NVIDIA BlueField Virtio-net v24.07

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About This Document

This document describes NVIDIA® BlueField® virtio-net PCIe devices.

Audience

This manual is intended for system administrators and developers.

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Glossary

Term	Description
AARFS	Accelerated receive flow steering
CLI	Command line interface
BFB	BlueField bootstream
DMA	Direct memory access
RDMA	Remote direct memory access

Term	Description
DPA	Data path accelerator
ETH	Ethernet
FW	Firmware
I/O	Input/output
IB	InfiniBand
OS	Operating system
PF	Physical function
RPC	Remote procedure call
SF	Scalable function
VF	Virtual function

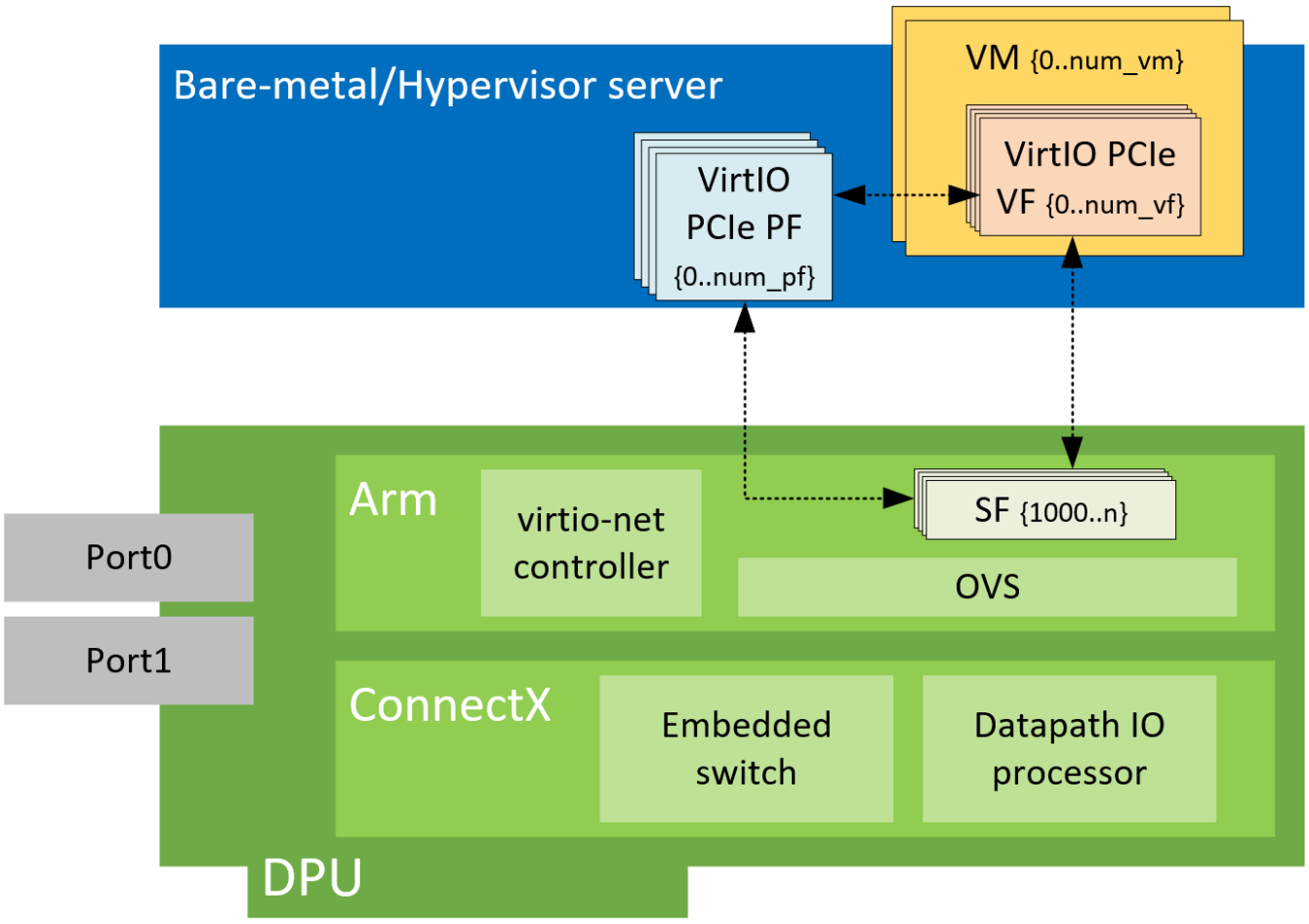
Related Documents

Title	Description
NVIDIA DOCA	NVIDIA DOCA™ SDK enables developers to rapidly create applications and services on top of NVIDIA® BlueField® networking platform, leveraging industry-standard APIs
NVIDIA BlueField DPU BSP	This guide provides product release notes as well as information on the BSP and how to develop and/or customize applications, system software, and file system images for the BlueField platform
NVIDIA BlueField BMC Software	This guide provides general information concerning the BMC on the NVIDIA® BlueField® DPUs and is intended for those who want to familiarize themselves with the functionality provided by the BMC
NVIDIA BlueField-3 SNAP for NVMe and Virtio-blk	This document describes the configuration parameters of NVIDIA® BlueField®-3 SNAP and virtio-blk SNAP in detail
BlueField DPU Hardware User Manual	This document provides details as to the interfaces of the BlueField DPU, specifications, required software and firmware for operating the device, and a step-by-step plan for bringing the DPU up

Introduction

NVIDIA® BlueField® virtio-net enables users to create virtio-net PCIe devices in the system where the BlueField is connected. In a traditional virtualization environment, virtio-net devices can be emulated by QEMU from the hypervisor, or offloading part of the work (e.g., dataplane) to the NIC (e.g., vDPA). Compared to those solutions, virtio-net PCIe devices offload both data and control plane to the BlueField networking device. The PCIe virtio-net devices exposed to the hypervisor do not depend on QEMU or other software emulators/vendor drivers from the guest OS.

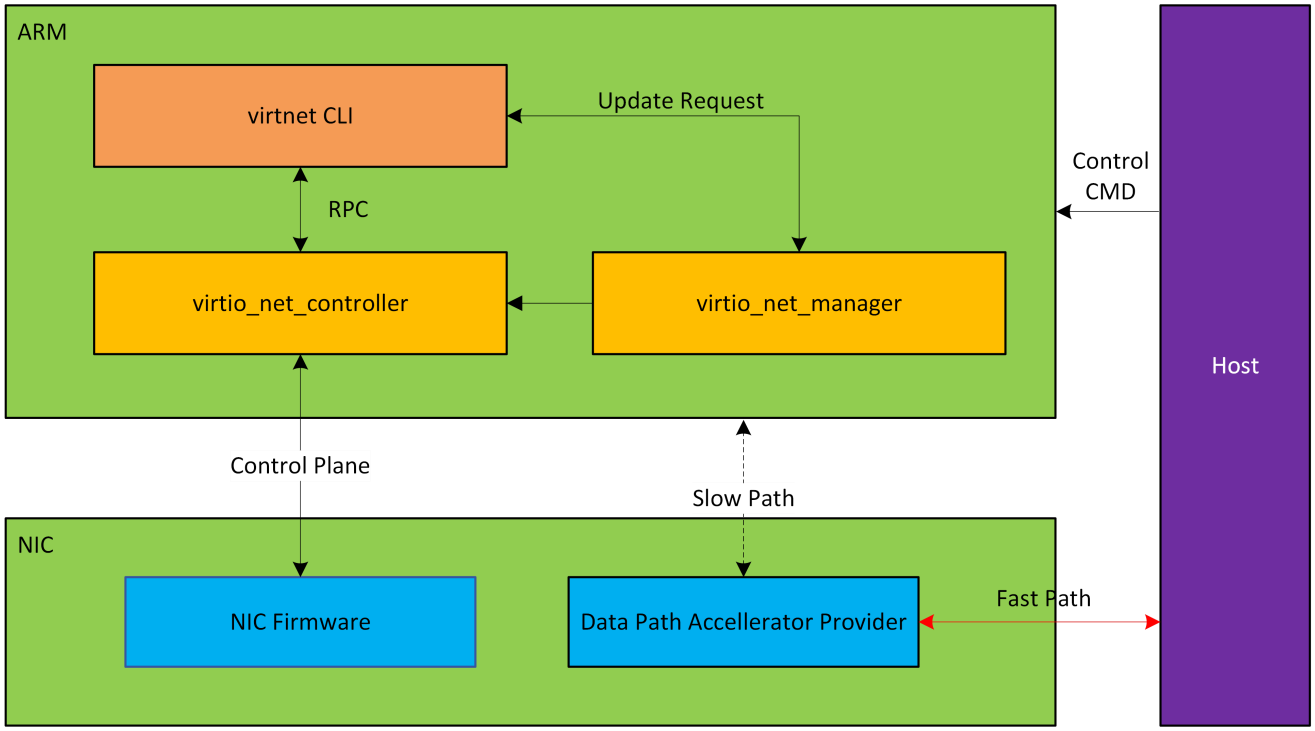
The solution is based on BlueField family technology on top of Virtual Switch and OVS, so that virtio-net devices can benefit from the full SDN and hardware offload methodologies.



Virtio-net Controller SystemD Service

Virtio-net-controller is a systemd service which runs the BlueField with a Command Line Interface (CLI) frontend to communicate with the service running in the background. The controller systemd service is enabled by default and runs automatically after certain firmware configurations are deployed. Please refer to "Virtio-net Deployment" for more information.

A separate process called virtio_net_manager is created to manage the Live Update process which does not interact with other virtnet CLI commands.



Release Notes

The release note pages provide information for NVIDIA® BlueField® virtio-net software such as changes and new features, software known issues, and bug fixes.

Changes and New Features

Changes and New Features in v24.07

- Added new command to query packet stats
- Added auto-AARFS (a ccelerated receive flow steering) support to PFs
- Increased BlueField-3 max number of queues from 64 to 256
- Added a new dedicated mlxconfig entry for VF number of msix, VIRTIO_NET_EMULATION_NUM_VF_MSIX
- Virtnet CLI changes in this release

CLI Command	Entry in v1.9	Entry in v24.07
Virtnet hotplug	--max_queues	--num_queues
Virtnet list	max_queues	num_queues
Virtnet list	bdf	pci_bdf
Virtnet list/query	net_mac	mac

CLI Command	Entry in v1.9	Entry in v24.07
Virtnet list/query	net_link_status	link_status
Virtnet list/query	net_max_queue_pairs	max_queue_pairs
Virtnet list/query	net_mtu	mtu

Bug Fixes in This Version

Ref #	Issue Description
3936435	Description: After changing uplink MTU to more than 1500, errors are printed from the virtio-net-controller side when using the vHost Acceleration Software Stack.
	Keyword: Virtio-net; vhost; live migration
	Reported in version: 1.9.0
3933592	Description: When FLR times out, virtnet commands begin to hang and not return.
	Keyword: FLR; commands
	Reported in version: 1.9.0

Known Issues

The following are known limitations of this NVIDIA® BlueField® virtio-net software version.

Ref #	Issue
3943905	Description: Host OS kernel <3.19 does not support 31 hotplug devices.
	Workaround: Avoid hotplugging more than 20 devices if host OS kernel is <3.19, or upgrade the kernel to ≥3.19.
	Keyword: Host OS; kernel; hotplug

Ref #	Issue
	Reported in version: 24.07
3974893	Description: VLAN traffic does not work in virtio interface because rq_attr.vlan_strip_disable is set to 0 by default, stripping the VLAN tag a packet arrives at the virtio RQ.
	Workaround: N/A
	Keyword: VLAN
	Reported in version: 24.07
4022160	Description: Feature bit VIRTIO_NET_F_CTRL_VLAN is not supported. Enabling it from the hotplug device may results in anomalous behavior.
	Workaround: Disable VIRTIO_NET_F_CTRL_VLAN.
	Keyword: Feature bit
	Reported in version: 24.07
4001261	Description: The virtnet.conf file does not check invalid values such as negative numbers or 0.
	Workaround: N/A
	Keyword: Virtnet; config; invalid value
	Reported in version: 24.07
3965598	Description: Admin-VQ-based transitional VF show a vf_get error when the controller is restarted. However, VF functionality is not affected.
	Workaround: N/A
	Keyword: Admin VQ; transitional device
	Reported in version: 24.07
3961951	Description: Out-of-memory call trace occurs when creating many (>300) VFs on a BlueField running OpenEuler or CentOS 7.6.
	Workaround: Update the kernel to support shared RQ.
	Keyword: OOM; OpenEuler; CentOS 7.6; virtual function
	Reported in version: 24.07

Ref #	Issue
3862683	Description: Creating VFs and hotplug PFs in parallel can lead to controller crash.
	Workaround: Create VFs followed by hotplug PF or vice versa.
	Keyword: Virtio-net emulation
	Reported in version: 1.9.0
3683801	Description: Starting from kernel 5.14, the virtio-net TX path has a logic which may trigger infinite loop when vq is broken (e.g., device is removed) under heavy traffic.
	Workaround: N/A
	Keyword: Virtio-net
	Reported in version: 1.8.0
3714522	Description: When creating/destroying VFs back to back, make sure the virtio-net controller side does not see any alive VF before recreating them from the guest OS (i.e., virtnet query).
	Workaround: N/A
	Keyword: Virtio-net; VFs
	Reported in version: 1.8.0
3694402	Description: When restarting the virtio-net-controller from the DPU while the guest OS is booting, the guest OS may see kernel call trace while the controller is preparing the device. It recovers once the controller starts.
	Workaround: N/A
	Keyword: Virtio-net; hotplug; restart
	Reported in version: 1.8.0
3633453	Description: Jumbo MTU is only supported on a guest OS with kernel 4.11 and above.
	Workaround: N/A
	Keyword: Virtio-net; jumbo MTU
	Reported in version: 1.7.0
302196	Description: When rebooting a DPU with a large number of VFs created on host, VF recovery may fail due to timeout.

Ref #	Issue
7	Workaround: Restart the driver on the host after the DPU is up.
	Keyword: Reboot; VFs
	Reported in version: 1.7.0
3232444	Description: After live migration of virtio-net devices using the VFE driver, the max_queues_size output from the virtnet list may be wrong. This does not affect the actual value.
	Workaround: N/A
	Keywords: Virtio-net; live migration
	Reported in version: 1.4.0
2801780	Description: When running virtio-net-controller with host kernel older than 3.10.0-1160.el7, host virtio driver may get error (Unexpected TXQ (13) queue failure: -28) from dmesg in traffic stress test.
	Workaround: N/A
	Keywords: Virtio-net; error
	Reported in version: 1.2.0
2870213	Description: Servers do not recover after configuring PCI_SWITCH_EMULATION_NUM_PORT to 32 followed by power cycle.
	Workaround: Clear NVRAM and reset mlxconfig to default
	Keywords: VirtIO-net; power cycle
	Reported in version: 1.2.0
2685191	Description: Once Virtio-net is enabled, the mlx5 Windows VF becomes unavailable.
	Workaround: N/A
	Keywords: Virtio-net; virtual function; WinOF-2
	Reported in version: 1.2.0
2702395	Description: When a device is hot-plugged from the virtio-net controller, the host OS may hang when warm reboot is performed on the host and Arm at the same time.

Ref #	Issue
	Workaround: Reboot the host OS first and only then reboot DPU.
	Keywords: Virtio-net controller; hot-plug; reboot
	Reported in version: 1.2.0

Change Log History

Changes and New Features in v1.9.0

- Added support for virtio feature bit VIRTIO_NET_F_HOST_USO
- Added support for virtio feature bit VIRTIO_NET_F_CTRL_GUEST_OFFLOADS
- Added support for virtio feature bit VIRTIO_NET_F_GUEST_ANNOUNCE
- Added support for virtio feature bit VIRTIO_F_MRG_RX_BUFFER; must enable from config file
- Added support for packed VQ at beta level; must enable from config file

Virtio-net Deployment

Updating OS Image on BlueField

To install the BFB bundle on the NVIDIA® BlueField®, run the following command from the Linux hypervisor:

```
[host]# sudo bfb-install --rshim <rshimN> --bfb <image_path.bfb>
```

For more information, refer to section "Deploying BlueField Software Using BFB from Host" in the *NVIDIA BlueField DPU BSP* documentation.

Updating NIC Firmware

From the BlueField networking platform, run:

```
[dpu]# sudo /opt/mellanox/mlnx-fw-updater/mlnx_fw_updater.pl --force-fw-update
```

For more information, refer to section "Upgrading Firmware" in the *NVIDIA DOCA Installation Guide for Linux*.

Configuring NIC Firmware

As default, DPU should be configured in DPU mode. A simple way to confirm DPU is running at DPU mode is to log into the BlueField Arm system and check if `p0` and `pf0hpf` both exists by running command below.

```
[dpu]# ip link show
```

Virtio-net full emulation only works in DPU mode. For more information about DPU mode configuration, please refer to page "Mode of Operation" in the *NVIDIA BlueField DPU BSP* documentation.

Before enabling the virtio-net service, configure firmware via mlxconfig tool is required. There are examples on typical configurations, the table listed relevant mlxconfig entry descriptions.

> **Note**
>
> For mlxconfig configuration changes to take effect, perform a BlueField system-level reset.

Mlxconfig Entries	Description
VIRTIO_NET_EMULATION_ENABLE	Must be set to TRUE, for virtio-net to be enabled
VIRTIO_NET_EMULATION_NUM_PF	Total number of PCIe functions (PFs) exposed by the device for virtio-net emulation. Those functions are persistent along with host/BlueField power cycle.
VIRTIO_NET_EMULATION_NUM_VF	The max number of virtual functions (VFs) that can be supported for each virtio-net PF
VIRTIO_NET_EMULATION_NUM_MSIX	Number of MSI-X vectors assigned for each PF of the virtio-net emulation device, minimal is 4.
VIRTIO_NET_EMULATION_NUM_VF_MSIX	Number of MSI-X vectors assigned for each VF of the virtio-net emulation device, minimal is 4. Relevant for BlueField-3 devices only.

Mlxconfig Entries	Description
PCI_SWITCH_EMULATION_ENABLE	When TRUE, the device exposes a PCIe switch. All PF configurations are applied on the switch downstream ports. In such case, each PF gets a different PCIe device on the emulated switch. This configuration allows exposing extra network PFs toward the host which can be enabled for virtio-net hot-plug devices.
PCI_SWITCH_EMULATION_NUM_PORT	The maximum number of emulated switch ports. Each port can hold a single PCIe device (emulated or not). This determines the supported maximum number of hot-plug virtio-net devices. The maximum number depends on hypervisor PCIe resource, and cannot exceed 31. **Note** Check system PCIe resource. Changing this entry to a big number may results in the host not booting up, which would necessitate disabling the BlueField device and clearing the host NVRAM.
PER_PF_NUM_SF	When TRUE, the SFs configuration is defined by TOTAL_SF and SF_BAR_SIZE for each PF individually. If they are not defined for a PF, device defaults are used.
PF_TOTAL_SF	The total number of scalable function (SF) partitions that can be supported for the current PF. Valid only when PER_PF_NUM_SF is set to TRUE. This number should be greater than the total number of virtio-net PFs (both static and hotplug) and VFs. **Note** This entry differs between the BlueField and host side mlxconfig. It is also a system wide value, which is shared by virtio-net and other users. The DPU normally creates 1 SF

Mlxconfig Entries	Description
	as default per port. Consider this default SF into account when reserving the PF_TOTAL_SF.
PF_SF_BAR_SIZE	Log (base 2) of the BAR size of a single SF, given in KB. Valid only when PF_TOTAL_SF is non-zero and PER_PF_NUM_SF is set to TRUE.
PF_BAR2_ENABLE	When TRUE, BAR2 is exposed on all external host PFs (but not on the embedded Arm PFs/ECPFs). The BAR2 size is defined by the log_pf_bar2_size.
SRIOV_EN	Enable single-root I/O virtualization (SR-IOV) for virtio-net and native PFs
EXP_ROM_VIRTIO_NET_PXE_ENABLE	Enable expansion ROM option for PXE for virtio-net functions **Note** All virtio EXP_ROM options should be configured from host side other than the BlueField platform's side, only static PF is supported.
EXP_ROM_VIRTIO_NET_UEFI_ARM_ENABLE	Enable expansion ROM option for UEFI for Arm based host for virtio-net functions
EXP_ROM_VIRTIO_NET_UEFI_x86_ENABLE	Enable expansion ROM option for UEFI for x86 based host for virtio-net functions

The maximum number of supported devices is listed below. It does not apply when there are hot-plug and VF created at the same time.

Static PF	Hot-plug PF	VF
31	31	1008

Static PF

Static PF is defined as virtio-net PFs which are persistent even after DPU or host power cycle. It also supports creating SR-IOV VFs.

The following is an example for enabling the system with 4 static PFs (VIRTIO_NET_EMULATION_NUM_PF) only:

> **Info**
>
> 10 SFs (PF_TOTAL_SF) are reserved to take into account other application using the SFs.

```
[dpu]# mlxconfig -d 03:00.0 s \
VIRTIO_NET_EMULATION_ENABLE=1 \
VIRTIO_NET_EMULATION_NUM_PF=4 \
VIRTIO_NET_EMULATION_NUM_VF=0 \
VIRTIO_NET_EMULATION_NUM_MSIX=64 \
PCI_SWITCH_EMULATION_ENABLE=0 \
PCI_SWITCH_EMULATION_NUM_PORT=0 \
PER_PF_NUM_SF=1 \
PF_TOTAL_SF=64 \
PF_BAR2_ENABLE=0 \
PF_SF_BAR_SIZE=8 \
SRIOV_EN=0
```

Hotplug PF

Hotplug PF is defined as virtio-net PFs which can be hotplugged or unplugged dynamically after the system comes up.

