100	Rate limit in Gb/s (-r) use 0 for est use 0 for unlimited rate
0	ets	12	0
1	ets	12	0
2	ets	12	0
3	ets	12	0
4	ets	12	0
5	ets	12	0
6	ets	12	0
7	ets	16	0

```
[root@localhost ~]#mlnx_qos -i eth2 -p 0,1,2,3,4,5,6,7 -s
ets,ets,ets,ets,ets,ets,ets,ets -t 12,12,12,12,12,12,12,16
```

This is the QOS level number used later in the “ip link” command

noticed in this command that the sum of the guaranteed bandwidth is 100.

rate limiting (strict) example Will create 8 virtual machines, would like all the machines to share the same physical interface (eth3), with a range of rate limits

Interface (-i): eth3

QOS Level (-p)	Transmission Algorithm (-s) ets or strict	Guaranteed bandwidth (-t) The sum of this column must equal 100 use 0 for strict	Rate limit in Gb/s (-r) use 0 for est use 0 for unlimited rate
0	strict	0	5
1	strict	0	10
2	strict	0	15
3	strict	0	20
4	strict	0	25
5	strict	0	30
6	strict	0	35
7	strict	0	0

```
[root@localhost ~]#mlnx_qos -i eth3 -p 0,1,2,3,4,5,6,7 -s
strict,strict,strict,strict,strict,strict,strict,strict -t
0,0,0,0,0,0,0,0 -r 5,10,15,20,25,30,35,0
```

Step 2- Applying the QOS levels to adapter virtual functions

use the:
ip link set <p-dev> vf <vf> vlan <vlan-num> qos <qos_level>

note here: The vlan element of the command is required, see transparent vLAN section above for details, using “vlan 0” does not apply any vlan tag on outgoing packets or require vlan tag on incoming packets.

examples applying service levels created above to specific virtual functions.

guaranteed bandwidth (ets) example

```
[root@localhost ~]# ip link set eth2 vf 0 vlan 0 qos 0
[root@localhost ~]# ip link set eth2 vf 1 vlan 0 qos 1
[root@localhost ~]# ip link set eth2 vf 2 vlan 0 qos 2
[root@localhost ~]# ip link set eth2 vf 3 vlan 0 qos 3
[root@localhost ~]# ip link set eth2 vf 4 vlan 0 qos 4
[root@localhost ~]# ip link set eth2 vf 5 vlan 0 qos 5
[root@localhost ~]# ip link set eth2 vf 6 vlan 0 qos 6
```

```
[root@localhost ~]# ip link set eth2 vf 7 vlan 0 qos 7
```

or

```
[root@localhost ~]# for i in {0..7}; do ip link set eth2 vf $i
vlan 0 qos $i; done
```

rate limiting (strict) example

```
[root@localhost ~]# ip link set eth3 vf 0 vlan 0 qos 0
[root@localhost ~]# ip link set eth3 vf 1 vlan 0 qos 1
[root@localhost ~]# ip link set eth3 vf 2 vlan 0 qos 2
[root@localhost ~]# ip link set eth3 vf 3 vlan 0 qos 3
[root@localhost ~]# ip link set eth3 vf 4 vlan 0 qos 4
[root@localhost ~]# ip link set eth3 vf 5 vlan 0 qos 5
[root@localhost ~]# ip link set eth3 vf 6 vlan 0 qos 6
[root@localhost ~]# ip link set eth3 vf 7 vlan 0 qos 7
```

or

```
[root@localhost ~]# for i in {0..7}; do ip link set eth3 vf $i
vlan 0 qos $i; done
```

Additional considerations:

QOS levels can be applied to multiple virtual adapter ports, it that case the resources defined in the QOS level will be shared in-between all the virtual ports.

QOS levels creation can combine guaranteed bandwidth (ets) and rate limiting (strict) transmission algorithms.

Checking virtual function/ports configurations

use:

ip link show <p-dev>

will display physical port and all virtual ports MAC address, vlan and QOS settings

use:

mlnx_qos -i <p-dev>

will display QOS levels associated with the physical port.

(Optional) Hypervisor performance tuning

These steps optimize the server's resources to provide best performance for the Mellanox adapters. Understand that these steps may effort negatively the performance of other functions of the server.

1) **Disable the irqbalance service.**
The irqbalance service attempts to spread out irq interrupts among all the available processors. In most cases that will enhance the other all server performance, however when certain very time critical processes require the attention of a specific processor core (ie: the processor core associated with a PCI function) the irqbalance may redirect that irq to a different core cause a delay in servering the interrupt. Overall, when network performance is of highest importance, disabling this service is suggested.