Note

Hotplug PF does not support creating SR-IOV VFs.

The following is an example for enabling 16 hotplug PFs (PCI_SWITCH_EMULATION_NUM_PORT):

```
[dpu]# mlxconfig -d 03:00.0 s \
VIRTIO_NET_EMULATION_ENABLE=1 \
VIRTIO_NET_EMULATION_NUM_PF=0 \
VIRTIO_NET_EMULATION_NUM_VF=0 \
VIRTIO_NET_EMULATION_NUM_MSIX=64 \
PCI_SWITCH_EMULATION_ENABLE=1 \
PCI_SWITCH_EMULATION_NUM_PORT=16 \
PER_PF_NUM_SF=1 \
PF_TOTAL_SF=64 \
PF_BAR2_ENABLE=0 \
PF_SF_BAR_SIZE=8 \
SRIOV_EN=0
```

SR-IOV VF

SR-IOV VF is defined as virtio-net VFs created on top of PFs. Each VF gets an individual virtio-net PCIe devices.

Note

VFs cannot be dynamically created or destroyed, they can only change from X to 0, or from 0 to X.

Note

VFs will be destroyed when reboot host or unbind PF from virtio-net kernel driver.

The following is an example for enabling 126 VFs per static PF—504 (4 PF x 126) VFs in total:

```
[dpu]# mlxconfig -d 03:00.0 s \
VIRTIO_NET_EMULATION_ENABLE=1 \
VIRTIO_NET_EMULATION_NUM_PF=4 \
VIRTIO_NET_EMULATION_NUM_VF=126 \
VIRTIO_NET_EMULATION_NUM_MSIX=64 \
VIRTIO_NET_EMULATION_NUM_VF_MSIX=64 \
PCI_SWITCH_EMULATION_ENABLE=0 \
PCI_SWITCH_EMULATION_NUM_PORT=0 \
PER_PF_NUM_SF=1 \
PF_TOTAL_SF=512 \
PF_BAR2_ENABLE=0 \
PF_SF_BAR_SIZE=8 \
NUM_VF_MSIX=0 \
SRIOV_EN=1
```

PF/VF Combinations

Creating static/hotplug PFs and VFs at the same time is supported.

The total sum of PCIe functions to the external host must not exceed 256. For example:

- If there are 2 PFs with no VFs (NUM_OF_VFS=0) and there is 1 RShim, then the remaining static functions is 253 (256-3).
- If 1 virtio-net PF is configured (VIRTIO_NET_EMULATION_NUM_PF=1), then up to 252 virtio-net VFs can be configured (VIRTIO_NET_EMULATION_NUM_VF=252)
- If 2 virtio-net PF (VIRTIO_NET_EMULATION_NUM_PF=2), then up to 125 virtio-net VFs can be configured (VIRTIO_NET_EMULATION_NUM_VF=125)

The following is an example for enabling 15 hotplug PFs, 2 static PFs, and 200 VFs (2 PFs x 100):

```
[dpu]# mlxconfig -d 03:00.0 s \
VIRTIO_NET_EMULATION_ENABLE=1 \
VIRTIO_NET_EMULATION_NUM_PF=2 \
VIRTIO_NET_EMULATION_NUM_VF=100 \
VIRTIO_NET_EMULATION_NUM_MSIX=10 \
VIRTIO_NET_EMULATION_NUM_VF_MSIX=64 \
PCI_SWITCH_EMULATION_ENABLE=1 \
PCI_SWITCH_EMULATION_NUM_PORT=15 \
PER_PF_NUM_SF=1 \
PF_TOTAL_SF=256 \
PF_BAR2_ENABLE=0 \
PF_SF_BAR_SIZE=8 \
NUM_VF_MSIX=0 \
SRIOV_EN=1
```

Note

In hotplug virtio-net PFs and virtio-net SR-IOV VFs setups, only up to 15 hotplug devices are supported.

System Configuration

Host System Configuration

For hotplug device configuration, it is recommended to modify the hypervisor OS kernel boot parameters and add the options below:

```
pci=realloc
```

For SR-IOV configuration, first enable SR-IOV from the host.

Info

Refer to MLNX_OFED documentation under Features Overview and Configuration > Virtualization > Single Root IO Virtualization (SR-IOV) > Setting Up SR-IOV for instructions on how to do that.

Make sure to add the following options to Linux boot parameter.

```
intel_iommu=on iommu=pt
```

Note

Add pci=assign-busses to the boot command line when creating more than 127 VFs. Without this option, the following errors may trigger from the host and the virtio driver would not probe those devices.

```
pci 0000:84:00.0: [1af4:1041] type 7f class 0xffffff
pci 0000:84:00.0: unknown header type 7f, ignoring device
```

Note

Because the controller from the BlueField side provides hardware resources and acknowledges (ACKs) the request from the host's virtio-net driver, it is mandatory to reboot the host OS first and the BlueField afterwards. This also applies to reconfiguring a controller

from the BlueField platform (e.g., reconfiguring LAG). Unloading the virtio-net driver from host OS side is recommended.

BlueField System Configuration

Virtio-net full emulation is based on ASAP^2. For each virtio-net device created from host side, there is an SF representor created to represent the device from the BlueField side. It is necessary to have the SF representor in the same OVS bridge of the uplink representor.

The SF representor name is designed in a fixed pattern to map different type of devices.

	Static PF	Hotplug PF	SR-IOV VF
SF Range	1000-1999	2000-2999	3000 and above

For example, the first static PF gets the SF representor of en3f0pf0sf1000 and the second hotplug PF gets the SF representor of en3f0pf0sf2001. It is recommended to verify the name of the SF representor from the sf_rep_net_device field in the output of virtnet list.

```
[dpu]# virtnet list
{
  ...
  "devices": [
    {
      "pf_id": 0,
      "function_type": "static PF",
      "transitional": 0,
      "vuid": "MT2151X03152VNETS0D0F2",
      "pci_bdf": "14:00.2",
      "pci_vhca_id": "0x2",
      "pci_max_vfs": "0",
      "enabled_vfs": "0",
      "msix_num_pool_size": 0,
      "min_msix_num": 0,
      "max_msix_num": 32,
      "min_num_of_qp": 0,
      "max_num_of_qp": 15,
```

```
    "qp_pool_size": 0,
    "num_msix": "64",
    "num_queues": "8",
    "enabled_queues": "7",
    "max_queue_size": "256",
    "msix_config_vector": "0x0",
    "mac": "D6:67:E7:09:47:D5",
    "link_status": "1",
    "max_queue_pairs": "3",
    "mtu": "1500",
    "speed": "25000",
    "rss_max_key_size": "0",
    "supported_hash_types": "0x0",
    "ctrl_mac": "D6:67:E7:09:47:D5",
    "ctrl_mq": "3",
    "sf_num": 1000,
    "sf_parent_device": "mlx5_0",
    "sf_parent_device_pci_addr": "0000:03:00.0",
    "sf_rep_net_device": "en3f0pf0sf1000",
    "sf_rep_net_ifindex": 15,
    "sf_rdma_device": "mlx5_4",
    "sf_cross_mkey": "0x18A42",
    "sf_vhca_id": "0x8C",
    "sf_rqt_num": "0x0",
    "aarfs": "disabled"
  }
 ]
}
```

Once SF representor name is located, add it to the same OVS bridge of the corresponding uplink representor and make sure the SF representor is up:

```
[dpu]# ovs-vsctl show
f2c431e5-f8df-4f37-95ce-aa0c7da738e0
   Bridge ovsbr1
      Port ovsbr1
         Interface ovsbr1
            type: internal
      Port en3f0pf0sf0
         Interface en3f0pf0sf0
      Port p0
```

```
        Interface p0
[dpu]# ovs-vsctl add-port ovsbr1 en3f0pf0sf1000
[dpu]# ovs-vsctl show
f2c431e5-f8df-4f37-95ce-aa0c7da738e0
   Bridge ovsbr1
      Port ovsbr1
         Interface ovsbr1
            type: internal
      Port en3f0pf0sf0
         Interface en3f0pf0sf0
      Port en3f0pf0sf1000
         Interface en3f0pf0sf1000
      Port p0
         Interface p0
[dpu]# ip link set dev en3f0pf0sf1000 up
```

Usage

After firmware/system configuration and after system power cycle, the virtio-net devices should be ready to deploy.

First, make sure that mlxconfig options take effect correctly by issuing the following command:

> **Info**
>
> The output has a list with 3 columns: default configuration, current configuration, and next-boot configuration. Verify that the values under the 2nd column match the expected configuration.

```
[dpu]# mlxconfig -d 03:00.0 -e q | grep -i \*
*       PER_PF_NUM_SF                       False(0)        True(1)         True(1)
*       NUM_OF_VFS                          16              0               0
*       PF_BAR2_ENABLE                      True(1)         False(0)        False(0)
*       PCI_SWITCH_EMULATION_NUM_PORT       0               8               8
```

```
*       PCI_SWITCH_EMULATION_ENABLE             False(0)        True(1)         True(1)
*       VIRTIO_NET_EMULATION_ENABLE             False(0)        True(1)         True(1)
*       VIRTIO_NET_EMULATION_NUM_VF             0               126             126
*       VIRTIO_NET_EMULATION_NUM_PF             0               1               1
*       VIRTIO_NET_EMULATION_NUM_MSIX           2               64              64
*       VIRTIO_NET_EMULATION_NUM_VF_MSIX        0               64              64
*       PF_TOTAL_SF                             0               508             508
*       PF_SF_BAR_SIZE                          0               8               8
```

If the system is configured correctly, virtio-net-controller service should be up and running. If the service does not appear as active, double check the firmware/system configurations above.

```
[dpu]# systemctl status virtio-net-controller.service
  virtio-net-controller.service - Nvidia VirtIO Net Controller Daemon
  Loaded: loaded (/etc/systemd/system/virtio-net-controller.service; enabled; vendor preset: disabled)
  Active: active (running)
    Docs: file:/opt/mellanox/mlnx_virtnet/README.md
Main PID: 30715 (virtio_net_mana)
   Tasks: 55
  Memory: 11.7M
  CGroup: /system.slice/virtio-net-controller.service
          30715 /usr/sbin/virtio_net_manager
          30859 virtio_net_controller
```

To reload or restart the service, run:

```
[dpu]# systemctl restart virtio-net-controller.service
```

Hotplug PF Devices

Creating PF Devices

1. To create a hotplug virtio-net device, run:

```
[dpu]# virtnet hotplug -i mlx5_0 -f 0x0 -m 0C:C4:7A:FF:22:93 -t 1500 -n 3 -s 1024
```

> **Info**
>
> Refer to "Virtnet CLI Commands" for full usage.

This command creates one hotplug virtio-net device with MAC address 0C:C4:7A:FF:22:93, MTU 1500, and 3 virtio queues with a depth of 1024 entries. The device is created on the physical port of mlx5_0. The device is uniquely identified by its index. This index is used to query and update device attributes. If the device is created successfully, an output similar to the following appears:

```
{
  "bdf": "15:00.0",
  "vuid": "MT2151X03152VNETS1D0F0",
  "id": 0,
  "transitional": 0,
  "sf_rep_net_device": "en3f0pf0sf2000",
  "mac": "0C:C4:7A:FF:22:93",
  "errno": 0,
  "errstr": "Success"
}
```

2. Add the representor port of the device to the OVS bridge and bring it up. Run:

```
[dpu]# ovs-vsctl add-port <bridge> en3f0pf0sf2000
[dpu]# ip link set dev en3f0pf0sf2000 up
```

Once steps 1-2 are completed, the virtio-net PCIe device should be available from hypervisor OS with the same PCIe BDF.

```
[host]# lspci | grep -i virtio
15:00.0 Ethernet controller: Red Hat, Inc. Virtio network device (rev 01)
```

3. Probe virtio-net driver (e.g., kernel driver):

```
[host]# modprobe -v virtio-pci && modprobe -v virtio-net
```

4. The virtio-net device should be created. There are two ways to locate the net device:
    - Check the dmesg from the host side for the corresponding PCIe BDF:

```
[host]# dmesg | tail -20 | grep 15:00.0 -A 10 | grep virtio_net
[3908051.494493] virtio_net virtio2 ens2f0: renamed from eth0
```

    - Check all net devices and find the corresponding MAC address:

```
[host]# ip link show | grep -i "0c:c4:7a:ff:22:93" -B 1
31: ens2f0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP
mode DEFAULT group default qlen 1000
    link/ether 0c:c4:7a:ff:22:93 brd ff:ff:ff:ff:ff:ff
```

5. Check that the probed driver and its BDF match the output of the hotplug device:

```
[host]# ethtool -i ens2f0
driver: virtio_net
version: 1.0.0
firmware-version:
expansion-rom-version:
bus-info: 0000:15:00.0
supports-statistics: yes
supports-test: no
supports-eeprom-access: no
supports-register-dump: no
```

```
supports-priv-flags: no
```

Now the hotplug virtio-net device is ready to use as a common network device.

Destroying PF Devices

To hot-unplug a virtio-net device, run:

```
[dpu]# virtnet unplug -p 0
{'id': '0x1'}
{
  "errno": 0,
  "errstr": "Success"
}
```

The hotplug device and its representor are destroyed.

SR-IOV VF Devices

Creating SR-IOV VF Devices

After configuring the firmware and BlueField/host system with correct configuration, users can create SR-IOV VFs.

The following procedure provides an example of creating one VF on top of one static PF:

1. Locate the virtio-net PFs exposed to the host side:

```
[host]# lspci | grep -i virtio
14:00.2 Network controller: Red Hat, Inc. Virtio network device
```

2. Verify that the PCIe BDF matches the backend device from the BlueField side:

```
[dpu]# virtnet list
{
  ...
   "devices": [
    {
      "pf_id": 0,
      "function_type": "static PF",
      "transitional": 0,
      "vuid": "MT2151X03152VNETS0D0F2",
      "pci_bdf": "14:00.2",
      "pci_vhca_id": "0x2",
      "pci_max_vfs": "0",
      "enabled_vfs": "0",
      "msix_num_pool_size": 0,
      "min_msix_num": 0,
      "max_msix_num": 32,
      "min_num_of_qp": 0,
      "max_num_of_qp": 15,
      "qp_pool_size": 0,
      "num_msix": "64",
      "num_queues": "8",
      "enabled_queues": "7",
      "max_queue_size": "256",
      "msix_config_vector": "0x0",
      "mac": "D6:67:E7:09:47:D5",
      "link_status": "1",
      "max_queue_pairs": "3",
      "mtu": "1500",
      "speed": "25000",
      "rss_max_key_size": "0",
      "supported_hash_types": "0x0",
      "ctrl_mac": "D6:67:E7:09:47:D5",
      "ctrl_mq": "3",
      "sf_num": 1000,
      "sf_parent_device": "mlx5_0",
      "sf_parent_device_pci_addr": "0000:03:00.0",
      "sf_rep_net_device": "en3f0pf0sf1000",
      "sf_rep_net_ifindex": 15,
      "sf_rdma_device": "mlx5_4",
      "sf_cross_mkey": "0x18A42",
      "sf_vhca_id": "0x8C",
```

```
    "sf_rqt_num": "0x0",
    "aarfs": "disabled"
  }
 ]
}
```

3. Probe virtio_pci and virtio_net modules from the host:

```
[host]# modprobe -v virtio-pci && modprobe -v virtio-net
```

The PF net device should be created.

```
[host]# ip link show | grep -i "4A:82:E3:2E:96:AB" -B 1
21: ens2f2: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP mode
DEFAULT group default qlen 1000
    link/ether 4a:82:e3:2e:96:ab brd ff:ff:ff:ff:ff:ff
```

The MAC address and PCIe BDF should match between the BlueField side (virtnet list) and host side (ethtool).

```
[host]# ethtool -i ens2f2
driver: virtio_net
version: 1.0.0
firmware-version:
expansion-rom-version:
bus-info: 0000:14:00.2
supports-statistics: yes
supports-test: no
supports-eeprom-access: no
supports-register-dump: no
supports-priv-flags: no
```

4. To create SR-IOV VF devices on the host, run the following command with the PF PCIe BDF (0000:14:00.2 in this example):

```
[host]# echo 1 > /sys/bus/pci/drivers/virtio-pci/0000\:14\:00.2/sriov_numvfs
```

1 extra virtio-net device is created from the host:

```
[host]# lspci | grep -i virtio
14:00.2 Ethernet controller: Red Hat, Inc. Virtio network device (rev 01)
14:00.4 Ethernet controller: Red Hat, Inc. Virtio network device (rev 01)
```

The BlueField side shows the VF information from virtnet list as well:

```
[dpu]# virtnet list
  ...
  {
    "vf_id": 0,
    "parent_pf_id": 0,
    "function_type": "VF",
    "transitional": 0,
    "vuid": "MT2151X03152VNETS0D0F2VF1",
    "pci_bdf": "14:00.4",
    "pci_vhca_id": "0xD",
    "pci_max_vfs": "0",
    "enabled_vfs": "0",
    "num_msix": "12",
    "num_queues": "8",
    "enabled_queues": "7",
    "max_queue_size": "256",
    "msix_config_vector": "0x0",
    "mac": "16:FF:A2:6E:6D:A9",
    "link_status": "1",
    "max_queue_pairs": "3",
    "mtu": "1500",
    "speed": "25000",
    "rss_max_key_size": "0",
    "supported_hash_types": "0x0",
    "ctrl_mac": "16:FF:A2:6E:6D:A9",
    "ctrl_mq": "3",
    "sf_num": 3000,
    "sf_parent_device": "mlx5_0",
```

```
 "sf_parent_device_pci_addr": "0000:03:00.0",
 "sf_rep_net_device": "en3f0pf0sf3000",
 "sf_rep_net_ifindex": 18,
 "sf_rdma_device": "mlx5_5",
 "sf_cross_mkey": "0x58A42",
 "sf_vhca_id": "0x8D",
 "sf_rqt_num": "0x0",
 "aarfs": "disabled"
}
```

5. Add the corresponding SF representor to the OVS bridge as the virtio-net PF and bring it up. Run:

```
[dpu]# ovs-vsctl add-port <bridge> en3f0pf0sf3000
[dpu]# ip link set dev en3f0pf0sf3000 up
```

Now the VF is functional.

Note

00000191-539a-d31e-adf1-53bf61dc0000 00000191-539a-d31e-adf1-53bf61dc0001

```
[host]# echo 0 > /sys/bus/pci/drivers/virtio-pci/<virtio_pf_bdf>/sriov_drivers_autoprobe
[host]# echo <num_vfs> > /sys/bus/pci/drivers/virtio-pci/<virtio_pf_bdf>/sriov_numvfs
```

Users can pass through the VFs directly to the VM after finishing. If using the VFs inside the hypervisor OS is required, bind the VF PCIe BDF:

```
[host]# echo <virtio_vf_bdf> > /sys/bus/pci/drivers/virtio-pci/bind
```

Keep in mind to reenable the autoprobe for other use cases:

```
[host]# echo 1 > /sys/bus/pci/drivers/virtio-pci/<virtio_pf_bdf>/sriov_drivers_autoprobe
```

Warning

Creating VFs for the same PF on different threads may cause the hypervisor OS to hang.

Destroying SR-IOV VF Devices

To destroy SR-IOV VF devices on the host, run:

```
[host]# echo 0 > /sys/bus/pci/drivers/virtio-pci/<virtio_pf_bdf>/sriov_numvfs
```

Note

When the echo command returns from the host OS, it does not necessarily mean the BlueField side has finished its operations. To verify that the BlueField is done and it is safe to recreate the VFs, either:

- Check controller log from the BlueField and make sure you see a log entry similar to the following:

```
[dpu]# journalctl -u virtio-net-controller.service -n 3 -f
```

```
virtio-net-controller[5602]: [INFO]
virtnet.c:675:virtnet_device_vfs_unload: static PF[0], Unload (1) VFs
finished
```

- Query the last VF from the BlueField side:

```
[dpu]# virtnet query -p 0 -v 0 -b
{'all': '0x0', 'vf': '0x0', 'pf': '0x0', 'dbg_stats': '0x0', 'brief': '0x1',
'latency_stats': '0x0', 'stats_clear': '0x0'}
{
  "Error": "Device doesn't exist"
}
```

Note

Once VFs are destroyed, SFs created for virtio-net from the BlueField side are not destroyed but are saved into the SF pool for reuse later.

Assigning Virtio-net Device to VM

All virtio-net devices (static/hotplug PF and VF) support PCIe passthrough to a VM. PCIe passthrough allows the device to get better performance in the VM.

Assigning a virtio-net device to a VM can be done via virt-manager or virsh command.

Locating Virtio-net Devices

All virtio-net devices can be scanned by the PCIe subsystem in hypervisor OS and displayed as a standard PCIe device. Run the following command to locate the virtio-net devices devices with its PCIe BDF.

```
[host]# lspci | grep 'Virtio network'
00:09.1 Ethernet controller: Red Hat, Inc. Virtio network device (rev 01)
```

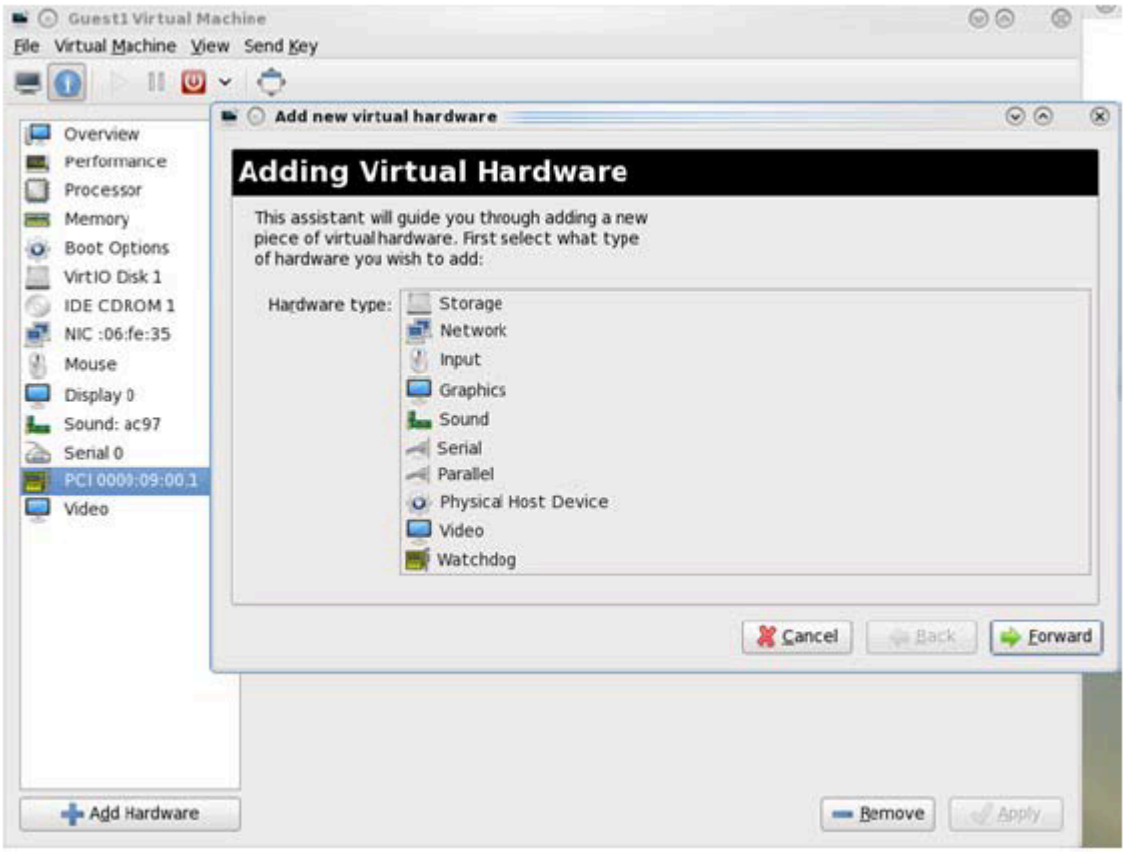
Using virt-manager

Start virt-manager, run the following command:

```
[host]# virt-manager
```

> **Note**
>
> Make sure your system has xterm enabled to show the virt-manager GUI.

Double-click the virtual machine and open its Properties. Navigate to Details Add hardware PCIe host device.



Choose a virtio-net device virtual function according to its PCIe device (e.g., 00:09.1), reboot or start the VM.

Using virsh Command

1. Run the following command to get the VM list and select the target VM by Name field:

```
[host]# virsh list --all
 Id   Name                    State
----------------------------------------------------
 1    host-101-CentOS-8.5     running
```

2. Edit the VMs XML file, run:

```
[host]# virsh edit <VM_NAME>
```

3. Assign the target virtio-net device PCIe BDF to the VM, using vfio as driver, replace BUS/SLOT/FUNCTION/BUS_IN_VM/SLOT_IN_VM/FUNCTION_IN_VM with corresponding settings.

```
<hostdev mode='subsystem' type='pci' managed='no'>
 <driver name='vfio'/>
  <source>
   <address domain='0x0000' bus='<#BUS>' slot='<#SLOT>' function='<#FUNCTION>'/>
  </source>
 <address type='pci' domain='0x0000' bus='<#BUS_IN_VM>' slot='<#SLOT_IN_VM>'
function='<#FUNCTION_IN_VM>'/>
</hostdev>
```

   For example, assign target device 00.09.1 to the VM and its PCIe BDF within the VM is 01:00.0:

```
<hostdev mode='subsystem' type='pci' managed='no'>
 <driver name='vfio'/>
  <source>
   <address domain='0x0000' bus='0x00' slot='0x09' function='0x1'/>
  </source>
 <address type='pci' domain='0x0000' bus='0x01' slot='0x00' function='0x0'/>
</hostdev>
```

4. Destroy the VM if it is already started:

```
[host]# virsh destory <VM_NAME>
```

5. Start the VM with new XML configuration:

```
[host]# virsh start <VM_NAME>
```

Configuration File

Configuration File Options

The controller service has an optional JSON format configuration file which allows users to customize several parameters. The configuration file should be defined on the DPU at /opt/mellanox/mlnx_virtnet/virtnet.conf. This file is read every time the controller starts.

> **Note**
>
> Controller systemd service should be restarted when there is configuration file change. Dynamic change of virtnet.conf is not supported.

Parameter	Default Value	Type	Description
ib_dev_p0	mlx5_0	String	RDMA device (e.g., mlx5_0) used to create SF on port 0. This port is the EMU manager when is_lag is 0.
ib_dev_p1	mlx5_1	String	RDMA device (e.g., mlx5_1) used to create SF on port 1
ib_dev_for_static_pf	mlx5_0	String	The RDMA device (e.g., mlx5_0) which the static virtio PF is created on
ib_dev_lag	Null	Strin	RDMA LAG device (e.g., mlx5_bond_0) used to create SF on LAG. Default value is mlx5_bond_0. This port is EMU manager when is_lag is 1. ib_dev_lag

<table>
<tr><th>Parameter</th><th>Default Value</th><th>Type</th><th>Description</th></tr>
<tr><td></td><td></td><td>g</td><td>and ib_dev_p0/ib_dev_p1 cannot be configured simultaneously.</td></tr>
<tr><td>static_pf</td><td>N/A</td><td>List</td><td>The following sub-parameters can be used to configure the static PF:
<table>
<tr><th>Sub-parameter</th><th>Default Value</th><th>Type</th><th>Description</th></tr>
<tr><td>mac_base</td><td>Null</td><td>String</td><td>Base MAC address for static PFs. MACs are automatically assigned with the following pattern: mac_base pf_0, mac_base + 1 pf_1, etc.

Note
Controller does not validate the MAC address (other than its length). The user must ensure the MAC is valid and unique.</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Parameter</th><th>Default Value</th><th>Type</th><th>Description</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Sub-parameter</th><th>Default Value</th><th>Type</th><th>Description</th></tr>
<tr><td>features</td><td>Auto</td><td>Number</td><td>Virtio spec-defined feature bits for static PFs.

Note
If unsure, leave features out of the JSON file and a default value is automatically assigned. The default value is determined dynamically when controller starts. Refer to the "Feature Bits" page for more information.</td></tr>
</table>
</td></tr>
<tr><td>is_lag</td><td>0</td><td>Number</td><td>Specifies whether LAG is used

Note
If LAG is used, make sure to use the correct IB dev for static PF</td></tr>
<tr><td>single_port</td><td>0</td><td>Number</td><td>Specifies whether the DPU is a single port device. It is mutually exclusive with is_lag.</td></tr>
</table>

Parameter	Default Value	Type	Description
recovery	1	Number	Specifies whether recovery is enabled. If unspecified, recovery is enabled by default. To disable it, set recovery to 0. Refer to the "Recovery" page for the items which are recovered and more information.
sf_pool_percent	0	Number	Determines the initial SF pool size as the percentage of PF_TOTAL_SF of mlxconfig. Valid range: [0, 100]. For instance, if the value is 5, an SF pool with 5% of PF_TOTAL_SF is created. 0 indicates that no SF pool is reserved beforehand (default). **Note** PF_TOTAL_SF is shared by all applications. The user must ensure that the percent request is guaranteed, or else the controller would not be able to reserve the requested SFs resulting in failure.
sf_pool_force_destroy	0	Number	Specifies whether to destroy the SF pool. When set to 1, the controller destroys the SF pool when stopped/restarted (and the SF pool is recreated if sf_pool_percent is not 0 when starting). Otherwise, it does not. Default value is 0.
packed_vq	0	Number	Specifies whether packed VQ mode is enabled. If unspecified, packed VQ is disabled by default. To enable, set packed_vq to 1. For VQ types, refer to the "Virt Queue Types" page.
mrg_rxbuf	0	Number	When enabled, the mergeable buffers feature is negotiated with the host driver. This feature allows the guest driver to use multiple RX descriptor chains to receive a single receive packet, hence increase bandwidth.
dpa_core_start	0	Num	Specifies the start DPA core for virtnet application. Valid only for NVIDIA® BlueField®-3 and up. Value must be greater than 0 and less

Parameter	Default Value	Type	Description
		ber	than 11. Together with dpa_core_end, dpa_core_start defines how many DPA cores are used for the virtio-net data plane. **Note** This is advanced options when there are multiple DPA applications running at the same time. Regular user should keep this option as default.
dpa_core_end	10	Number	Specifies the end DPA core for virtnet application. Valid only for BlueField-3 and up. Value must be greater than dpa_core_start and less than 11.
vf	N/A	List	The following sub-parameters can be used to configure the VF:

<table>
<tr><th>Parameter</th><th>Default Value</th><th>Type</th><th>Description</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Sub-parameter</th><th>Default Value</th><th>Type</th><th>Description</th></tr>
<tr><td>mac_base</td><td>Null</td><td>String</td><td>Base MAC address for VFs. MACs are automatically assigned with the following pattern: mac_base vf_0, mac_base + 1 vf_1, etc.

Note
Controller does not validate the MAC address (other than its length). The user must ensure the MAC is valid and unique.</td></tr>
<tr><td>features</td><td>Auto</td><td>Number</td><td>Virtio spec-defined feature bits for VFs.

Note
If unsure, leave features out of the JSON file and a default value is automatically assigned. The default value is determined dynamically when controller starts. Refer to the "Feature Bits" page for more information.</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Parameter</th><th>Default Value</th><th>Type</th><th>Description</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Sub-parameter</th><th>Default Value</th><th>Type</th><th>Description</th></tr>
<tr><td>vfs_per_pf</td><td>0</td><td>Number</td><td>The number of VFs to create on each PF . For example: if vfs_per_pf is 100, then vf_0 on pf_1 will use mac_base + 100 as its MAC.

Note
vfs_per_pf ≤ VIRTIO_NET_EMULATION_NUM_VF in mlxconfig.

Note
User is responsible for ensuring, on each static PF, that the created VFs ≤ vfs_per_pf.

Note
This parameter is mandatory if mac_base is specified.</td></tr>
<tr><td>max_que</td><td>Auto</td><td>Num</td><td>Number of queue pairs to use. If not specified, default queue pair number is inherited from the parent PF.</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Parameter</th><th>Default Value</th><th>Type</th><th>Description</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Sub-parameter</th><th>Default Value</th><th>Type</th><th>Description</th></tr>
<tr><td>ue_pairs</td><td></td><td>ber</td><td></td></tr>
<tr><td>max_queue_size</td><td>Auto</td><td>Number</td><td>Virtqueue size (i.e., vq depth) to use. If not specified, default vq size is inherited from the parent PF.</td></tr>
<tr><td>mtu</td><td>1500</td><td>Number</td><td>Maximum transmission unit for the VF, can be ≤ 9216.</td></tr>
</table>
</td></tr>
</table>

Configuration File Examples

> **Note**
>
> Validate the JSON format of the configuration file before restarting the controller, especially the syntax and symbols. Otherwise, the controller may fail to start.

Configuring LAG on Dual Port BlueField

Refer to the "Link Aggregation" page in *NVIDIA BlueField BSP* documentation for information on configuring BlueField in LAG mode.

Refer to the "Link Aggregation" page for information on configuring virtio-net in LAG mode.

Configuring Static PF on Dual Port BlueField

The following configures all static PFs to use mlx5_0 (port 0) as the data path device in a non-LAG configuration, and the default MAC and features for the PF:

```
{
  "ib_dev_p0": "mlx5_0",
  "ib_dev_p1": "mlx5_1",
  "ib_dev_for_static_pf": "mlx5_0",
  "is_lag": 0,
  "static_pf": {
    "mac_base": "08:11:22:33:44:55",
    "features": "0x230047082b"
  }
}
```

Configuring VF Specific Options

The following configures VFs with default parameters. With this configuration, each PF assigns the MAC based on mac_base up to 126 VFs. Each VF creates 4 queue pairs, with each queue having a depth of 256.

> **Note**
>
> If vfs_per_pf is less than the VIRTIO_NET_EMULATION_NUM_VF in mlxconfig, and more VFs are created, duplicated MACs would be assigned to different VFs.

```
{
  "vf": {
    "mac_base": "06:11:22:33:44:55",
    "features": "0x230047082b",
    "vfs_per_pf": 126,
    "max_queue_pairs": 4,
    "max_queue_size": 256
  }
}
```

Virtnet CLI Commands

User Front End CLI

To communicate with the virtio-net-controller backend service, a user frontend program, virtnet, is installed on the BlueField which is based on r emote procedure call (RPC) protocol with JSON format output. Run the following command to check its usage:

```
# virtnet -h usage: virtnet [-h] [-v]
            {hotplug,unplug,list,query,modify,log,version,validate,update,debug,stats} ...

NVIDIA virtio-net-controller command line interface v24.07.04

positional arguments:
  {hotplug,unplug,list,query,modify,log,version,update,debug}
                        ** Use -h for sub-command usage
    hotplug             hotplug virtnet device
    unplug              unplug virtnet device
    list                list all virtnet devices
    query               query all or individual virtnet device(s)
    modify              modify virtnet device
    log                 set log level
    version             show virtio net controller version info
    validate            validate configurations
    update              update controller
    debug               For debug purpose, cmds can be changed without notice
    stats               stats of virtnet device

optional arguments:
  -h, --help            show this help message and exit
  -v, --version         show program's version number and exit
```

Virtnet supports command line autocomplete by inputting one command with tab.

To check the currently running controller version:

```
# virtnet -v
v24.07.09
```

Hotplug

This command hotplugs a virtio-net PCIe PF device exposed to the host side.

Syntax

```
virtnet hotplug -i IB_DEVICE -m MAC -t MTU -n MAX_QUEUES -s MAX_QUEUE_SIZE [-h] [-u SF_NUM] [-f FEATURES] [-l]
```

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit
--ib_device	-i	String	Yes	RDMA device (e.g., mlx5_0) of the physical port on top of which the hotplug device is created. Options: • mlx5_0 – port 1 • mlx5_1 – port 2 • mlx5_bond_0 – LAG
--features	-f	Hex Number	No	Feature bits to be enabled in hex format. Refer to the "Virtio-net Feature Bits" page. **Note** Note that some features are enabled by default. Query the device to show the supported bits.

Option	Abbr	Argument Type	Required	Description
--mac	-m	Number	Yes	MAC address of the virtio-net device. **Note** Controller does not validate the MAC address (other than its length). The user must ensure MAC is valid and unique.
--mtu	-t	Number	Yes	Maximum transmission unit (MTU) size of the virtio-net device. It must be less than the uplink rep MTU size.
--num_queues	-n	Number	Yes	Mutually exclusive with max_queue_pairs. Max number of virt queues could be created for the virtio-net device. TX, RX, ctrl queues are counted separately (e.g., 3 has 1 TX VQ, 1 RX VQ, 1 Ctrl VQ). **Note** This option will be depreciated in the future.
--max_queue_pairs	-qp	Number	Yes	Mutually exclusive with num_queues . Number of data VQ pairs. One VQ pair has one TX queue and one RX queue. It does not count control or admin VQ. From the host side, it appears as Pre-set maximums->Combined in ethtool -l <virtio-dev>.
--max_queue_size	-s	Number	Yes	Maximum number of buffers in the virt queue, between 0x4 and 0x8000. Must be power of 2.
--sf_num	-u	Number	No	SF number to be used for this hotplug device, must between 2000 and 2999.
--	-l	N/A	No	Create legacy (transitional) hotplug device

Option	Abbr	Argument Type	Required	Description
legacy				

Output

Entry	Type	Description
bdf	String	The PCIe BDF (bus:device:function) number enumerated by host. The user should see this PCIe device from host side.
vuid	String	Unique device SN. It can be used as an index to query/modify/unplug this device.
id	Num	Unique device ID. It can be used as an index to query/modify/unplug this device.
transitional	Num	Is the current device a transitional hotplug device. • 0 – modern device • 1 – transitional device
sf_rep_net_device	String	The SF representor name represents the virtio-net device. It should be added into the OVS bridge.
mac	String	The hotplug virtio-net device MAC address
errno	Num	Error number if hotplug failed. • 0 – success • non-0 – failed
errstr	String	Explanation of the error number

Example

Hotplug one device with MAC address 0C:C4:7A:FF:22:93, MTU 1500, and 3 virtio queues (1 tx, 1 rx, 1 ctrl) with a depth of 1024 entries. The device is created on the physical port of mlx5_0.

```
# virtnet hotplug -i mlx5_0 -f 0x80000 -m 0C:C4:7A:FF:22:93 -t 1500 -n 3 -s 1024
{
  "bdf": "15:00.0",
  "vuid": "MT2151X03152VNETS1D0F0",
  "id": 0,
  "transitional": 0,
  "sf_rep_net_device": "en3f0pf0sf2000",
  "mac": "0C:C4:7A:FF:22:93",
  "errno": 0,
  "errstr": "Success"
}
```

Unplug

This command unplugs a virtio-net PCIe PF device.

Syntax

```
virtnet unplug [-h] [-p PF | -u VUID]
```

Only one of --pf and --vuid is needed to unplug the device.

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit
--pf	-p	Number	Yes	Unique device ID returned when doing hotplug. Can be retrieved by using virtnet list.
--vuid	-u	String	Yes	Unique device SN returned when doing hotplug. Can be retrieved by using virtnet list.

Output

Entry	Type	Description
errno	Num	Error number if operation failed • 0 – success • non-0 – failed
errstr	String	Explanation of the error number

Example

Unplug-hotplug device using the PF ID:

```
# virtnet unplug -p 0
{'id': '0x1'}
{
  "errno": 0,
  "errstr": "Success"
}
```

List

This command lists all existing virtio-net devices, with global information and individual information for each device.

Syntax

```
virtnet list [-h]
```

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit

Output

The output has two main sections. The first section wrapped by the controller are global configurations and capabilities.

Entry	Type	Description
controller	String	Entries under this section is global information for the controller
emulation_manager	String	The RDMA device manager used to manage internal resources. Should be default mlx5_0.
max_hotplug_devices	String	Maximum number of devices that can be hotpluged
max_virt_net_devices	String	Total number of emulated devices managed by the device emulation manager
max_virt_queues	String	Maximum number of virt queues supported per device
max_tunnel_descriptors	String	Maximum number of descriptors the device can send in a single tunnel request
supported_features	String	Total list of features supported by device
supported_virt_queue_types	String	Currently supported virt queue types: Packed and Split
supported_event_modes	String	Currently supported event modes: no_msix_mode, qp_mode, msix_mode

Each device has its own section under devices.

Entry	Type	Description
devices	String	Entries under this section is per device information
pf_id	String	Physical function ID
function_type	String	Function type: Static PF, hotplug PF, VF
transitional	Number	The current device a transitional hotplug device: • 0 – modern device • 1 – transitional device
vuid	String	Unique device SN, it can be used as an index to query/modify/unplug a device
pci_bdf	String	Bus:device:function to describe the virtio-net PCIe device
pci_vhca_id	Number	Virtual HCA identifier for the general virtio-net device. For debug purposes only.
pci_max_vfs	Number	Maximum number of virtio-net VFs that can be created for this PF. Valid only for PFs.
enabled_vfs	Number	Currently enabled number of virtio-net VFs for this PF
msix_num_pool_size	Number	Number of free dynamic MSIX available for the VFs on this PF
min_msix_num	Number	The minimum number of dynamic MSI-Xs that can be set for an virtio-net VF
max_msix_num	Number	The maximum number of dynamic MSI-Xs that can be set for an virtio-net VF

Entry	Type	Description
min_num_of_qp	Number	The minimum number of dynamic data VQ pairs (i.e., each pair has one TX and 1 RX queue) that can be set for an virtio-net VF
max_num_of_qp	Number	The minimum number of dynamic data VQ pairs (i.e., each pair has one TX and 1 RX queue) that can be set for an virtio-net VF
qp_pool_size	Number	Number of free dynamic data VQ pairs (i.e., each pair has one TX and 1 RX queue) available for the VFs on this PF
num_msix	Number	Maximum number of MSI-X available for this device
num_queues	Number	Maximum virtual queues can be created for this device, driver can choose to create less
enabled_queues	Number	Currently enabled number of virtual queues by the driver
max_queues_size	Number	Maximum virtual queue depth in byte can be created for each VQ, driver can use less
msix_config_vector	String	MSIX vector number used by the driver for the virtio config space. 0xFFFF means that no vector is requested.
mac	String	The virtio-net device permanent MAC address, can be only changed from controller side via modify command
link_status	Number	Link status of the virtio-net device on the driver side • 0 – down • 1 – up
max_queue_pairs	Number	Number of data VQ pairs. One VQ pair has one TX queue and one RX queue. Control or admin VQ are not counted. From the host side, it appears as Pre-set maximums->Combined in ethtool -l <virtio-dev>.