To disable the service use the following command:

```
[root@localhost ~]# service irqbalance stop
```

To disable the service from starting when the OS loads, use the following command. (this command will not stop the service, if it's currently running.

```
[root@localhost ~]# chkconfig irqbalance off
```

2) Start the Mellanox Affinity service

In conjunction to stopping the irqbalance service, using the Mellanox Affinity service directs the operating system to direct all the Mellanox networking interupts to the correct processor cores. This service is optimized for a single adapter installed on the server, if muliple adapters are installed, refer to the Mellanox documention included in the driver/tool install package.

To enable the service use the following command:

```
[root@localhost ~]# mlnx_affinity start
```

It is suggested that starting the mlnx_affinity service when configuring the Mellanox adapters before starting any virtual machines using virtualized Mellanox adapter functions.

3) Disable processor power saving management

Intel adjusts the CPU clock frequencies to save power. When additional CPU performance is required, the CPU will increase the clock rate. This process to increase the clock rate takes time and temporally results in suboptimal performance. To avoid this issue, the following script can be used to keep the CPU from entering the clock frequency power savings mode.

```
echo "Checking your cpu frequency settings..."
NUM_CPU="1"
rm -rf /tmp/cpuinfo
cat /proc/cpuinfo  | grep processor > /tmp/cpuinfo
NUM_CPU=$(less /proc/cpuinfo | grep -c processor)
COUNTER=0
```

```
if [ -e /sys/devices/system/cpu/cpu0/cpufreq ]; then
                echo "changing cpu frequency to performance mode"
                while [ $COUNTER -lt $NUM_CPU ]; do
                        echo performance > /sys/devices/system/cpu/cpu$COUNTER/cpufreq/scaling_governor
                        let COUNTER=$COUNTER+1
                done
else
        echo "cpu frequency change is not supported"
fi
echo "done."
```

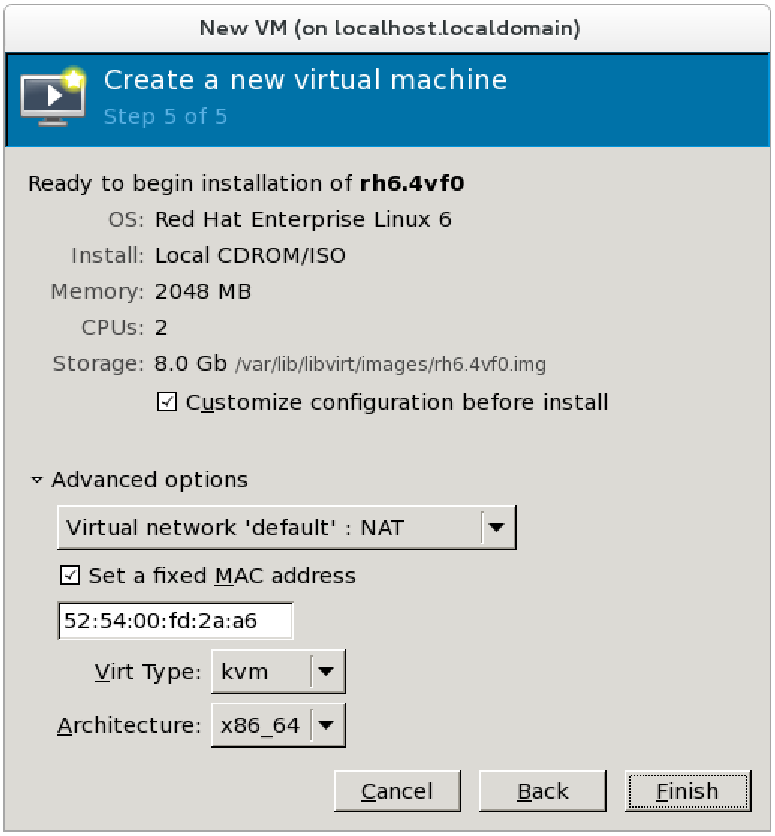
4) Ensure that flow control is enabled all the way along the network path.

Refer to the command reference manuals for the switches in your network to ensure the flow control is enabled on all the ports critical in the performance path.

Creating SR-IOV enabled Virtual Machines

Important: Only RHEL 6 and SLES 11 based virtual machines support SR-IOV enabled Virtual Functions.