Entry	Type	Description
mtu	Number	The virtio-net device MTU. Default is 1500.
speed	Number	The virtio-net device link speed in Mb/s
rss_max_key_size	Number	The maximum supported length of the RSS key. Only applicable when VIRTIO_NET_F_RSS or VIRTIO_NET_F_HASH_REPORT is enabled.
supported_hash_types	Number	Supported hash types for this device in hex. Only applicable when VIRTIO_NET_F_HASH_REPORT is enabled: • VIRTIO_NET_HASH_TYPE_IPv4 (bit 0) • VIRTIO_NET_HASH_TYPE_TCPv4 (bit 1) • VIRTIO_NET_HASH_TYPE_UDPv4 (bit 2) • VIRTIO_NET_HASH_TYPE_IPv6 (bit 3) • VIRTIO_NET_HASH_TYPE_TCPv6 (bit 4) • VIRTIO_NET_HASH_TYPE_UDPv6 (bit 5)
ctrl_mac	String	Admin MAC address configured by driver. Not persistent with driver reload or host reboot.
ctrl_mq	Number	Number of queue pairs/channels configured by the driver. From the host side, it appears as Current hardware settings->Combined in ethtool -l <virtio-dev>.
sf_num	Number	Scalable function number used for this virtio-net device
sf_parent_device	String	The RDMA device to use to create the SF
sf_parent_device_pci_addr	String	The PCIe device address (bus:device:function) to use to create the SF
sf_rep_net	String	Represents the virtio-net device

Entry	Type	Description
_device		
sf_rep_net_ifindex	Number	The SF representor network interface index
sf_rdma_device	String	The SF RDMA device interface name
sf_cross_mkey	Number	The cross-device MKEY created for the SF. For debug purposes only.
sf_vhca_id	Number	Virtual HCA identifier for the SF. For debug purposes only.
rqt_num	Number	The RQ table ID used for this virtio-net device. For debug purposes only.
aarfs	String	Whether Accelerated Receive Flow Steering configuration is enabled or disabled

Example

The following is an example of a list with 1 static PF created:

```
# virtnet list
{
  "controller": {
    "emulation_manager": "mlx5_0",
    "max_hotplug_devices": "0",
    "max_virt_net_devices": "1",
    "max_virt_queues": "256",
    "max_tunnel_descriptors": "6",
    "supported_features": {
      "value": "0x8b00037700ef982f",
      "    0": "VIRTIO_NET_F_CSUM",
```

```
    "    1": "VIRTIO_NET_F_GUEST_CSUM",
    "    2": "VIRTIO_NET_F_CTRL_GUEST_OFFLOADS",
    "    3": "VIRTIO_NET_F_MTU",
    "    5": "VIRTIO_NET_F_MAC",
    "   11": "VIRTIO_NET_F_HOST_TSO4",
    "   12": "VIRTIO_NET_F_HOST_TSO6",
    "   15": "VIRTIO_F_MRG_RX_BUFFER",
    "   16": "VIRTIO_NET_F_STATUS",
    "   17": "VIRTIO_NET_F_CTRL_VQ",
    "   18": "VIRTIO_NET_F_CTRL_RX",
    "   19": "VIRTIO_NET_F_CTRL_VLAN",
    "   21": "VIRTIO_NET_F_GUEST_ANNOUNCE",
    "   22": "VIRTIO_NET_F_MQ",
    "   23": "VIRTIO_NET_F_CTRL_MAC_ADDR",
    "   32": "VIRTIO_F_VERSION_1",
    "   33": "VIRTIO_F_IOMMU_PLATFORM",
    "   34": "VIRTIO_F_RING_PACKED",
    "   36": "VIRTIO_F_ORDER_PLATFORM",
    "   37": "VIRTIO_F_SR_IOV",
    "   38": "VIRTIO_F_NOTIFICATION_DATA",
    "   40": "VIRTIO_F_RING_RESET",
    "   41": "VIRTIO_F_ADMIN_VQ",
    "   56": "VIRTIO_NET_F_HOST_USO",
    "   57": "VIRTIO_NET_F_HASH_REPORT",
    "   59": "VIRTIO_NET_F_GUEST_HDRLEN",
    "   63": "VIRTIO_NET_F_SPEED_DUPLEX"
   },
   "supported_virt_queue_types": {
    "value": "0x1",
    "    0": "SPLIT"
   },
   "supported_event_modes": {
    "value": "0x5",
    "    0": "NO_MSIX_MODE",
    "    2": "MSIX_MODE"
   }
  },
  "devices": [
   {
    "pf_id": 0,
    "function_type": "static PF",
    "transitional": 0,
    "vuid": "MT2306XZ00BNVNETS0D0F2",
    "pci_bdf": "e2:00.2",
```

```
      "pci_vhca_id": "0x2",
      "pci_max_vfs": "0",
      "enabled_vfs": "0",
      "msix_num_pool_size": 0,
      "min_msix_num": 0,
      "max_msix_num": 256,
      "min_num_of_qp": 0,
      "max_num_of_qp": 127,
      "qp_pool_size": 0,
      "num_msix": "256",
      "num_queues": "255",
      "enabled_queues": "0",
      "max_queue_size": "256",
      "msix_config_vector": "0xFFFF",
      "mac": "16:B0:E0:41:B8:0D",
      "link_status": "1",
      "max_queue_pairs": "127",
      "mtu": "1500",
      "speed": "100000",
      "rss_max_key_size": "0",
      "supported_hash_types": "0x0",
      "ctrl_mac": "00:00:00:00:00:00",
      "ctrl_mq": "0",
      "sf_num": 1000,
      "sf_parent_device": "mlx5_0",
      "sf_parent_device_pci_addr": "0000:03:00.0",
      "sf_rep_net_device": "en3f0pf0sf1000",
      "sf_rep_net_ifindex": 10,
      "sf_rdma_device": "mlx5_3",
      "sf_cross_mkey": "0x12642",
      "sf_vhca_id": "0x124",
      "sf_rqt_num": "0x0",
      "aarfs": "disabled"
    }
  ]
}
```


Query

This command queries detailed information for a given device, including all VQ information if created.

Syntax

```
virtnet query [-h] {[-a] | [-p PF] [-v VF] | [-u VUID]} [--dbg_stats] [-b] [--latency_stats] [-q QUEUE_ID] [--stats_clear]
```

Info

The options --pf , --vf , --vuid , and --all are mutually exclusive, but one of them must be applied.

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit
--all	-a	N/A	No	Query all the detailed information for all available devices. It can be time consuming if a large number of devices is available.
--pf	-p	Number	No	Unique device ID for the PF. Can be retrieved by using virtnet list.
--vf	-v	Number	No	Unique device ID for the VF. Can be retrieved by using virtnet list.
--vuid	-u	String	No	Unique device SN for the device (PF/VF). Can be retrieved by using virtnet list.
--queue_id	-q	Number	No	Queue index of the device VQs
--brief	-b	N/A	No	Query brief information of the device (does not print VQ information)
--dbg_stats	N/A	N/A	No	Print debug counters and information

Option	Abbr	Argument Type	Required	Description
				Note This option will be depreciated in the future.
--stats_clear	N/A	N/A	No	Clear all the debug counter stats **Note** This option will be depreciated in the future.

Output

Output has two main sections.

- The first section, wrapped by devices, are configuration and capabilities on the device level, the majority of which are the same as the list command. This section only covers the differences between the two.

Entry	Type	Description
devices	String	Entries under this section is per-device information
pci_dev_id	String	Virtio-net PCIe device ID. Default: 0x1041. **Note**

Entry	Type	Description
		This option will be depreciated in the future.
pci_vendor_id	String	Virtio-net PCIe vendor ID. Default: 0x1af4. **Note** This option will be depreciated in the future.
pci_class_code	String	Virtio-net PCIe device class code. Default: 0x20000. **Note** This option will be depreciated in the future.
pci_subsys_id	String	Virtio-net PCIe vendor ID. Default: 0x1041. **Note** This option will be depreciated in the future.
pci_subsys_vendor_id	String	Virtio-net PCIe subsystem vendor ID. Default: 0x1af4. **Note** This option will be depreciated in the future.

Entry	Type	Description
pci_revision_id	String	Virtio-net PCIe revision ID. Default: 1. **Note** This option will be depreciated in the future.
device_features	String	Enabled device feature bits according to the virtio spec. Refer to Virtio-net Feature Bits.
driver_features	String	Enabled driver feature bits according to the virtio spec. Valid only when the driver probes the device. Refer to Virtio-net Feature Bits.
status	String	Device status field bit masks according to the virtio spec: ○ ACKNOWLEDGE (bit 0) ○ DRIVER (bit 1) ○ DRIVER_OK (bit 2) ○ FEATURES_OK (bit 3) ○ DEVICE_NEEDS_RESET (bit 6) ○ FAILED (bit 7)
reset	Number	Shows if the current virtio-net device undergoing reset: ○ 0 – not undergoing reset ○ 1 – undergoing reset
enabled	Number	Shows if the current virtio-net device is enabled: ○ 0 – disabled, likely FLR has occurred ○ 1 – enabled

- The second section, wrapped by enabled-queues-info, provides per-VQ information:

Entry	Type	Description
index	Number	VQ index starting from 0 to enabled_queues

Entry	Type	Description
size	Number	Driver VQ depth in bytes. It is bound by device max_queues_size .
msix_vector	Number	The MSI-X vector number used for this VQ
enable	Number	If current VQ is enabled or not ◦ 0 – disabled ◦ 1 – enabled
notify_offset	Number	Driver reads this to calculate the offset from start of notification structure at which this virtqueue is located
descriptor_address	Number	The physical address of the descriptor area
driver_address	Number	The physical address of the driver area
device_address	Number	The physical address of the device area

Entry	Type	Description
received_desc	Number	Total number of received descriptors by the device on this VQ **Note** This option will be depreciated in the future.
completed_desc	Number	Total number of completed descriptors by the device on this VQ **Note** This option will be depreciated in the future.
bad_desc_errors	Number	Total number of bad descriptors received on this VQ **Note** This option will be depreciated in the future.
error_cqes	Number	Total number of error CQ entries on this VQ **Note** This option will be depreciated in the future.
exceed_max_chain	Number	Total number of chained descriptors received that exceed the maximum allowed chain by device

Entry	Type	Description
		Note This option will be depreciated in the future.
invalid_buffer	Number	Total number of times the device tried to read or write buffer that is not registered to the device **Note** This option will be depreciated in the future.
batch_number	Number	The number of RX descriptors for the last received packet. Relevant for BlueField-3 only. **Note** This option will be depreciated in the future.
dma_q_used_number	Number	The DMA q index used for this VQ. Relevant for BlueField-3 only. **Note** This option will be depreciated in the future.
handler_schd_number	Number	Scheduler number for this VQ. Relevant for BlueField-3 only. **Note**

Entry	Type	Description
		This option will be depreciated in the future.
aux_handler_schd_number	Number	Aux scheduler number for this VQ. Relevant for BlueField-3 only. **Note** This option will be depreciated in the future.
max_post_desc_number	Number	Maximum number of posted descriptors on this VQ. Relevant for DPA. **Note** This option will be depreciated in the future.
total_bytes	Number	Total number of bytes handled by this VQ. Relevant for BlueField-3 only **Note** This option will be depreciated in the future.
rq_cq_max_count	Number	Event generation moderation counter of the queue. Relevant for RQ. **Note**

Entry	Type	Description
		This option will be depreciated in the future.
rq_cq_period	Number	Event generation moderation timer for the queue in 1 µ sec granularity. Relevant for RQ. **Note** This option will be depreciated in the future.
rq_cq_period_mode	Number	Current period mode for RQ • 0x0 – default_mode – use device best defaults • 0x1 – upon_event – queue_period timer restarts upon event generation • 0x2 – upon_cqe – queue_period timer restarts upon completion generation **Note** This option will be depreciated in the future.

Example

The following is an example of querying the information of the first PF:

```
# virtnet query -p 0
{
  "devices": [
    {
```

```
"pf_id": 0,
"function_type": "static PF",
"transitional": 0,
"vuid": "MT2349X00018VNETS0D0F1",
"pci_bdf": "23:00.1",
"pci_vhca_id": "0x1",
"pci_max_vfs": "0",
"enabled_vfs": "0",
"pci_dev_id": "0x1041",
"pci_vendor_id": "0x1af4",
"pci_class_code": "0x20000",
"pci_subsys_id": "0x1041",
"pci_subsys_vendor_id": "0x1af4",
"pci_revision_id": "1",
 "device_feature": {
  "value": "0x8930032300e7182f",
  "    0": "VIRTIO_NET_F_CSUM",
  "    1": "VIRTIO_NET_F_GUEST_CSUM",
  "    2": "VIRTIO_NET_F_CTRL_GUEST_OFFLOADS",
  "    3": "VIRTIO_NET_F_MTU",
  "    5": "VIRTIO_NET_F_MAC",
  "   11": "VIRTIO_NET_F_HOST_TSO4",
  "   12": "VIRTIO_NET_F_HOST_TSO6",
  "   16": "VIRTIO_NET_F_STATUS",
  "   17": "VIRTIO_NET_F_CTRL_VQ",
  "   18": "VIRTIO_NET_F_CTRL_RX",
  "   21": "VIRTIO_NET_F_GUEST_ANNOUNCE",
  "   22": "VIRTIO_NET_F_MQ",
  "   23": "VIRTIO_NET_F_CTRL_MAC_ADDR",
  "   32": "VIRTIO_F_VERSION_1",
  "   33": "VIRTIO_F_IOMMU_PLATFORM",
  "   37": "VIRTIO_F_SR_IOV",
  "   40": "VIRTIO_F_RING_RESET",
  "   41": "VIRTIO_F_ADMIN_VQ",
  "   52": "VIRTIO_NET_F_VQ_NOTF_COAL",
  "   53": "VIRTIO_NET_F_NOTF_COAL",
  "   56": "VIRTIO_NET_F_HOST_USO",
  "   59": "VIRTIO_NET_F_GUEST_HDRLEN",
  "   63": "VIRTIO_NET_F_SPEED_DUPLEX"
},
"driver_feature": {
  "value": "0x8000002300e7182f",
  "    0": "VIRTIO_NET_F_CSUM",
  "    1": "VIRTIO_NET_F_GUEST_CSUM",
```

```
  "    2": "VIRTIO_NET_F_CTRL_GUEST_OFFLOADS",
  "    3": "VIRTIO_NET_F_MTU",
  "    5": "VIRTIO_NET_F_MAC",
  "   11": "VIRTIO_NET_F_HOST_TSO4",
  "   12": "VIRTIO_NET_F_HOST_TSO6",
  "   16": "VIRTIO_NET_F_STATUS",
  "   17": "VIRTIO_NET_F_CTRL_VQ",
  "   18": "VIRTIO_NET_F_CTRL_RX",
  "   21": "VIRTIO_NET_F_GUEST_ANNOUNCE",
  "   22": "VIRTIO_NET_F_MQ",
  "   23": "VIRTIO_NET_F_CTRL_MAC_ADDR",
  "   32": "VIRTIO_F_VERSION_1",
  "   33": "VIRTIO_F_IOMMU_PLATFORM",
  "   37": "VIRTIO_F_SR_IOV",
  "   63": "VIRTIO_NET_F_SPEED_DUPLEX"
 },
 "status": {
  "value": "0xf",
  "    0": "ACK",
  "    1": "DRIVER",
  "    2": "DRIVER_OK",
  "    3": "FEATURES_OK"
 },
 "reset": "0",
 "enabled": "1",
 "num_msix": "64",
 "num_queues": "63",
 "enabled_queues": "63",
 "max_queue_size": "256",
 "msix_config_vector": "0x0",
 "mac": "4E:6A:E1:41:D8:BE",
 "link_status": "1",
 "max_queue_pairs": "31",
 "mtu": "1500",
 "speed": "200000",
 "rss_max_key_size": "0",
 "supported_hash_types": "0x0",
 "ctrl_mac": "4E:6A:E1:41:D8:BE",
 "ctrl_mq": "31",
 "sf_num": 1000,
 "sf_parent_device": "mlx5_0",
 "sf_parent_device_pci_addr": "0000:03:00.0",
 "sf_rep_net_device": "en3f0pf0sf1000",
 "sf_rep_net_ifindex": 12,
```

```
    "sf_rdma_device": "mlx5_2",
    "sf_cross_mkey": "0xC042",
    "sf_vhca_id": "0x7E8",
    "sf_rqt_num": "0x0",
    "aarfs": "disabled"
    "enabled-queues-info": [
     {
       "index": "0",
       "size": "256",
       "msix_vector": "0x1",
       "enable": "1",
       "notify_offset": "0",
       "descriptor_address": "0x10cece000",
       "driver_address": "0x10cecf000",
       "device_address": "0x10cecf240",
       "received_desc": "256",
       "completed_desc": "0",
       "bad_desc_errors": "0",
       "error_cqes": "0",
       "exceed_max_chain": "0",
       "invalid_buffer": "0",
       "batch_number": "64",
       "dma_q_used_number": "6",
       "handler_schd_number": "4",
       "aux_handler_schd_number": "3",
       "max_post_desc_number": "0",
       "total_bytes": "0",
       "rq_cq_max_count": "0",
       "rq_cq_period": "0",
       "rq_cq_period_mode": "1"
      },
      ......
      }
    ]
   }
  ]
}
```


Stats

Tip

This command is recommended for obtaining all packet counter information. The existing packet counter information available using the virtnet list and virtnet query commands, but will be deprecated in the future.

This command retrieves the packet counters for a specified device, including detailed information for all Rx and Tx virtqueues (VQs).

To enable/disable byte wise packet counters for each Rx queue, use the following command:

```
virtnet modify {[-p PF] [-v VF]} device -pkt_cnt {enable,disable}
```

- When enabled, byte-wise packet counters are initialized to zero.
- When disabled, the previous values are retained for debugging purposes. The command will still return these old, disabled counter values.

Note

Packet counters are attached to an RQ. Thus, RQ must be created first. This means that the virtio-net device should be probed by the driver on the host OS before running the commands above.

Syntax

```
virtnet stats [-h] {[-p PF] [-v VF] | [-u VUID]} [-q QUEUE_ID]
```

Info

The options --pf , --vf , and --vuid are mutually exclusive, but one of them must be applied.

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit
--pf	-p	Number	No	Unique device ID for the PF. Can be retrieved by using virtnet list.
--vf	-v	Number	No	Unique device ID for the VF. Can be retrieved by using virtnet list.
--vuid	-u	String	No	Unique device SN for the device (PF/VF). Can be retrieved by using virtnet list.
--queue_id	-q	Number	No	Queue index of the device RQs or SQs

Output

The output has two sections.

- The first section wrapped by device are device details along with the packet counter statics enable state.

Entry	Type	Description
device	String	Entries under this section is per-device information
pf_id	String	Physical function ID

Entry	Type	Description
packet_counters	String	Indicates whether the packet counters feature is enabled or disabled

- The second section wrapped by queues-stats are information for each receive VQ.

Entry	Type	Description
VQ Index	Number	The VQ index starts at 0 (the first RQ) and continues up to the last SQ
rx_64_or_less_octet_packets	Number	The number of packets received with a size of 0 to 64 bytes. Relevant for BlueField-3 RQ.
rx_65_to_127_octet_packets	Number	The number of packets received with a size of 65 to 127 bytes. Relevant for BlueField-3 RQ.
rx_128_to_255_octet_packets	Number	The number of packets received with a size of 128 to 255 bytes. Relevant for BlueField-3 RQ.
rx_256_to_511_octet_packets	Number	The number of packets received with a size of 256 to 511 bytes. Relevant for BlueField-3 RQ.
rx_512_to_1023_octet_packets	Number	The number of packets received with a size of 512 to 1023 bytes. Relevant for BlueField-3 RQ.
rx_1024_to_1522_octet_packets	Number	The number of packets received with a size of 1024 to 1522 bytes. Relevant for BlueField-3 RQ.

Entry	Type	Description
rx_1523_to_2047_octet_packets	Number	The number of packets received with a size of 1523 to 2047 bytes. Relevant for BlueField-3 RQ.
rx_2048_to_4095_octet_packets	Number	The number of packets received with a size of 2048 to 4095 bytes. Relevant for BlueField-3 RQ.
rx_4096_to_8191_octet_packets	Number	The number of packets received with a size of 4096 to 8191 bytes. Relevant for BlueField-3 RQ.
rx_8192_to_9022_octet_packets	Number	The number of packets received with a size of 8192 to 9022 bytes. Relevant for BlueField-3 RQ.
received_desc	Number	Total number of received descriptors by the device on this VQ
completed_desc	Number	Total number of completed descriptors by the device on this VQ
bad_desc_errors	Number	Total number of bad descriptors received on this VQ
error_cqes	Number	Total number of error CQ entries on this VQ
exceed_max_chain	Num	Total number of chained descriptors received that exceed the max allowed chain by device

Entry	Type	Description
	ber	
invalid_buffer	Number	Total number of times the device tried to read or write a buffer which is not registered to the device
batch_number	Number	The number of RX descriptors for the last received packet. Relevant for BlueField-3.
dma_q_used_number	Number	The DMA q index used for this VQ. Relevant for BlueField-3.
handler_schd_number	Number	Scheduler number for this VQ. Relevant for BlueField-3.
aux_handler_schd_number	Number	Aux scheduler number for this VQ. Relevant for BlueField-3.
max_post_desc_number	Number	Maximum number of posted descriptors on this VQ. Relevant for DPA.
total_bytes	Number	Total number of bytes handled by this VQ. Relevant for BlueField-3.
rq_cq_max_count	Number	Event generation moderation counter of the queue. Relevant for RQ.

Entry	Type	Description
rq_cq_period	Number	Event generation moderation timer for the queue in 1 µ sec granularity. Relevant for RQ.
rq_cq_period_mode	Number	Current period mode for RQ ◦ 0x0 – default_mode – use device best defaults ◦ 0x1 – upon_event – queue_period timer restarts upon event generation ◦ 0x2 – upon_cqe – queue_period timer restarts upon completion generation

Example

The following is an example of querying the packet statistics information of PF 0 and VQ 0 (i.e., RQ):

```
# virtnet stats -p 0 -q 0
{'pf': '0x0', 'queue_id': '0x0'}
{
  "device": {
    "pf_id": 0,
    "packet_counters": "Enabled",
    "queues-stats": [
     {
       "VQ Index": 0,
       "rx_64_or_less_octet_packets": 0,
       "rx_65_to_127_octet_packets": 259,
       "rx_128_to_255_octet_packets": 0,
       "rx_256_to_511_octet_packets": 0,
       "rx_512_to_1023_octet_packets": 0,
       "rx_1024_to_1522_octet_packets": 0,
       "rx_1523_to_2047_octet_packets": 0,
       "rx_2048_to_4095_octet_packets": 199,
       "rx_4096_to_8191_octet_packets": 0,
       "rx_8192_to_9022_octet_packets": 0,
       "received_desc": "4096",
```

```
      "completed_desc": "0",
      "bad_desc_errors": "0",
      "error_cqes": "0",
      "exceed_max_chain": "0",
      "invalid_buffer": "0",
      "batch_number": "64",
      "dma_q_used_number": "0",
      "handler_schd_number": "44",
      "aux_handler_schd_number": "43",
      "max_post_desc_number": "0",
      "total_bytes": "0",
      "err_handler_schd_num": "0",
      "rq_cq_max_count": "0",
      "rq_cq_period": "0",
      "rq_cq_period_mode": "1"
    }
   ]
  }
}
```


Modify Device

This command modifies the attributes of a given device.

Syntax

```
virtnet modify [-h] [-p PF] [-v VF] [-u VUID] [-a] {device,queue} ...
```

Info

The options --pf , --vf , --vuid , and --all are mutually exclusive, but one of them must be applied.

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit
--all	-a	N/A	No	Modify all available device attributes depending on the selection of device or queue
--pf	-p	Number	No	Unique device ID for the PF. May be retrieved using virtnet list.
--vf	-v	Number	No	Unique device ID for the VF. May be retrieved using virtnet list.
--vuid	-u	String	No	Unique device SN for the device (PF/VF). May be retrieved by using virtnet list.
device	N/A	Number	No	Modify device specific options
queue	N/A	N/A	No	Modify queue specific options

Device Options

```
virtnet modify device [-h] [-m MAC] [-t MTU] [-e SPEED] [-l LINK]
                      [-s STATE] [-f FEATURES]
                      [-o SUPPORTED_HASH_TYPES] [-k RSS_MAX_KEY_SIZE]
                      [-r RX_MODE] [-n MSIX_NUM] [-q MAX_QUEUE_SIZE]
                      [-d DST_PORT] [-b RX_DMA_Q_NUM]
                      [-dim {enable,disable}] [-dc {enable,disable}] [-pkt_cnt {enable,disable}]
                      [-aarfs {enable,disable}] [-qp MAX_QUEUE_PAIRS]
```

Option	Abbr	Argument Type	Required	Description
--help	-h	String	No	Show the help message and exit
--mac	-m	Number	No	The virtio-net device MAC address

Option	Abbr	Argument Type	Required	Description
--mtu	-t	Number	No	The virtio-net device MTU
--speed	-e	Number	No	The virtio-net device link speed in Mb/s
--link	-l	Number	No	The virtio-net device link status • 0 – down • 1 – up
--state	-s	Number	No	The virtio-net device status field bit masks according to the virtio spec: • ACKNOWLEDGE (bit 0) • DRIVER (bit 1) • DRIVER_OK (bit 2) • FEATURES_OK (bit 3) • DEVICE_NEEDS_RESET (bit 6) • FAILED (bit 7)
--features	-f	Hex Number	No	The virtio-net device feature bits according to the virtio spec
--supported_hash_types	-o	Hex Number	No	Supported hash types for this device in hex. Only applicable when VIRTIO_NET_F_HASH_REPORT is enabled. • VIRTIO_NET_HASH_TYPE_IPv4 (bit 0) • VIRTIO_NET_HASH_TYPE_TCPv4 (bit 1) • VIRTIO_NET_HASH_TYPE_UDPv4 (bit 2) • VIRTIO_NET_HASH_TYPE_IPv6 (bit 3) • VIRTIO_NET_HASH_TYPE_TCPv6 (bit 4) • VIRTIO_NET_HASH_TYPE_UDPv6 (bit 5)
--rss_max_key_size	-k	Number	No	The maximum supported length of RSS key. Only applicable when VIRTIO_NET_F_RSS or VIRTIO_NET_F_HASH_REPORT is enabled.

Option	Abbr	Argument Type	Required	Description
--rx_mode	-r	Hex Number	No	The RX mode exposed to the driver: • 0 – promisc • 1 – all-multi • 2 – all-uni • 3 – no-multi • 4 – no-uni • 5 – no-broadcast
--msix_num	-n	Number	No	Maximum number of VQs (both data and ctrl/admin VQ). It is bound by the cap of max_virt_queues at the controller level (virtnet list).
--max_queue_size	-q	Number	No	Maximum number of buffers in the VQ. The queue size value is always a power of 2. The maximum queue size value is 32768.
--max_queue_pairs	-qp	Number	No	Number of data VQ pairs. One VQ pair has one TX queue and one RX queue. Control or admin VQs are not counted. From the host side, it appears as Pre-set maximums->Combined in ethtool -l <virtio-dev> .
--dst_port	-d	Hex number	No	Modify IPv4 dst_port rules. **Note** Will be depreciated in the future.
--rx_dma_q_num	-b	Number	No	Modify max RX DMA queue number
--rx_dim_config	-dim	String	No	Enable/disable RX dynamic interrupt moderation

Option	Abbr	Argument Type	Required	Description
--drop_counter	-dc	String	No	Enable/disable virtio-net drop counter
--packet_counter	-pkt_cnt	String	No	Enable/disable virtio-net device packet counter stats
--aarfs_config	-aarfs	String	No	Enable/disable auto-AARFS. Only applicable for PF devices (static PF and hotplug PF).

Note

The following modify options require unbinding the virtio device from virtio-net driver in the guest OS:

- mac
- mtu
- features
- msix_num
- max_queue_size
- max_queue_pairs

For example:

1. On the guest OS:

```
[host]# echo "bdf of virtio-dev" > /sys/bus/pci/drivers/virtio-pci/unbind
```

2. On the DPU side:

    1. Modify the max queue size of device:

        ```
        [dpu]# virtnet modify -p 0 -v 0 device -q 2048
        ```

    2. Modify the MSI-X number of VF device:

        ```
        [dpu]# virtnet modify -p 0 -v 0 device -n 8
        ```

    3. Modify the MAC address of virtio physical device ID 0 (or with its "VUID string", which can be obtained through virtnet list/query):

        ```
        [dpu]# virtnet modify -p 0 device -m 0C:C4:7A:FF:22:93
        ```

    4. Modify the maximum number of queue pairs of VF device:

        ```
        [dpu]# virtnet modify -p 0 -v 0 device -qp 2
        ```

3. On the guest OS:

    ```
    [host]# echo "bdf of virtio-dev" > /sys/bus/pci/drivers/virtio-pci/bind
    ```

Queue Options

```
virtnet modify queue [-h] -e {event,cqe} -n PERIOD -c MAX_COUNT
```

Option	Abbr	Argument Type	Required	Description
--help	-h	String	No	Show the help message and exit
--period_mode	-e	String	No	RQ period mode: event or cqe. Default is selected by device for the best result.
--period	-n	Number	No	The event generation moderation timer for the queue in 1 μ sec granularity
--max_count	-c	Number	No	The max event generation moderation counter of the queue

Output

Entry	Type	Description
errno	Number	Error number: • 0 – success • Non-0 – failed
errstr	String	Explanation of the error number

Example

To modify the link status of the first VF on the first PF to be down:

```
# virtnet modify -p 0 device -l 0
{'pf': '0x0', 'all': '0x0', 'subcmd': '0x0', 'link': '0x0'}
```

```
{
  "errno": 0,
  "errstr": "Success"
}
```

Log

This command manages the log level of virtio-net-controller.

Syntax

```
virtnet log [-h] -l {info,err,debug}
```

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit
--level	-l	String	Yes	Change the log level of virtio_net_controller from the journal. Default is DEBUG.

Output

Entry	Type	Description
Stdout	String	Success or failed with message

Example

To change the log level to info:

```
# virtnet log -l info
{'level': 'info'}
"Success"
```

To monitor current log output of the controller service with the latest 100 lines printed out:

```
$ journalctl -u virtio-net-controller -f -n 100
```

Validate

This command validates configurations of virtio-net-controller.

Syntax

```
virtnet validate [-h] -f PATH_TO_FILE
```

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit
--file	-f	String	No	Validate the JSON format of the virtnet.conf file of the virtio_net_controller

Output

Entry	Type	Description
Stdout	String	Success or failed with message

Example

To check if virtnet.conf is a valid JSON file:

```
# virtnet validate -f /opt/mellanox/mlnx_virtnet/virtnet.conf
/opt/mellanox/mlnx_virtnet/virtnet.conf is valid
```

Version

This command prints current and updated version of virtio-net-controller.

Syntax

```
virtnet version [-h]
```

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit

Output

Entry	Type	Description
Original Controller	String	The original controller version
Destination Controller	String	The to be updated controller version

Example

Check current and next available controller version:

```
# virtnet version
[
 {
  "Original Controller": "v1.8.12"
 },
 {
  "Destination Controller": "v1.9.14"
 }
]
```

Update

Live update minimizes network interface down time by performing online upgrade of the virtio-net controller without necessitating a full restart.

Syntax

```
virtnet update [-h] [-s | -t]
```

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit
--start	-s	N/A	No	Start live update virtio-net-controller
--status	-t	N/A	No	Check live update status

Output

Entry	**Type**	**Description**
stdout	String	If the update started successfully

Example

To start the live update process, run:

```
# virtnet update -s
{'start': '0x1'}
"Update started, use 'virtnet update -t' or check logs for status"
```

To check the update status during the update process:

```
# virtnet update -t
{'status': '0x1'}
{
  "current status": "inactive",
  "last status": "success",
  "time_used (s)": 0.604152
}
```

Error Code

CLI commands will return non-0 error code upon failure. All error numbers are negative. When there is error happening from log, it could return error number as well.

If the error number is greater than -1000, it's standard error. Please refer to Linux error code at errno

If the error number is less or equal -1000, please refer to the table below for the explaination.

Errno	Error Name	Error Description
-1000	VIRTNET_ERR_DEV_FEATURE_VALIDATE	Failed to validate device feature
-1001	VIRTNET_ERR_DEV_NOT_FOUND	Failed to find device

Errno	Error Name	Error Description
-1002	VIRTNET_ERR_DEV_NOT_PLUGGED	Failed - Device is not hotplugged
-1003	VIRTNET_ERR_DEV_NOT_STARTED	Failed - Device did not start
-1004	VIRTNET_ERR_DRIVER_PROBED	Failed - Virtio driver should not be loaded
-1005	VIRTNET_ERR_EPOLL_ADD	Failed to add epoll
-1006	VIRTNET_ERR_ID_OUT_OF_RANGE	Failed - ID input exceeds the max range
-1007	VIRTNET_ERR_VUID_INVALID	Failed - VUID is invalid
-1008	VIRTNET_ERR_MAC_INVALID	Failed - MAC is invalid
-1009	VIRTNET_ERR_MSIX_INVALID	Failed - MSIX is invalid
-1010	VIRTNET_ERR_MTU_INVALID	Failed - MTU is invalid
-1011	VIRTNET_ERR_PORT_CONTEXT_NOT_FOUND	Failed to find port contex
-1012	VIRTNET_ERR_REC_CONFIG_LOAD	Failed to load config from recovery file
-1013	VIRTNET_ERR_REC_CONFIG_SAVE	Failed to save config into recovery file
-1014	VIRTNET_ERR_REC_FILE_CREATE	Failed to create recovery file
-1015	VIRTNET_ERR_REC_MAC_DEL	Failed to delete MAC in recovery file
-1016	VIRTNET_ERR_REC_MAC_LOAD	Failed to load MAC from recovery file
-1017	VIRTNET_ERR_REC_MAC_SAVE	Failed to save MAC into recovery file
-1018	VIRTNET_ERR_REC_MQ_SAVE	Failed to save MQ into recovery file
-1019	VIRTNET_ERR_REC_PFNUM_LOAD	Failed to load PF number from recovery file

Errno	Error Name	Error Description
-1020	VIRTNET_ERR_REC_RX_MODE_SAVE	Failed to save RX mode into recovery file
-1021	VIRTNET_ERR_REC_SF_SAVE	Failed to save PF and SF number into recovery file
-1022	VIRTNET_ERR_REC_SFNUM_LOAD	Failed to load SF number from recovery file
-1023	VIRTNET_ERR_SF_MAC_FLOW_APPLY	Failed to apply MAC flow by SF
-1024	VIRTNET_ERR_SF_MQ_UPDATE	Failed to update MQ by SF
-1025	VIRTNET_ERR_SF_RX_MODE_SET	Failed to set RX mode by SF
-1026	VIRTNET_ERR_SNAP_NET_CTRL_OPEN	Failed to open SNAP device control
-1027	VIRTNET_ERR_SNAP_CROSS_MKEY_CREATE	Failed to create SNAP cross mkey
-1028	VIRTNET_ERR_SNAP_DMA_Q_CREATE	Failed to create SNAP DMA Q
-1029	VIRTNET_ERR_SNAP_NET_DEV_QUERY	Failed to query SNAP device
-1030	VIRTNET_ERR_SNAP_NET_DEV_MODIFY	Failed to modify SNAP device
-1031	VIRTNET_ERR_SNAP_PF_HOTPLUG	Failed to hotplug SNAP PF
-1032	VIRTNET_ERR_VQ_PERIOD_UPDATE	Failed to update VQ period
-1033	VIRTNET_ERR_QUEUE_SIZE_INVALID	Failed - Queue size is invalid
-1034	VIRTNET_ERR_SF_PORT_ADD	Failed to add SF port
-1035	VIRTNET_ERR_WQ_WORKQUEUE_ALLOC	Failed to alloc workqueue
-1036	VIRTNET_ERR_ETH_VQS_OPERATION_ALLOC	Failed to alloc eth VQS operation
-1037	VIRTNET_ERR_ETH_VQS_OPERATION_COMP	Failed to complete eth VQS operation

Errno	Error Name	Error Description
-1038	VIRTNET_ERR_JSON_OBJ_NOT_EXIST	Failed - JSON obj does not exist
-1039	VIRTNET_ERR_DEV_LOAD_PREP	Failed to prepare device load
-1040	VIRTNET_ERR_DEV_SW_MIGRATION	Failed to sw migrate a device
-1041	VIRTNET_ERR_DEV_IS_SW_MIGRATING	Failed - Device is migrating
-1042	VIRTNET_ERR_MAX_QUEUE_SIZE	Error - queue size must be greater than 2 and is power of 2
-1043	VIRTNET_ERR_MSIX_LESS_EQUAL_THREE	Warning - this device won't function, don't try to probe with virtio driver
-1044	VIRTNET_ERR_SF_POOL_CREATING	SF pool is creating try again later
-1045	VIRTNET_ERR_DST_PORT	Failed to set dst port rule
-1046	VIRTNET_ERR_INVALID_OPTION	Option is not supported
-1047	VIRTNET_ERR_SF_CREATE	Failed to create SF
-1048	VIRTNET_ERR_DEV_SF_NUM_OUT_OF_RANGE	SF number for hotplug device should be between 2000 and 2999
-1049	VIRTNET_ERR_DEV_SF_NUM_USED	SF number is already used
-1050	VIRTNET_ERR_QUEUE_NUMBER_INVALID	Queue index is invalid
-1051	VIRTNET_ERR_SPEED_INVALID	Invalid speed please check help menu for supported link speeds
-1052	VIRTNET_ERR_SUPPORTED_HASH_TYPES_INVALID	Invalid hash types please check help menu for supported hash types
-1053	VIRTNET_ERR_RSS_MAX_KEY_SIZE_INVALID	Invalid rss max key size supported key size is 40
-1054	VIRTNET_ERR_REC_OFFLOADS_SAVE	Failed to save OFFLOADS into recovery file

Errno	Error Name	Error Description
-1055	VIRTNET_ERR_SF_OFFLOADS_UPDATE	Failed to update OFFLOADS by SF
-1056	VIRTNET_ERR_READ_LINK	Failed to readlink
-1057	VIRTNET_ERR_PATH_FORMAT	Error - Path format is invalid
-1058	VIRTNET_ERR_Q_COUNTER_ALLOC	Failed to alloc q counter
-1059	VIRTNET_ERR_REC_DIRTY_LOG_SAVE	Failed to save dirty log
-1060	VIRTNET_ERR_REC_DIRTY_LOG_DEL	Failed to delete dirty log
-1061	VIRTNET_ERR_REC_LM_STATUS_SAVE	Failed to save LM status
-1062	VIRTNET_ERR_REC_LM_STATUS_REC	Failed to found LM status record
-1063	VIRTNET_ERR_REC_DEV_MODE_SAVE	Failed to save dev mode
-1064	VIRTNET_ERR_REC_DEV_MODE_REC	Failed to found dev mode record
-1065	VIRTNET_ERR_UNPLUG_NOT_READY	Error - Device is not ready to be unplugged please check host and retry
-1066	VIRTNET_ERR_REC_MAC_TABLE_DEL	Failed to delete MAC table in recovery file
-1067	VIRTNET_ERR_REC_MAC_TABLE_LOAD	Failed to load MAC table from recovery file
-1068	VIRTNET_ERR_REC_MAC_TABLE_SAVE	Failed to save MAC table into recovery file
-1069	VIRTNET_ERR_REC_HASH_CFG_DEL	Failed to delete hash cfg in recovery file
-1070	VIRTNET_ERR_REC_HASH_CFG_LOAD	Failed to load hash cfg from recovery file
-1071	VIRTNET_ERR_REC_HASH_CFG_SAVE	Failed to save hash cfg into recovery file
-107	VIRTNET_ERR_DEV_VF_GET	Failed to get VF device

Errno	Error Name	Error Description
2		
-1073	VIRTNET_ERR_MAX_QUEUES_INVALID	Failed - QUEUES is invalid
-1074	VIRTNET_ERR_DEBUGFS_SAVE	Failed to save into debugfs file
-1075	VIRTNET_ERR_DEBUGFS_DEL	Failed to delete from debugfs file

Feature Guidance

This section is composed of the following pages:

Counters

Packet Statistics

To query the packet counters, use stats command.

```
[dpu]# virtnet stats [-h] {[-p PF] [-v VF] | [-u VUID]} [-q QUEUE_ID]
```

Info

The options --pf , --vf and --vuid are mutually exclusive, but one of them must be applied.

Option	Abbr	Argument Type	Required	Description
--help	-h	N/A	No	Show the help message and exit
--pf	-p	Number	No	Unique device ID for the PF. Can be retrieved by using virtnet list.
--vf	-v	Number	No	Unique device ID for the VF. Can be retrieved by using virtnet list.
--vuid	-u	String	No	Unique device SN for the device (PF/VF). Can be retrieved by using virtnet list.
--queue_id	-q	Number	No	Queue index of the device RQs or SQs

Note

This command is recommended for obtaining all packet counter information. The existing packet counter information available through the virtnet list and virtnet query commands will be deprecated in the future.

The following command queries PF 0 and VQ 0 (i.e., RQ):

```
[dpu]# virtnet stats -p 0 -q 0
```

Output:

```
# virtnet stats -p 0 -q 0
{'pf': '0x0', 'queue_id': '0x0'}
{
  "device": {
    "pf_id": 0,
    "packet_counters": "Enabled",
    "queues-stats": [
      {
        "VQ Index": 0,
        "rx_64_or_less_octet_packets": 0,
        "rx_65_to_127_octet_packets": 259,
        "rx_128_to_255_octet_packets": 0,
        "rx_256_to_511_octet_packets": 0,
        "rx_512_to_1023_octet_packets": 0,
        "rx_1024_to_1522_octet_packets": 0,
        "rx_1523_to_2047_octet_packets": 0,
        "rx_2048_to_4095_octet_packets": 199,
        "rx_4096_to_8191_octet_packets": 0,
        "rx_8192_to_9022_octet_packets": 0,
        "received_desc": "4096",
        "completed_desc": "0",
        "bad_desc_errors": "0",
        "error_cqes": "0",
        "exceed_max_chain": "0",
        "invalid_buffer": "0",
        "batch_number": "64",
        "dma_q_used_number": "0",
        "handler_schd_number": "44",
        "aux_handler_schd_number": "43",
        "max_post_desc_number": "0",
        "total_bytes": "0",
        "err_handler_schd_num": "0",
        "rq_cq_max_count": "0",
        "rq_cq_period": "0",
        "rq_cq_period_mode": "1"
      }
```

```
    ]
  }
}
```

The output has two sections.

- The first section, wrapped by device, are device details along with the packet counter statics enable state.

Entry	Type	Description
device	String	Entries under this section is per device information
pf_id	String	Physical function ID
packet_counters	String	packet counters feature: enabled/disabled

- The second section, wrapped by queues-stats, are information for each receive VQ.

Entry	Type	Description
VQ Index	Number	The VQ index starts at 0 (the first RQ) and continues up to the last SQ
rx_64_or_less_octet_packets	Number	The number of packets received with a size of 0 to 64 bytes. Relevant for BlueField-3 RQ when packet counter is enabled.
rx_65_to_127_octet_packets	Number	The number of packets received with a size of 65 to 127 bytes. Relevant for BlueField-3 RQ when packet counter is enabled.
rx_128_to_255_octet_packets	Number	The number of packets received with a size of 128 to 255 bytes. Relevant for BlueField-3 RQ when packet counter is enabled.
rx_256_to_511_octet_packets	Number	The number of packets received with a size of 256 to 511 bytes. Relevant for BlueField-3 RQ when packet counter is enabled.