A) From virt-manager GUI. Create new virtual machine as normal, in “Step 5 of 5”, select “Customize configuration before install”



New VM (on localhost.localdomain)

Create a new virtual machine

Step 5 of 5

Ready to begin installation of **rh6.4vf0**

OS: Red Hat Enterprise Linux 6

Install: Local CDROM/ISO

Memory: 2048 MB

CPUs: 2

Storage: 8.0 Gb /var/lib/libvirt/images/rh6.4vf0.img

☑ Customize configuration before install

Advanced options

Virtual network 'default' : NAT

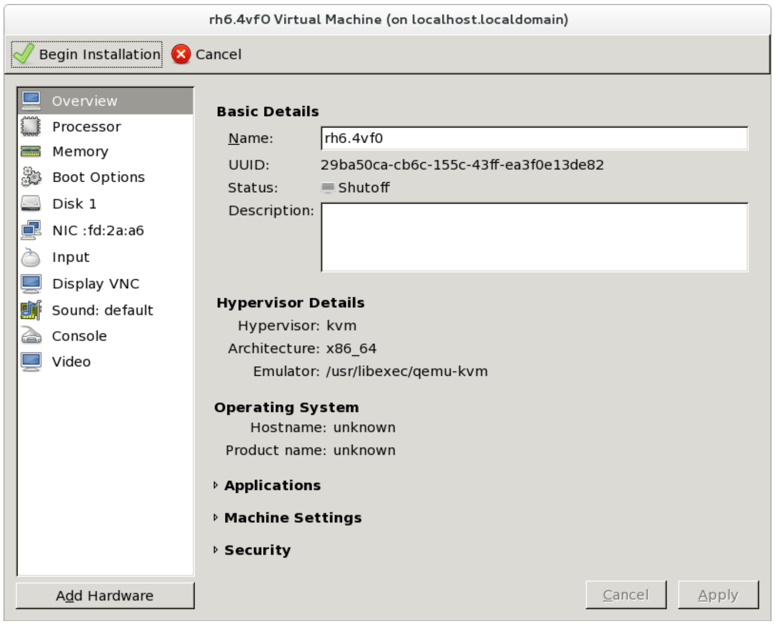
☑ Set a fixed MAC address

52:54:00:fd:2a:a6

Virt Type: kvm

Architecture: x86_64

Then Select “Add Hardware Button”



Basic Details

Name: rh6.4vf0
UUID: 29ba50ca-cb6c-155c-43ff-ea3f0e13de82
Status: Shutoff
Description:

Hypervisor Details

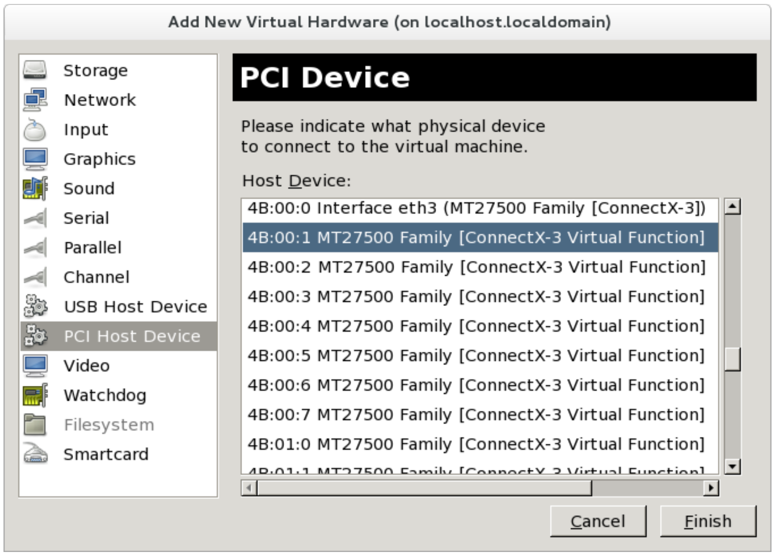
Hypervisor: kvm
Architecture: x86_64
Emulator: /usr/libexec/qemu-kvm