Entry	Type	Description
rx_512_to_1023_octet_packets	Number	The number of packets received with a size of 512 to 1023 bytes. Relevant for BlueField-3 RQ when packet counter is enabled.
rx_1024_to_1522_octet_packets	Number	The number of packets received with a size of 1024 to 1522 bytes. Relevant for BlueField-3 RQ when packet counter is enabled.
rx_1523_to_2047_octet_packets	Number	The number of packets received with a size of 1523 to 2047 bytes. Relevant for BlueField-3 RQ when packet counter is enabled.
rx_2048_to_4095_octet_packets	Number	The number of packets received with a size of 2048 to 4095 bytes. Relevant for BlueField-3 RQ when packet counter is enabled.
rx_4096_to_8191_octet_packets	Number	The number of packets received with a size of 4096 to 8191 bytes. Relevant for BlueField-3 RQ when packet counter is enabled.
rx_8192_to_9022_octet_packets	Number	The number of packets received with a size of 8192 to 9022 bytes. Relevant for BlueField-3 RQ when packet counter is enabled.
received_desc	Number	Total number of received descriptors by the device on this VQ
completed_desc	Number	Total number of completed descriptors by the device on this VQ
bad_desc_errors	Number	Total number of bad descriptors received on this VQ
error_cqes	Number	Total number of errors CQ entries on this VQ
exceed_max_chain	Number	Total number of chained descriptors received that exceed the max allowed chain by the device

Entry	Type	Description
invalid_buffer	Number	Total number of times device tried to read or write buffer that is not registered to the device
batch_number	Number	The number of RX descriptors for the last received packet. Relevant for BlueField-3.
dma_q_used_number	Number	The DMA q index used for this VQ. Relevant for BlueField-3.
handler_schd_number	Number	Scheduler number for this VQ. Relevant for BlueField-3.
aux_handler_schd_number	Number	Aux scheduler number for this VQ. Relevant for BlueField-3.
max_post_desc_number	Number	Maximum number of posted descriptors on this VQ. Relevant for DPA.
total_bytes	Number	Total number of bytes handled by this VQ. Relevant for BlueField-3.
rq_cq_max_count	Number	Event generation moderation counter of the queue. Relevant for RQ.
rq_cq_period	Number	Event generation moderation timer for the queue in 1 μ sec granularity. Relevant for RQ.
rq_cq_period_mode	Number	Current period mode for RQ ◦ 0x0 – default_mode – use device best defaults ◦ 0x1 – upon_event – queue_period timer restarts upon event generation ◦ 0x2 – upon_cqe – queue_period timer restarts upon completion generation

Entry	Type	Description
		The second section wrapped by queues-stats IS information for each receive VQ.

VQ Statistics

To query Rx VQ statistics, use the corresponding VQ index. For example, If there are 3 queues configured then to query Rx, VQ uses queue 0, Tx VQ uses queue 1, and Ctrl VQ uses queue 2.

The following is the command to query PF 0, VF 0, and VQ 0 (i.e., Rx).

```
[dpu]# virtnet query -p 0 -v 0 -q 0
```

Output:

```
"enabled-queues-info": [
 {
  "index": "0",
  "size": "256",
  "msix_vector": "0x1",
  "enable": "1",
  "notify_offset": "0",
  "descriptor_address": "0xffffe000",
  "driver_address": "0xfffff000",
  "device_address": "0xfffff240",
  "received_desc": "256",
  "completed_desc": "19",
  "bad_desc_errors": "0",
  "error_cqes": "0",
  "exceed_max_chain": "0",
  "invalid_buffer": "0",
  "batch_number": "64",
  "dma_q_used_number": "0",
  "handler_schd_number": "4",
  "aux_handler_schd_number": "3",
  "max_post_desc_number": "0",
```

```
  "total_bytes": "6460",
  "rq_cq_max_count": "0",
  "rq_cq_period": "0",
  "rq_cq_period_mode": "1"
}
```

The following are some of the important VQ counters:

Counter Name	Description
total_bytes	Number of bytes received
received_desc	Number of available descriptors received by device
completed_desc	Number of available descriptors completed by the device
error_cqes	Number of error CQEs received on the queue
bad_desc_errors	Number of bad descriptors received
exceed_max_chain	Number of chained descriptors received that exceed the max allowed chain by device
invalid_buffer	Number of times device tried to read or write buffer that is not registered to the device

RQ Drop Counter

When DPA is the data path provider, each RQ has its corresponding drop counter, which counts the number of packets dropped inside the DPA virtio RQs.

Info

The drop could also happen from the uplink or SF.

The drop counter only increments (initial value being 0), and its value gets reset to 0 when disabled.

RQ drop counter can be enabled and disabled as follows (using VF 0 on PF 0):

```
[dpu]# virtnet modify -p 0 -v 0 device -dc enable
[dpu]# virtnet modify -p 0 -v 0 device -dc disable
```

> **Note**
>
> Drop counter is attached to a RQ, thus RQ must be created first. This means that the virtio-net device should be probed by the driver on the host OS before running the commands above.

To query the drop counter value(s), run:

```
[dpu]# virtnet query -p 0 -v 0 | grep num_desc_drop_pkts
```

If there are more than one RQ for a device, the drop count is the sum of all RQ's value.

Packet Counter

> **Note**
>
> Relevant for BlueField-3 only.

The packet counter feature helps the user query the byte-wise packet counters for each Rx queue.

By default, byte-wise packet counters are disabled as that negatively impacts performance. When the user is interested in the debug, enable the packet counter feature using the below command

Packet counter can be enabled and disabled as follows (using VF 0 on PF 0):

```
[dpu]# virtnet modify -p 0 -v 0 device -pkt_cnt enable
[dpu]# virtnet modify -p 0 -v 0 device -pkt_cnt disable
```

- When enabled, byte-wise packet counters are initialized to zero.
- When disabled, the previous values are retained for debugging purposes. The command will still return these old, disabled counter values.

Note

Packet counters are attached to an RQ. Thus, RQ must be created first. This means that the virtio-net device should be probed by the driver on the host OS before running the commands above.

Jumbo MTU

Introduction

Jumbo MTU is critical for increasing the efficiency of Ethernet and network processing by reducing the protocol overhead (ratio of headers and payload size).

Configuration

To support jumbo MTU run the following virtnet command:

```
[dpu]# virtnet modify -p 0 -v 0 device -t 9216
```

Info

The example sets the MTU to 9126 for VF 0 on PF 0.

Jumbo MTU is only supported starting from the following kernel version:

	Release
Upstream	VM kernel: 4.18.0-193.el8.x86_64 (VM Linux version supports big MTU after 4.11)
Ubuntu	DOCA_2.5.0_BSP_4.5.0_Ubuntu_22.04
Virtnet controller	v1.7 or v1.6.26

To configure jumbo MTU (e.g., using VF 0 on PF 0):

1. Change the MTU of the uplink and SF representor from the BlueField:

   ```
   [dpu]# ifconfig p0 mtu 9216
   [dpu]# ifconfig en3f0pf0sf3000 mtu 9216
   ```

   If a bond is configured, change the MTU of the bond rather than p0:

   ```
   [dpu]# ifconfig bond0 mtu 9216
   [dpu]# ifconfig en3f0pf0sf3000 mtu 9216
   ```

2. Restart the virtio-net-controller from the BlueField:

   ```
   [dpu]# systemctl restart virtio-net-controller
   ```

3. Change the corresponding device MTU on the BlueField:

   ```
   [dpu]# virtnet modify -p 0 -v 0 device -t 9216
   ```

4. Reload virtio driver from the host OS:

```
[host]# modprobe -rv virtio-net && modprobe -v virtio-net
```

5. Check virtqueue MTU configuration is correct on the BlueField:

```
[dpu]# virtnet query -p 0 -v 0 --dbg_stats | grep jumbo_mtu
   "jumbo_mtu": 1
   "jumbo_mtu": 1
```

6. Change the MTU of virtio-net interface from the host OS:

```
[host]# ifconfig <vnet> mtu 9216
```

Link Aggregation

It is common to use link aggregation (LAG) or bond interfaces to increase reliability, availability, or bandwidth of networking devices. Virtio-net devices support this mode via DPU-side LAG configurations.

To configure the virtio-net-controller in LAG mode must follow a specific procedure due to the dependency on mlx5 RDMA device:

1. Stop the virtio-net-controller to avoid resource leakage (which would be caused by LAG destroying the existing mlx5 RDMA device and creating a new bond RDMA device).

```
[dpu]# systemctl stop virtio-net-controller.service
```

2. Configure the LAG interface for two uplink interfaces from the DPU side. Refer to the " Link Aggregation " page in *NVIDIA BlueField BSP* documentation for detailed steps.

> **Note**
>
> The virtio-net-controller service starts by default. If DPU is rebooted during LAG configuration, it is necessary to stop the controller before creating a bond interfaces from the DPU side.

3. Update the controller configuration file to use bond interface.

```
[dpu]# cat /opt/mellanox/mlnx_virtnet/virtnet.conf
{
  "ib_dev_lag": "mlx5_bond_0",
  "ib_dev_for_static_pf": "mlx5_bond_0",
  "is_lag": 1,
}
```

> **Info**
>
> Refer to page "Configuration File" for details.

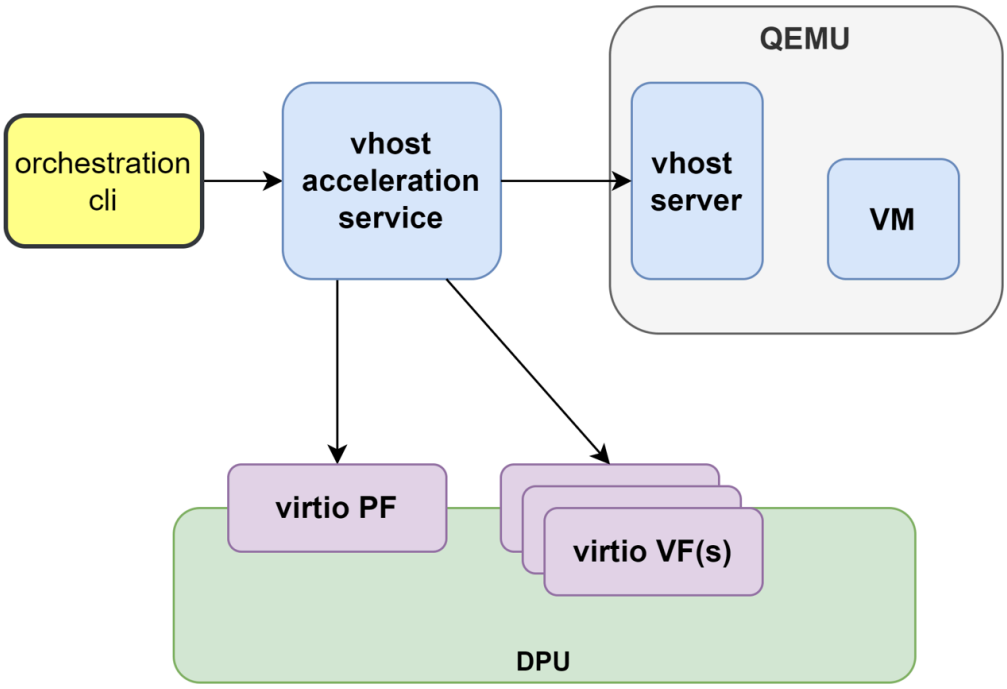
4. Start the controller for the new configuration to take effect.

```
[dpu]# systemctl start virtio-net-controller.service
```

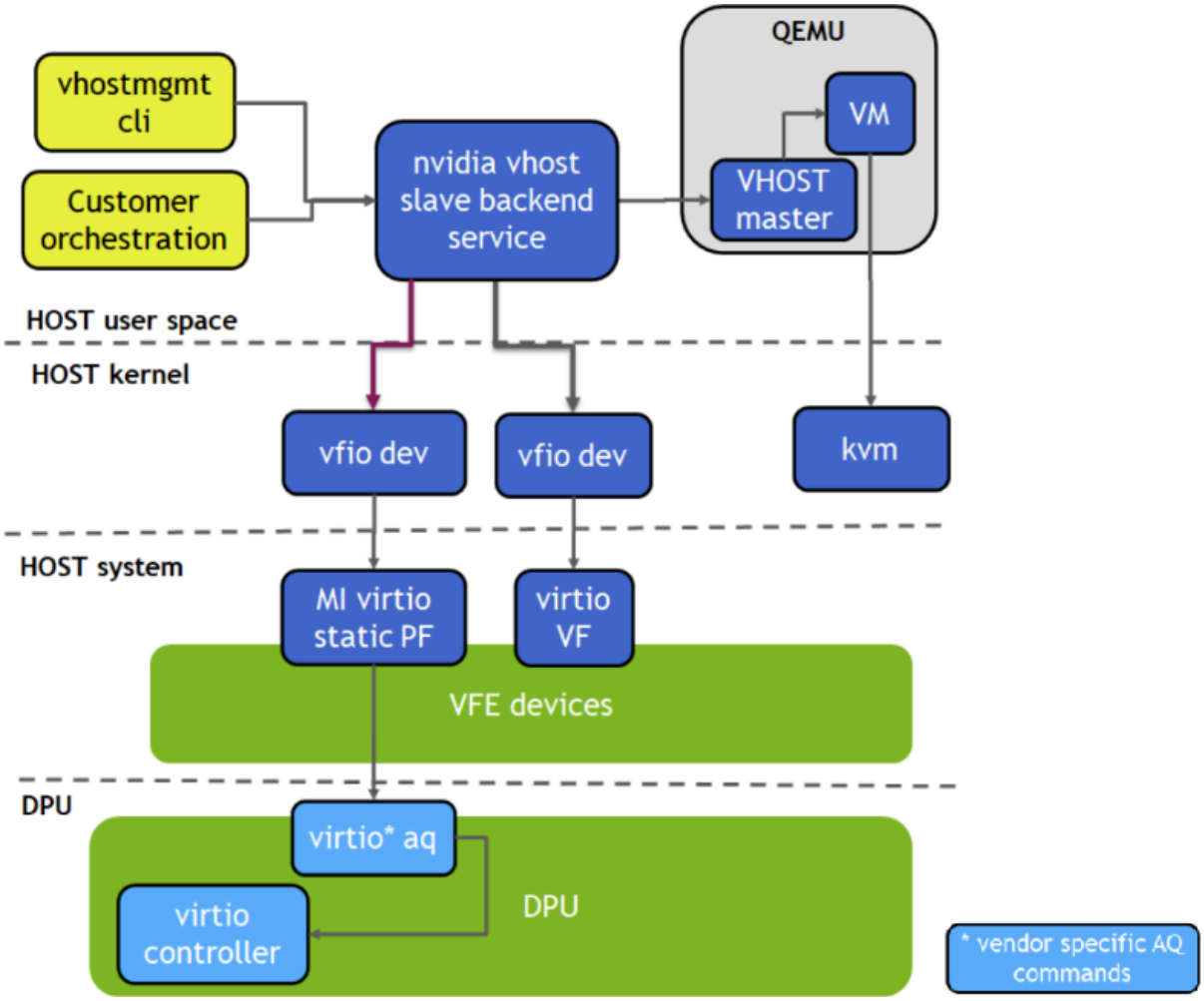
Live Migration

Live Migration Using vHost Acceleration Software Stack

Virtio VF PCIe devices can be attached to the guest VM using the vhost acceleration software stack. This enables performing live migration of guest VMs.



This section provides the steps to enable VM live migration using virtio VF PCIe devices along with vhost acceleration software.



Prerequisites

- Minimum hypervisor kernel version – Linux kernel 5.7 (for VFIO SR-IOV support)
- To use high-availability (the additional vfe-vhostd-ha service which can persist datapath when vfe-vhostd crashes), this kernel patch must be applied.

Install vHost Acceleration Software Stack

Vhost acceleration software stack is built using open-source BSD licensed DPDK.

- To install vhost acceleration software:

1.

1. Clone the software source code:

```
[host]# git clone https://github.com/Mellanox/dpdk-vhost-vfe
```

> **Info**
>
> The latest release tag is vfe-24.07-rc2.

2. Build software:

```
[host]# apt-get install libev-dev -y
[host]# apt-get install libev-libevent-dev  -y
[host]# apt-get install uuid-dev  -y
[host]# apt-get install libnuma-dev -y
[host]# meson build --debug -
Denable_drivers=vdpa/virtio,common/virtio,common/virtio_mi,common/virtio_ha
[host]# ninja -C build install
```

- To install QEMU:

> **Info**
>
> Upstream QEMU later than 8.1 can be used or the following NVIDIA QEMU.

1.

1. Clone NVIDIA QEMU sources.

```
[host]# git clone https://github.com/Mellanox/qemu -b stable-8.1-presetup
```

> **Info**
>
> Latest release tag is vfe-0.6.

2. Build NVIDIA QEMU.

```
[host]# mkdir bin
[host]# cd bin
[host]# ../configure --target-list=x86_64-softmmu --enable-kvm
[host]# make -j24
```

Configure vHost on Hypervisor

1.

    1. Configure 1G huge pages :

```
[host]# mkdir /dev/hugepages1G
[host]# mount -t hugetlbfs -o pagesize=1G none /dev/hugepages1G
[host]# echo 16 > /sys/devices/system/node/node0/hugepages/hugepages-
1048576kB/nr_hugepages
[host]# echo 16 > /sys/devices/system/node/node1/hugepages/hugepages-
1048576kB/nr_hugepages
```

    2. Enable qemu:commandline in VM XML by adding the xmlns:qemu option:

```
<domain type='kvm' xmlns:qemu='http://libvirt.org/schemas/domain/qemu/1.0'>
```

3. Assign a memory amount and use 1GB page size for huge pages in VM XML:

```
<memory unit='GiB'>4</memory>
<currentMemory unit='GiB'>4</currentMemory>
<memoryBacking>
  <hugepages>
    <page size='1' unit='GiB'/>
  </hugepages>
</memoryBacking>
```

4. Set the memory access for the CPUs to be shared:

```
<cpu mode='custom' match='exact' check='partial'>
 <model fallback='allow'>Skylake-Server-IBRS</model>
 <numa>
  <cell id='0' cpus='0-1' memory='4' unit='GiB' memAccess='shared'/>
 </numa>
</cpu>
```

5. Add a virtio-net interface in VM XML:

```
<qemu:commandline>
 <qemu:arg value='-chardev'/>
 <qemu:arg value='socket,id=char0,path=/tmp/vhost-net0,server=on'/>
 <qemu:arg value='-netdev'/>
 <qemu:arg value='type=vhost-user,id=vhost1,chardev=char0,queues=4'/>
 <qemu:arg value='-device'/>
 <qemu:arg value='virtio-net-pci,netdev=vhost1,mac=00:00:00:00:33:00,vectors=10,page-per-vq=on,rx_queue_size=1024,tx_queue_size=1024,mq=on,disable-legacy=on,disable-modern=off'/>
</qemu:commandline>
```

Run vHost Acceleration Service

1. Bind the virtio PF devices to the vfio-pci driver:

```
[host]# modprobe vfio vfio_pci
[host]# echo 1 > /sys/module/vfio_pci/parameters/enable_sriov
[host]# echo 0x1af4 0x1041 > /sys/bus/pci/drivers/vfio-pci/new_id
[host]# echo 0x1af4 0x1042 > /sys/bus/pci/drivers/vfio-pci/new_id
[host]# echo <pf_bdf> > /sys/bus/pci/drivers/virtio-pci/unbind
[host]# echo <vf_bdf> > /sys/bus/pci/drivers/virtio-pci/unbind
[host]# echo <pf_bdf> > /sys/bus/pci/drivers/vfio-pci/bind
[host]# echo <vf_bdf> > /sys/bus/pci/drivers/vfio-pci/bind
[host]# lspci -vvv -s <pf_bdf> | grep "Kernel driver"
Kernel driver in use: vfio-pci
[host]# lspci -vvv -s <vf_bdf> | grep "Kernel driver"
Kernel driver in use: vfio-pci
```

> **Info**
>
> Example of <pf_bdf> or <vf_bdf> format: 0000:af:00.3

2. Enable SR-IOV and create a VF(s):

```
[host]# echo 1 > /sys/bus/pci/devices/<pf_bdf>/sriov_numvfs
[host]# lspci | grep Virtio
0000:af:00.1 Ethernet controller: Red Hat, Inc. Virtio network device
0000:af:00.3 Ethernet controller: Red Hat, Inc. Virtio network device
```

3. Add a VF representor to the OVS bridge on the BlueField:

```
[dpu]# virtnet query -p 0 -v 0 | grep sf_rep_net_device
"sf_rep_net_device": "en3f0pf0sf3000",
```

```
[dpu]# ovs-vsctl add-port ovsbr1 en3f0pf0sf3000
```

4. Run the vhost acceleration software service:

   start the vfe-vhostd service:

```
[host]# systemctl start vfe-vhostd
```

> **Info**
>
> A log of the service can be viewed by running the following:
>
> ```
> [host]# journalctl -u vfe-vhostd
> ```

5. Provision the virtio-net PF and VF:

```
[host]#  /usr/local/bin/vfe-vhost-cli mgmtpf -a <pf_bdf>
# Wait on virtio-net-controller finishing handle PF FLR

# On BlueField, change VF MAC address or other device options
[dpu]# virtnet modify -p 0 -v 0 device -m 00:00:00:00:33:00

# Add VF into vfe-dpdk
[host]# /usr/local/bin/vfe-vhost-cli vf -a <vf_bdf> -v /tmp/vhost-net0
```

> **Note**

If the SR-IOV is disabled and reenabled, the user must re-provision the VFs. 00:00:00:00:33:00 is a virtual MAC address used in VM XML.

Start the VM

```
[host]# virsh start <vm_name>
```

HA Service

Running the vfe-vhostd-ha service allows the datapath to persist should vfe-vhostd crash:

```
[host]# systemctl start vfe-vhostd-ha
```

Simple Live Migration

1. Prepare two identical hosts and perform the provisioning of the virtio device to DPDK on both.
2. Boot the VM on one server:

```
[host]# virsh migrate --verbose --live --persistent <vm_name>
qemu+ssh://<dest_node_ip_addr>/system --unsafe
```

Remove Device

When finished with the virtio devices, use following commands to remove them from DPDK:

```
[host]# /usr/local/bin/vfe-vhost-cli vf -r <vf_bdf>
[host]# /usr/local/bin/vfe-vhost-cli mgmtpf -r <pf_bdf>
```

Live Update

Live update minimizes network interface downtime by performing online upgrade of the virtio-net controller without necessitating a full restart.

Requirements

To perform a live update, the user must install a newer version of the controller either using the rpm or deb package (depending on the OS distro used). Run:

For Ubuntu/Debian	[dpu]# dpkg --force-all -i virtio-net-controller-x.y.z-1.mlnx.aarch64.deb
For CentOS/RedHat	[dpu]# rpm -Uvh virtio-net-controller-x.y.z-1.mlnx.aarch64.rpm --force

Check Versions

Before staring live update, the following command can be used to check the version of the original and destination controllers:

```
[dpu]# virtnet version
```

Example output:

```
{
  "Original Controller": "v1.9.13"
},
{
  "Destination Controller": "v1.9.14"
}
```

Start Updating

If no errors occur, issue the following command to start the live update process:

```
[dpu]# virtnet update -s
```

> **Note**
>
> If an error appears regarding the "update" command not being supported, this implies that the controller version you are trying to install is too old. Reinstalling the proper version will resolve this issue.

Check Status

During the update process, the following command may be used to check the update status:

```
[dpu]# virtnet update -t
```

Example output:

```
{
  "current status": "inactive",   # updating status, whether live update is finished or ongoing
```

```
  "last status": "success",      # last live update status
  "time_used (s)": 1.655439      # time cost for last live update
}
```

During the update, some existing virtnet commands (e.g., list, query, modify) remain supported.

When the update process completes successfully, the command virtnet update status reflects the status accordingly

Note

If a device is actively migrating, the existing virtnet commands appear as "migrating" for that specific device so that the user can retry later.

Note

When live update is in progress, hotplug/unplug and VF creation/deletion are not supported.

Mergeable Rx Buffer

When negotiating with the driver, mergeable buffers is a mode where multiple descriptors are posted to fit a single jumbo sized packet coming from the wire. This is a receive-side only feature which helps im prove performance in situations of a large MTU (e.g., 9K).

Enabling and using mergeable buffers requires updating the configuration file along with advertising feature bits from the controller side as described in the following subsections.

Enabling/Disabling Mergeable Buffers

To enable or disable the mergeable Rx buffer feature, set the mrg_rxbuf attribute in the virtnet.conf configuration file to 1 or 0 respectively.

For example, to enable mergeable Rx buffer:

```
[dpu]# cat /opt/mellanox/mlnx_virtnet/virtnet.conf
{
...
"mrg_rxbuf": 1
...
}
```

Note

Updating the configuration file requires a restart of the virtio-net-controller.

Info

Refer to "Configuration File" page for more information.

Configuring Device

Mergeable buffer is a per-device feature.

1. Users must query a device to check if VIRTIO_F_MRG_RX_BUFFER is available. For example, the following PF 0 does not support mergeable buffer:

   ```
   [dpu]# virtnet query -p 0 -b
   {'all': '0x0', 'pf': '0x0', 'dbg_stats': '0x0', 'brief': '0x1', 'latency_stats': '0x0', 'stats_clear': '0x0'}
   {
   ```

```
  "devices": [
   {
    "pf_id": 0,
    "transitional": 0,
    "vuid": "MT2251X00020VNETS1D0F0",
    "pci_bdf": "86:00.0",
    "pci_dev_id": "0x1041",
    "pci_vendor_id": "0x1af4",
    "pci_class_code": "0x20000",
    "pci_subsys_id": "0x1",
    "pci_subsys_vendor_id": "0x1af4",
    "pci_revision_id": "1",
    "pci_max_vfs": "0",
    "enabled_vfs": "0",
    "device_feature": {
     "value": "0x8900010300e7182f",
     "    0": "VIRTIO_NET_F_CSUM",
     "    1": "VIRTIO_NET_F_GUEST_CSUM",
     "    2": "VIRTIO_NET_F_CTRL_GUEST_OFFLOADS",
     "    3": "VIRTIO_NET_F_MTU",
     "    5": "VIRTIO_NET_F_MAC",
     "   11": "VIRTIO_NET_F_HOST_TSO4",
     "   12": "VIRTIO_NET_F_HOST_TSO6",
     "   16": "VIRTIO_NET_F_STATUS",
     "   17": "VIRTIO_NET_F_CTRL_VQ",
     "   18": "VIRTIO_NET_F_CTRL_RX",
     "   21": "VIRTIO_NET_F_GUEST_ANNOUNCE",
     "   22": "VIRTIO_NET_F_MQ",
     "   23": "VIRTIO_NET_F_CTRL_MAC_ADDR",
     "   32": "VIRTIO_F_VERSION_1",
     "   33": "VIRTIO_F_IOMMU_PLATFORM",
     "   40": "VIRTIO_F_RING_RESET",
     "   56": "VIRTIO_NET_F_HOST_USO",
     "   59": "VIRTIO_NET_F_GUEST_HDRLEN",
     "   63": "VIRTIO_NET_F_SPEED_DUPLEX"
    },
...
}
```

2. To enable the feature:

    1. Make sure there is no driver loaded from the guest-OS side:

```
[host]# modprobe -rv virtio_net && modprobe -rv virtio_pci
```

2. Set the 15th bit to 1 in the feature bits, and modify the device:

```
[dpu]# virtnet modify -p 0 device -f 0x8900010300e7982f
{'pf': '0x0', 'all': '0x0', 'subcmd': '0x0', 'features': '0x8900010300e7982f'}
{
  "errno": 0,
  "errstr": "Success"
}
```

3. Load the drivers from the host:

```
[host]# modprobe -v virtio_pci && modprobe -v virtio_net
```

4. Query the device again, checking whether VIRTIO_F_MRG_RX_BUFFER is available. The following query shows VIRTIO_F_MRG_RX_BUFFER under device_feature and driver_feature. Now mergeable buffer is enabled on PF 0.

```
[dpu]# virtnet query -p 0 -b
{'all': '0x0', 'pf': '0x0', 'dbg_stats': '0x0', 'brief': '0x1', 'latency_stats': '0x0', 'stats_clear': '0x0'}
{
  "devices": [
    {
      "pf_id": 0,
      "transitional": 0,
      "vuid": "MT2251X00020VNETS0D0F1",
      "pci_bdf": "85:00.1",
      "pci_dev_id": "0x1041",
      "pci_vendor_id": "0x1af4",
      "pci_class_code": "0x20000",
      "pci_subsys_id": "0x1041",
      "pci_subsys_vendor_id": "0x1af4",
      "pci_revision_id": "1",
      "pci_max_vfs": "0",
```

```
"enabled_vfs": "0",
"device_feature": {
  "value": "0x8900032300e7982f",
  "    0": "VIRTIO_NET_F_CSUM",
  "    1": "VIRTIO_NET_F_GUEST_CSUM",
  "    2": "VIRTIO_NET_F_CTRL_GUEST_OFFLOADS",
  "    3": "VIRTIO_NET_F_MTU",
  "    5": "VIRTIO_NET_F_MAC",
  "   11": "VIRTIO_NET_F_HOST_TSO4",
  "   12": "VIRTIO_NET_F_HOST_TSO6",
  "   15": "VIRTIO_F_MRG_RX_BUFFER",
  "   16": "VIRTIO_NET_F_STATUS",
  "   17": "VIRTIO_NET_F_CTRL_VQ",
  "   18": "VIRTIO_NET_F_CTRL_RX",
  "   21": "VIRTIO_NET_F_GUEST_ANNOUNCE",
  "   22": "VIRTIO_NET_F_MQ",
  "   23": "VIRTIO_NET_F_CTRL_MAC_ADDR",
  "   32": "VIRTIO_F_VERSION_1",
  "   33": "VIRTIO_F_IOMMU_PLATFORM",
  "   37": "VIRTIO_F_SR_IOV",
  "   40": "VIRTIO_F_RING_RESET",
  "   41": "VIRTIO_F_ADMIN_VQ",
  "   56": "VIRTIO_NET_F_HOST_USO",
  "   59": "VIRTIO_NET_F_GUEST_HDRLEN",
  "   63": "VIRTIO_NET_F_SPEED_DUPLEX"
},
"driver_feature": {
  "value": "0x8000002300e7982f",
  "    0": "VIRTIO_NET_F_CSUM",
  "    1": "VIRTIO_NET_F_GUEST_CSUM",
  "    2": "VIRTIO_NET_F_CTRL_GUEST_OFFLOADS",
  "    3": "VIRTIO_NET_F_MTU",
  "    5": "VIRTIO_NET_F_MAC",
  "   11": "VIRTIO_NET_F_HOST_TSO4",
  "   12": "VIRTIO_NET_F_HOST_TSO6",
  "   15": "VIRTIO_F_MRG_RX_BUFFER",
  "   16": "VIRTIO_NET_F_STATUS",
  "   17": "VIRTIO_NET_F_CTRL_VQ",
  "   18": "VIRTIO_NET_F_CTRL_RX",
  "   21": "VIRTIO_NET_F_GUEST_ANNOUNCE",
  "   22": "VIRTIO_NET_F_MQ",
  "   23": "VIRTIO_NET_F_CTRL_MAC_ADDR",
  "   32": "VIRTIO_F_VERSION_1",
  "   33": "VIRTIO_F_IOMMU_PLATFORM",
```

```
      "   37": "VIRTIO_F_SR_IOV",
      "   63": "VIRTIO_NET_F_SPEED_DUPLEX"
    },
...
}
```

Limitations

- The number of descriptors per work queue entry depends on the MTU size. For best performance, it is recommended to not enable the feature if the MTU is set to the default value (1500).
- Performance is expected to degrade with this feature when receiving small sized packets (e.g., 64 bytes) from the wire.
- Mergeable buffer does not work with the packed VQ feature.

Performance Tuning

Number of Queues and MSIX

Driver Configuration

The virtio-net driver can configure the number of combined channels via ethtool. This determines how many virtqueues (VQs) can be used for the netdev. Normally, more VQs result in better overall throughput when if multi-threaded (e.g., iperf with multiple streams).

```
[host]# ethtool -l eth0
Channel parameters for eth0:
Pre-set maximums:
RX:             n/a
TX:             n/a
Other:          n/a
Combined:       31
Current hardware settings:
RX:             n/a
```

```
TX:             n/a
Other:          n/a
Combined:       15
```

Therefore, it is common to pick a larger number (less than pre-set maximums) of channels using the following command.

> **Tip**
>
> Normally, configuring the combined number of channels to be the same as number of CPUs available on the guest OS will yield good performance.

```
[host]# ethtool -L eth0 combined 31
[host]# ethtool -l eth0
Channel parameters for eth0:
Pre-set maximums:
RX:             n/a
TX:             n/a
Other:          n/a
Combined:       31
Current hardware settings:
RX:             n/a
TX:             n/a
Other:          n/a
Combined:       31
```

Device Configuration

To reach the best performance, it is required to make sure each tx/rx queue has an assigned MSIX. Check the information of a particular device and make sure num_queues is less than num_msix.

```
[dpu]# virtnet query -p 0 -b | grep -i num_
    "num_msix": "64",
    "num_queues": "8",
```

If num_queues is greater than num_msix, it is necessary to change mlxconfig to reserve more MSIX than queues. It is determined by the VIRTIO_NET_EMULATION_NUM_VF_MSIX and VIRTIO_NET_EMULATION_NUM_MSIX. Please refer to the "Virtio-net Deployment" page for more information.

Queue Depth

By default, queue depth is set to 256. It is common to use a larger queue depth (e.g., 1024). This cannot be requested from the driver side but must be done from the device side.

Refer to the "Virtnet CLI Commands" page to learn how to modify device max_queue_size.

MTU

To improve performance, the user can use jumbo MTU. Refer to "Jumbo MTU" page for information regarding MTU configuration.

Recovery

Introduction

Recovery is critical for status restoration (both control plane and data plane) for cases such as controller restart, live update, or live migration.

Recovery depends on the JSON files stored in /opt/mellanox/mlnx_virtnet/recovery where there is a file corresponding to each device (either PF or VF). The filename is the unique VUID of the corresponding device.

The following entries are saved to the recovery file and restored when necessary:

Entry	Type	Description
port_ib_dev	String	RDMA device name the virtio-net device is created on
pf_id	Number	ID of PF
vf_id	Number	ID of VF, valid for VF only
function_type	String	PF or VF
bdf_raw	Number	Virtio-net device bus:device:function in uint16 type
device_type	String	Static or hotplug (only for PF)
mac	String	MAC address of device
pf_num	Number	PCIe function number
sf_num	Number	SF number which was used for this virtio-net device
mq	Number	Number of multi-queue created for this virtio-net device

An example of recovery file for a hotplug PF device:

```
{
  "port_ib_dev": "mlx5_0",
  "pf_id": 0,
  "function_type": "pf",
  "bdf_raw": 57611,
  "device_type": "hotplug",
  "mac": "0c:c4:7a:ff:22:93",
  "pf_num": 0,
  "sf_num": 2000,
  "mq": 3
}
```

Use Cases

Depending on the actions of the BlueField or host, recovery may or may not be performed. Please refer to the following table for individual scenarios:

	DPU Actions			Host Actions				
	Restart Controller	Live Update	Hot Unplug	Destroy VFs	Unload Driver	Power Cycle Host & DPU	Warm Reboot	Live Migration
Static PF	Recover	Recover	N/A	N/A	Recover	No recover	Recover	Recover
Hotplug PF	Recover	Recover	No recover	N/A	Recover	No recover	Recover	Recover
VF	Recover	Recover	N/A	Recovery file deleted	No Recover	No recover	No recover	Recover

Note

These recovery files are internal to the controller and should not be modified.

Note

Controller recovery is enabled by default and does not need user configuration or intervention. When the mlxconfig settings used by the controller take effect, the newly started controller service automatically deletes all recovery files.

Transitional Device

Overview

A transitional device is a virtio device which supports drivers conforming to virtio specification 1.x and legacy drivers operating under virtio specification 0.95 (i.e., legacy mode) so servers with old Linux kernels can still utilize virtio-based technology.

Info

Currently, only transitional VF device is supported.

Note

Host kernel version must be newer than v6.9.

Note

When using this feature, vfe-vdpa-dpdk solutions cannot be used anymore, including vfe-vdpa-dpdk live migration.

Note

Libvirt does not support the virtio_vfio_pci kernel driver. Use the QEMU command line to start the VM instead.

Transitional Virtio-net VF Device

1. Configure virtio-net SR-IOV. R efer to "Virtio-net Deployment" for details.

2. Modify configuration file to add the "lm_prov": "kernel" option.

```
[dpu]# cat /opt/mellanox/mlnx_virtnet/virtnet.conf
{
...
"lm_prov": "kernel",
...
}
```

3. Restart the virtio-net controller for the configuration to take effect:

```
[dpu]# systemctl restart virtio-net-controller.service
```

4. Create virtio-net VF devices on the host:

```
[host]# modprobe -v virtio_pci
[host]# modprobe -v virtio_net
[host]# echo <vf_num> > /sys/bus/pci/devices/<pf_bdf>/sriov_numvfs
```

5. Bind the VF devices with the virtio_vfio_pci kernel driver:

```
[host]# echo <vf_bdf> > /sys/bus/pci/devices/<vf_bdf>/driver/unbind
[host]# echo 0x1af4 0x1041 > /sys/bus/pci/drivers/virtio_vfio_pci/new_id
[host]# modprobe -v virtio_vfio_pci
[host]# lspci -s <vf_bdf> -vvv | grep -i virtio_vfio_pci
Kernel driver in use: virtio_vfio_pci
```

6. Add the following option into the QEMU cmdline to passthrough the VF device into the VM:

```
-device vfio-pci,host=<vf_bdf>,id=hostdev0,bus=pci.<#BUS_IN_VM>,addr=<#FUNC_IN_VM>
```

7. Load virtio-net driver as legacy mode inside the VM:

```
[vm]# modprobe -v virtio_pci force_legacy=1
[vm]# modprobe -v virtio_net
[vm]# lspci -s <vf_bdf_in_vm> -n
00:0a.0 0200: 1af4:1000
```

8. Verify that the VF is a transitional device:

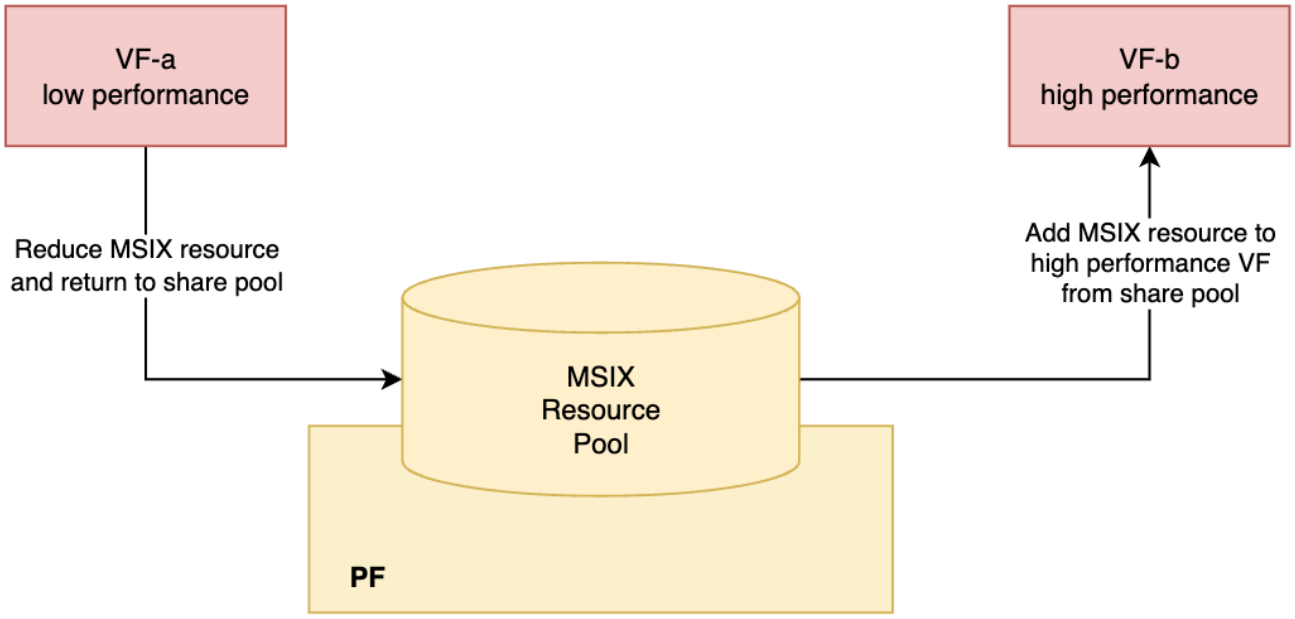
```
[dpu]# virtnet query -p <pf_id> -v <vf_id> | grep transitional
    "transitional": 1,
```

VF Dynamic MSIX

In virtio-net controller, each VF gets the same number of MSIX and virtqueues (VQs) so that each data VQ has a MSIX assigned. This means that changing the number of MSIX updates the number of VQs.

By default, each VF is assigned with the same number of MSIX, the default number is determined by the minimum of NUM_VF_MSIX and VIRTIO_NET_EMULATION_NUM_MSIX.

Using dynamic VF MSIX, a VF can be assigned with more MSIX/queues than its default. MSIX hardware resources of all VF devices are managed by PF via a shared MSIX pool. The user can reduce the MSIX of one VF, thus releasing its MSIX resources to the shared pool. On the other hand, another VF can be assigned with more MSIX than its default to gain more performance.



Firmware Configuration

The emulation VF device uses VIRTIO_NET_EMULATION_NUM_VF_MSIX to set the MSIX number.

VIRTIO_NET_EMULATION_NUM_VF_MSIX is available to set the MSIX number of the emulation VF device. For the emulation VF device, uses the new configuration VIRTIO_NET_EMULATION_NUM_VF_MSIX instead of the old configuration NUM_VF_MSIX.

- If VIRTIO_NET_EMULATION_NUM_VF_MSIX!=0, VIRTIO_NET_EMULATION_NUM_ MSIX is used for the PF only, and VF uses VIRTIO_NET_EMULATION_NUM_VF_MSIX.

  For example, to configure the default MSIX number for a VF to 32:

  ```
  [dpu]# mlxconfig -y -d 03:00.0 s VIRTIO_NET_EMULATION_NUM_ MSIX=32
  VIRTIO_NET_EMULATION_NUM_VF_MSIX=32
  ```

- If VIRTIO_NET_EMULATION_NUM_VF_MSIX==0, VIRTIO_NET_EMULATION_NUM_ MSIX is used for the PF and VF.