Operating System

Hostname: unknown
Product name: unknown

▸ **Applications**
▸ **Machine Settings**
▸ **Security**

Then select Virtual Function to add to Virtual Machine



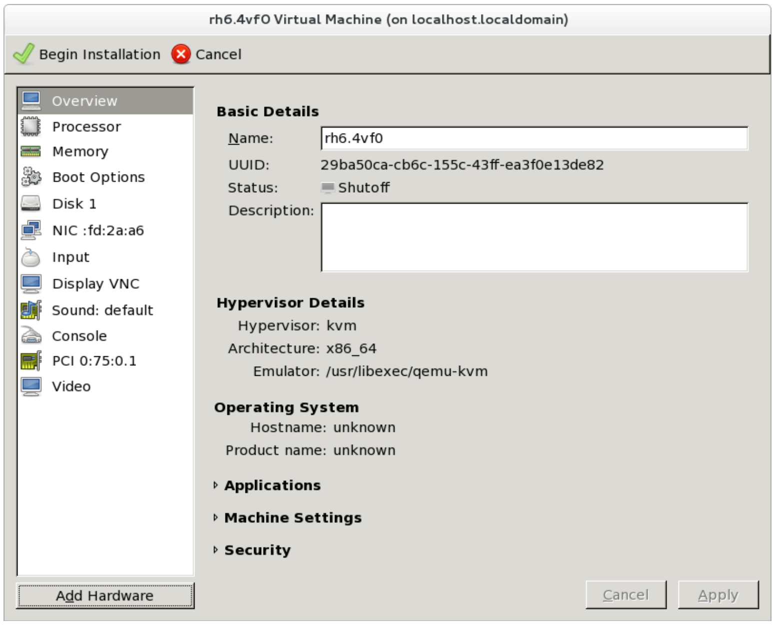
PCI Device

Please indicate what physical device
to connect to the virtual machine.

Host Device:

```
4B:00:0 Interface eth3 (MT27500 Family [ConnectX-3])
4B:00:1 MT27500 Family [ConnectX-3 Virtual Function]
4B:00:2 MT27500 Family [ConnectX-3 Virtual Function]
4B:00:3 MT27500 Family [ConnectX-3 Virtual Function]
4B:00:4 MT27500 Family [ConnectX-3 Virtual Function]
4B:00:5 MT27500 Family [ConnectX-3 Virtual Function]
4B:00:6 MT27500 Family [ConnectX-3 Virtual Function]
4B:00:7 MT27500 Family [ConnectX-3 Virtual Function]
4B:01:0 MT27500 Family [ConnectX-3 Virtual Function]
4B:01:1 MT27500 Family [ConnectX-3 Virtual Function]
```

The Begin Installation (note that PCI function number in list DOES NOT match) PCI function number selected.



rh6.4vf0 Virtual Machine (on localhost.localdomain)

Basic Details

Name: rh6.4vf0
UUID: 29ba50ca-cb6c-155c-43ff-ea3f0e13de82
Status: Shutoff
Description:

Hypervisor Details

Hypervisor: kvm
Architecture: x86_64
Emulator: /usr/libexec/qemu-kvm

Operating System

Hostname: unknown
Product name: unknown

RHEL OS load on virtualized Guest

Hint: Avoid using LVM disk partitioning on Virtualized Guest OS. LVM disks are difficult to customize/duplicate after creation.

Basic functionality of a virtualized RHEL machine requires the “Basic Server Install” plus the following packages:

Base System: Compatibility Libraries
Base System: Legacy UNIX compatibility
Server: Network Infrastructure Server
Development: Development tools
Development : Additional Development + tcl-devel + tk-devel

After the Virtual Machine is created, copy the Mellanox Update Express payload to the server. Then execute the payload using the following command:

```
[root@localhost ~]./mlnx_fw_nic_2.0.3.0.0.4_rhel6_x86-64.bin -s –guest
```

Load the driver after the installation with following command

```
[root@localhost ~]service openibd restart
```

Confirm virtualized adapter ports are available with the following commands

```
[root@localhost ~]ibdev2netdev
```

and

```
[root@localhost ~]ip address show
```

SLES OS load on virtualized Guest

Hint: Avoid using LVM disk partitioning on Virtualized Guest OS. LVM disks are difficult to customize/duplicate after creation.

Basic functionality of a virtualized SLES machine requires the “Basic Server Install” plus the following options/packages:

Physical Machine
C/C++ Development Tools

After the Virtual Machine is created, copy the Mellanox Update Express payload to the server. Then execute the payload using the following command:

```
[root@localhost ~]./mlnx_fw_nic_2.0.3.0.0.4_sles11_x86-64.bin -s –guest
```

Load the driver after the installation with following command

```
 [root@localhost ~]service openibd restart
```

Confirm virtualized adapter ports are available with the following commands

```
[root@localhost ~]ibdev2netdev
```

and

```
[root@localhost ~]ip address show
```