The default number of MSIX for each VF is determined by minimum(NUM_VF_MSIX, VIRTIO_NET_EMULATION_NUM_MSIX). For example, to configure the default MSIX number for a VF to 32:

```
[dpu]# mlxconfig -y -d 03:00.0 s VIRTIO_NET_EMULATION_NUM_MSIX=32 NUM_VF_MSIX=32
```

Power cycle the BlueField and host to have the mlxconfig taking effect.

MSIX

MSIX Capability

The MSIX pool for VFs is managed by their PF. To check the share pool size, run the following command (using PF 0 as example):

```
[dpu]# virtnet list | grep -i '"pf_id": 0' -A 8 | grep -i msix_num_pool_size
```

By default, the share pool size is empty (0), since all MSIX resources have already been allocated to VFs evenly. Upon reducing the MSIX of one or more VFs, the reduced MSIX is released back to the pool.

However, the number of MSIX can be assigned to a given VF is also bound by capability. To check those caps, run the following command:

```
[dpu]# virtnet list | grep -i '"pf_id": 0' -A 10 | grep -i max_msix_num
[dpu]# virtnet list | grep -i '"pf_id": 0' -A 10 | grep -i min_msix_num
```

To check the currently assigned number of MSIX, run the following command:

```
[dpu]# virtnet query -p 0 -v 0 | grep num_msix
```

If num_msix is less than max_msix_num cap, more MSIX can be assigned to the VF.

Reallocating VF MSIX

To allocate more MSIX to one VF, there should be MSIX available from the pool. This is done by reducing the MSIX from another VF(s).

The following example shows the steps to reallocate MSIX from VF1 to VF0, assuming that each VF has 32 MSIX available as default:

1. Unbind both VF devices from host driver.

```
[host]# echo <vf0_bdf> > /sys/bus/pci/drivers/virtio-pci/unbind
[host]# echo <vf1_bdf> > /sys/bus/pci/drivers/virtio-pci/unbind
```

2. Reduce the MSIX of VF1.

```
[dpu]# virtnet modify -p 0 -v 1 device -n 4
```

3. Check pool size of PF0.

```
[dpu]# virtnet list | grep -i '"pf_id": 0' -A 8 | grep -i msix_num_pool_size
```

   Confirm the reduced MSIX are added to the share pool.

4. Increase the MSIX of VF0.

```
[dpu]# virtnet modify -p 0 -v 0 device -n 48
```

5. Check the MSIX of VF0.

```
[dpu]# virtnet query -p 0 -v 0 | grep -i num_msix
```

6. Bind both VF devices to host driver.

```
[host]# echo <vf0_bdf> > /sys/bus/pci/drivers/virtio-pci/bind
[host]# echo <vf1_bdf> > /sys/bus/pci/drivers/virtio-pci/bind
```

Note

The number of MSIX must be an even number greater than 4.

MSIX Limitations

- MSIX and QP configuration is mutually exclusive (i.e., only one of them can be configured at a time). For example, the following modify command should result in failure:

  ```
  [dpu]# virtnet modify -p 0 -v 1 device -qp 2 -n 6
  ```

- To use a VF, make sure to assign a valid MSIX number:

  ```
  [dpu]# virtnet modify -p 0 -v 1 device -n 10
  ```

  The minimum number of MSIX resources required for the VF to load the host driver is 4 if VIRTIO_NET_F_CTRL_VQ is negotiated, or 2 if it is not.

- The MSIX resources of a VF can be reduced to 0, but doing so prevents the VF from functioning.

  ```
  [dpu]# virtnet modify -p 0 -v 1 device -n 0
  ```

Queue Pairs

Queue pairs (QPs) are the number of data virtio queue (VQ) pairs. Each VQ pair has one transmit (TX) queue and one receive (RX) queue. These pairs are dedicated to handling data traffic and do not include control or admin VQs.

QP Capability

The QP pool for VFs is managed by their PF.

To check the shared pool size, run the following command (using PF 0 as example):

```
[dpu]# virtnet list | grep -i '"pf_id": 0' -A 13 | grep -i qp_pool_size
```

By default, the shared pool size is empty (0), since all QP resources have already been allocated to VFs evenly. Upon reducing the QP of one or more VFs, the reduced QP is released back into the pool.

However, the number of QPs assignable to a VF depends on its supported capabilities. To verify these capabilities, run the following command:

```
[dpu]# virtnet list | grep -i '"pf_id": 0' -A 12 | grep -i max_num_of_qp
[dpu]# virtnet list | grep -i '"pf_id": 0' -A 12 | grep -i min_num_of_qp
```

To check the currently assigned number of QPs, run the following command:

```
[dpu]# virtnet query -p 0 -v 0 | grep max_queue_pairs
```

If max_queue_pairs is less than max_num_of_qp cap, then more QPs can be assigned to the VF.

Reallocating VF QPs

To allocate more QPs to one VF, there should be QPs available from the pool as explained in the previous section.

The following example illustrates the process of reallocating a QP from VF1 to VF0, assuming that each VF initially has 32 QPs available by default:

1. Unbind both VF devices from the host driver:

```
[host]# echo <vf0_bdf> > /sys/bus/pci/drivers/virtio-pci/unbind
[host]# echo <vf1_bdf> > /sys/bus/pci/drivers/virtio-pci/unbind
```

2. Reduce the number of QPs VF1 has:

```
[dpu]# virtnet modify -p 0 -v 1 device -qp 1
```

3. Check the pool size of PF0 and confirm that the reduced number of QPs are added to the shared pool:

```
[dpu]# virtnet list | grep -i '"pf_id": 0' -A 13 | grep -i qp_pool_size
```

4. Increase the number of QPs VF0 has:

```
[dpu]# virtnet modify -p 0 -v 0 device -qp 23
```

5. Check the number of QPs VF0 has:

```
[dpu]# virtnet query -p 0 -v 0 | grep -i max_queue_pairs
```

6. Bind both VF devices to the host driver:

```
[host]# echo <vf0_bdf> > /sys/bus/pci/drivers/virtio-pci/bind
[host]# echo <vf1_bdf> > /sys/bus/pci/drivers/virtio-pci/bind
```

Note

The number of QPs must be greater than 0.

QP Limitations

- QP and MSIX configuration is mutually exclusive (i.e., only one of them can be configured at a time). For example, the following modify command should result in failure:

```
[dpu]# virtnet modify -p 0 -v 1 device -qp 2 -n 6
```

- To use a VF, assign it with a valid QP number:

```
[dpu]# virtnet modify -p 0 -v 1 device -n 4
```

  The minimum number of QP resources which allows the VF to load the host driver is 1.

- The QP resources of a VF can be reduced to 0. However, the VF would not be functional in this case.

```
[dpu]# virtnet modify -p 0 -v 1 device -qp 0
```

Virtio-net Feature Bits

Per virtio spec, virtio the device negotiates with the virtio driver on the supported features when the driver probes the device. The final negotiated features are a subset of the features supported by the device.

From the controller's perspective, all feature bits can be supported by a device are populated by `virtnet list`. Each individual virtio-net device is able to choose the feature bits supported by itself.

The following is a list of the feature bits currently supported by controller:

- VIRTIO_NET_F_CSUM
- VIRTIO_NET_F_GUEST_CSUM
- VIRTIO_NET_F_CTRL_GUEST_OFFLOADS
- VIRTIO_NET_F_MTU
- VIRTIO_NET_F_MAC
- VIRTIO_NET_F_HOST_TSO4
- VIRTIO_NET_F_HOST_TSO6
- VIRTIO_NET_F_MRG_RXBUF
- VIRTIO_NET_F_STATUS
- VIRTIO_NET_F_CTRL_VQ
- VIRTIO_NET_F_CTRL_RX
- VIRTIO_NET_F_CTRL_VLAN
- VIRTIO_NET_F_GUEST_ANNOUNCE
- VIRTIO_NET_F_MQ
- VIRTIO_NET_F_CTRL_MAC_ADDR

- VIRTIO_F_VERSION_1
- VIRTIO_F_IOMMU_PLATFORM
- VIRTIO_F_RING_PACKED
- VIRTIO_F_ORDER_PLATFORM
- VIRTIO_F_SR_IOV
- VIRTIO_F_NOTIFICATION_DATA
- VIRTIO_F_RING_RESET
- VIRTIO_F_ADMIN_VQ
- VIRTIO_NET_F_HOST_USO
- VIRTIO_NET_F_HASH_REPORT
- VIRTIO_NET_F_GUEST_HDRLEN
- VIRTIO_NET_F_SPEED_DUPLEX

Info

For more information on these bits, refer to the *VIRTIO Version 1.2 Specifications*.

Virt Queue Types

Virtqueues (VQs) are the mechanism for bulk data transport on virtio devices. Each device can have zero or more VQs.

VQs can be in one of the following modes:

- Split

- Packed

> ⚠ **Warning**
>
> When changing the supported VQ types, make sure to unload the guest driver first so the device can modify the supported feature bits.

Split VQ

Currently the default VQ type. Split VQ format is the only format supported by version 1.0 of the virtio spec.

In split VQ mode, each VQ is separated into three parts:

- Descriptor table – occupies the descriptor area
- Available ring – occupies the driver area
- Used ring – occupies the device area

Each of these parts is physically-contiguous in guest memory. Split VQ has a very simple design, but its sparse memory usage puts pressure on CPU cache utilization and requires several PCIe transactions for each descriptor.

Configuration

The following shows how the output of the virtnet list command appears only when split VQ mode is enabled:

```
"supported_virt_queue_types": {
    "value": "0x1",
    "    0": "SPLIT"
  },
```

Packed VQ

Packed VQ addresses the limitations of split VQ by merging the three rings in one location in virtual environment guest memory. This mode allows for fewer PCIe transactions and better CPU cache utilization per each descriptor access.

> **Info**
>
> Packed VQ is supported from kernel 5.0 with the virtio-support-packed-ring commit from the guest OS.

Configuration

Packed VQ mode can be enabled by defining packed_vq in the configuration file at the following path /opt/mellanox/mlnx_virtnet/virtnet.conf.

The following is an example of the packed_vq enabled in the configuration file:

```
{
  "single_port": 1,
  "packed_vq": 1,
  "sf_pool_percent": 0,
  "sf_pool_force_destroy": 0,
   "vf": {
    "mac_base": "CC:48:15:FF:00:00",
    "vfs_per_pf": 126
  }
}
```

The controller must be restarted after the configuration file is modified for the changes to take effect. Make sure to unload virtio-net/virtio-pcie drivers on the host and run:

```
[dpu]# systemctl restart virtio-net-controller.service
```

To check if the configuration has taken effect and controller supported packed VQ mode, run:

```
[dpu]# virtnet list
```

Check for PACKED in supported_virt_queue_types:

```
"supported_virt_queue_types": {
     "value": "0x3",
     "    0": "SPLIT",
     "    1": "PACKED"
   },
```

Virtio-net/virtio-pci drivers can be loaded at this point to create VQs in packed mode. Once the driver is loaded to verify that the device has packed VQ mode enabled, run the following command:

```
[dpu]# virtnet query -p <PFID> -v <VFID>
```

Check for VIRTNET_F_RING_PACKED in the driver features:

```
"driver_feature": {
       "value": "0x8930012700e7182f",
       "    0": "VIRTIO_NET_F_CSUM",
       "    1": "VIRTIO_NET_F_GUEST_CSUM",
       "    2": "VIRTIO_NET_F_CTRL_GUEST_OFFLOADS",
       "    3": "VIRTIO_NET_F_MTU",
       "    5": "VIRTIO_NET_F_MAC",
       "   11": "VIRTIO_NET_F_HOST_TSO4",
       "   12": "VIRTIO_NET_F_HOST_TSO6",
       "   16": "VIRTIO_NET_F_STATUS",
       "   17": "VIRTIO_NET_F_CTRL_VQ",
       "   18": "VIRTIO_NET_F_CTRL_RX",
       "   21": "VIRTIO_NET_F_GUEST_ANNOUNCE",
       "   22": "VIRTIO_NET_F_MQ",
```

```
    "   23": "VIRTIO_NET_F_CTRL_MAC_ADDR",
    "   32": "VIRTIO_F_VERSION_1",
    "   33": "VIRTIO_F_IOMMU_PLATFORM",
    "   34": "VIRTIO_F_RING_PACKED",
    "   37": "VIRTIO_F_SR_IOV",
    "   40": "VIRTIO_F_RING_RESET",
    "   52": "VIRTIO_NET_F_VQ_NOTF_COAL",
    "   53": "VIRTIO_NET_F_NOTF_COAL",
    "   56": "VIRTIO_NET_F_HOST_USO",
    "   59": "VIRTIO_NET_F_GUEST_HDRLEN",
    "   63": "VIRTIO_NET_F_SPEED_DUPLEX"
  },
```

If there are VFs mapped to multiple VMs then it is possible to have some devices create VQs in packed mode and some in split mode depending on the OS version and whether the driver has the feature supported.

Known Limitations

The following features are not currently supported when packed VQ is enabled:

- Mergeable buffer
- Jumbo MTU
- UDP segmentation offload and RSS hash report

Trobuleshooting

This section covers the following topics:

BlueField-3 Jumbo MTU Not Working

Problem

Ping failed with packet size greater than 1500/4000 after configuring jumbo MTU.

Solution

Jumbo MTU is supported starting from the following kernel version:

	Release
Upstream	VM kernel: 4.18.0-193.el8.x86_64 VM Linux version supports big MTU after 4.11.
Ubuntu	DOCA_2.5.0_BSP_4.5.0_Ubuntu_22.04
Virtnet	v1.7 or v1.6.26

The following steps configure jumbo MTU:

1. Change the MTU of uplink representor (or bond) from the BlueField Arm OS:

```
# echo 9216 > /sys/bus/pci/devices/0000:03:00.0/net/p0/mtu
```

2. Restart virtio-net-controller from the BlueField Arm OS:

```
# systemctl restart virtio-net-controlle
```

3. Change the corresponding device MTU on BlueField Arm OS. For example, for the first VF on the first PF, run:

```
# virtnet modify -p 0 -v 0 device -t 9216
```

4. Reload the virtio driver from the guest OS:

```
# modprobe -rv virtio-net && modprobe -v virtio-net
```

5. Verify the VQs' MTU configuration is correct on BlueField Arm OS:

```
# virtnet query -p 0 -v 0 --dbg_stats | grep jumbo_mtu
   "jumbo_mtu": 1
   "jumbo_mtu": 1
```

6. Change the MTU of the virtio-net interface from the guest OS:

```
# echo 9216 > /sys/bus/pci/devices/0000:af:00.2/virtio0/net/enp175s0f2/mtu
```

Failed to Start virtio-net-controller.service

Problem

The problem can be verified using the following commands:

```
# virtnet list
ERR: Can't connect to virtnet controller: [Errno 111] Connection refused
    Check 'systemctl status virtio-net-controller'
    Or controller is not ready to accept commands
```

```
# systemctl status virtio-net-controller
  virtio-net-controller.service - Nvidia VirtIO Net Controller Daemon
  Loaded: loaded (/etc/systemd/system/virtio-net-controller.service; enabled; vendor preset: disabled)
  Active: inactive (dead) since Fri 2023-10-27 17:46:59 CDT; 2min 26s ago
    Docs: file:/opt/mellanox/mlnx_virtnet/README.md
 Process: 29652 ExecStart=/usr/sbin/virtio_net_manager (code=exited, status=0/SUCCESS)
Main PID: 29652 (code=exited, status=0/SUCCESS)
```

Solution

The problem may happen due to the following reasons.

Virtio-net Not Enabled

1. Check if mlxconfig has VIRTIO_NET_EMULATION_ENABLE enabled:

   ```
   # mlxconfig -d 03:00.0 -e q | grep -i VIRTIO_NET_EMULATION_ENABLE
   *        VIRTIO_NET_EMULATION_ENABLE              False(0)         True(1)         True(1)
   ```

   Both 2 and 3 columns should appear as true.

2. If they are not, perform the following from the BlueField Arm side:

```
# mlxconfig -d 03:00.0 s VIRTIO_NET_EMULATION_ENABLE=1
```

3. Perform a BlueField system-level reset as documented in the BlueField software documentation.

Not Enough SFs Reserved

This can happen when more VIRTIO_NET_EMULATION_NUM_PF are reserved than PF_TOTAL_SF, as each virtio-net PF/VF requires a corresponding SF created:

```
# mlxconfig -d 03:00.0 -e q | grep -iE 'PF_TOTAL_SF|VIRTIO_NET_EMULATION_NUM_PF'
*        VIRTIO_NET_EMULATION_NUM_PF              0            4            4
*        PF_TOTAL_SF                              0            8            8
```

Info

By default, the BlueField creates an SF for each PF. Take this into consideration when reserving PF_TOTAL_SF.

Function Not Implemented Error When Creating VF

Problem

Creating a virtio-net VF returns an error from the command line:

```
# echo 3 > /sys/bus/pci/drivers/virtio-pci/0000:41:00.2/sriov_numvfs
write error: Function not implemented
```

The host-side dmesg shows the following:

```
[  301.204661] virtio-pci 0000:41:00.2: Driver doesn't support SRIOV configuration via sysfs
```

Solution

Virtio SR-IOV is only supported starting from the following kernel version:

	Release
Upstream	4.18 with commit cfecc2918d2b3
Ubuntu	Ubuntu-hwe-4.18.0-9.10_18.04.1
CentOS	3.10.0-957.el7 / 7.6.1810

Guest OS Hangs When Creating VF

Problem

The following command from the hypervisor hangs:

```
# echo 100 > /sys/bus/pci/drivers/virtio-pci/0000:89:00.4/sriov_numvfs
```

Solution

This can happen when more VIRTIO_NET_EMULATION_NUM_PF/VIRTIO_NET_EMULATION_NUM_VF are reserved than PF_TOTAL_SF (VIRTIO_NET_EMULATION_NUM_PF + VIRTIO_NET_EMULATION_NUM_VF >

PF_TOTAL_SF) as each virtio-net PF/VF requires a corresponding SF created. Example:

```
# mlxconfig -d 03:00.0 -e q | grep -iE
'PF_TOTAL_SF|VIRTIO_NET_EMULATION_NUM_PF|VIRTIO_NET_EMULATION_NUM_VF'
*        VIRTIO_NET_EMULATION_NUM_VF              0          126          126
*        VIRTIO_NET_EMULATION_NUM_PF              0          4            4
*        PF_TOTAL_SF                              0          508          508
```

Info

By default, BlueField creates an SF for each PF. Take this into consideration when reserving PF_TOTAL_SF.

Note

BlueField supports a limited number of SFs. The SF reserved on the BlueField Arm side and host side are not shared. Make sure to remove the SFs reserved on the host side when reserving a large number on the BlueField Arm side.

Hotplug Device Does Not Show Correctly in Guest OS

Problem

After creating a hotplug device from the BlueField side, probing virtio drivers does not create the virtio-net device correctly.

Solution

The problem may happen due to the following reasons.

BAR 0

Possible failure on BAR 0. check dmesg from guest OS for corresponding hotplug BDF:

```
[10.874845] pci 0000:87:00.1: BAR 0: failed to assign [mem size 0x00100000]
```

> **Info**
>
> In this example, the hotplug PCIe BDF is 87:00.1. This value can be retrieved using "lspci | grep -i virtio" from the guest OS.

This can be normally resolved by adding "pci=realloc" in the Linux command line (grub).

BAR 14/15

Possible failure on other PCIe BAR. Check the dmesg from the guest OS for the corresponding hotplug BDF:

```
[ 2893.484281] pcieport 0000:10:01.0: bridge window [mem 0x00100000-0x000fffff] to [bus 12]
add_size 200000 add_align 100000
[ 2893.484285] pcieport 0000:10:01.0: BAR 14: no space for [mem size 0x00200000]
[ 2893.484287] pcieport 0000:10:01.0: BAR 14: failed to assign [mem size 0x00200000]
[ 2893.484289] pcieport 0000:10:01.0: BAR 14: no space for [mem size 0x00200000]
[ 2893.484290] pcieport 0000:10:01.0: BAR 14: failed to assign [mem size 0x00200000]
```

> **Info**

In this example, the hotplug PCIe BDF is 10:01.0. This value can be retrieved using "lspci | grep -i virtio" from the guest OS.

- This is mostly due to there being insufficient BAR resources. Try to reduce the PF BAR size by performing the following from the BlueField side:

```
# mlxconfig -d 03:00.0 s PF_LOG_BAR_SIZE=0
```

- This can also be caused by the BIOS provider not reserving enough memory. Check the guest OS's dmesg for similar messages for the PCIe bus of the BlueField device:

```
[3.979061] pci_bus 0000:a0: root bus resource [mem 0x41c0800000-0x41c10fffff window] (9M)
[3.979062] pci_bus 0000:a0: root bus resource [bus a0-bf]
[4.017770] pci 0000:a4:00.0:   bridge window [mem 0x41c0800000-0x41c0ffffff 64bit pref] (8M)
[4.018243] pci 0000:a4:00.0: BAR 15: no space for [mem size 0x05800000 64bit pref] (88M)
[4.018245] pci 0000:a4:00.0: BAR 15: failed to assign [mem size 0x05800000 64bit pref]
```

  - On the host, the prefetchable memory limit of the root bus (a0) is only 9 M. This means that all the devices under this bus (including BlueField) can only be allocated 9M prefetchable memory in total.

  - The BAR 15 is the total prefetchable memory limit on the bridge (a4) of the device. The PCI bridge window of the BlueField for prefetchable memory is 8M, but the bridge requires 88M for its child device (BlueField). A fter several attempts, the PCIe bridge did not find sufficient IO memory to allocate for BlueField BARs. This can be solved by contacting the BIOS provider to provide enough memory to the PCI root.

Rescan

If the the hotplug operation from the BlueField Arm side is performed before the guest OS is up, and the virtio device is not found by the command "lspci | grep -i virtio". Try to rescan from guest OS:

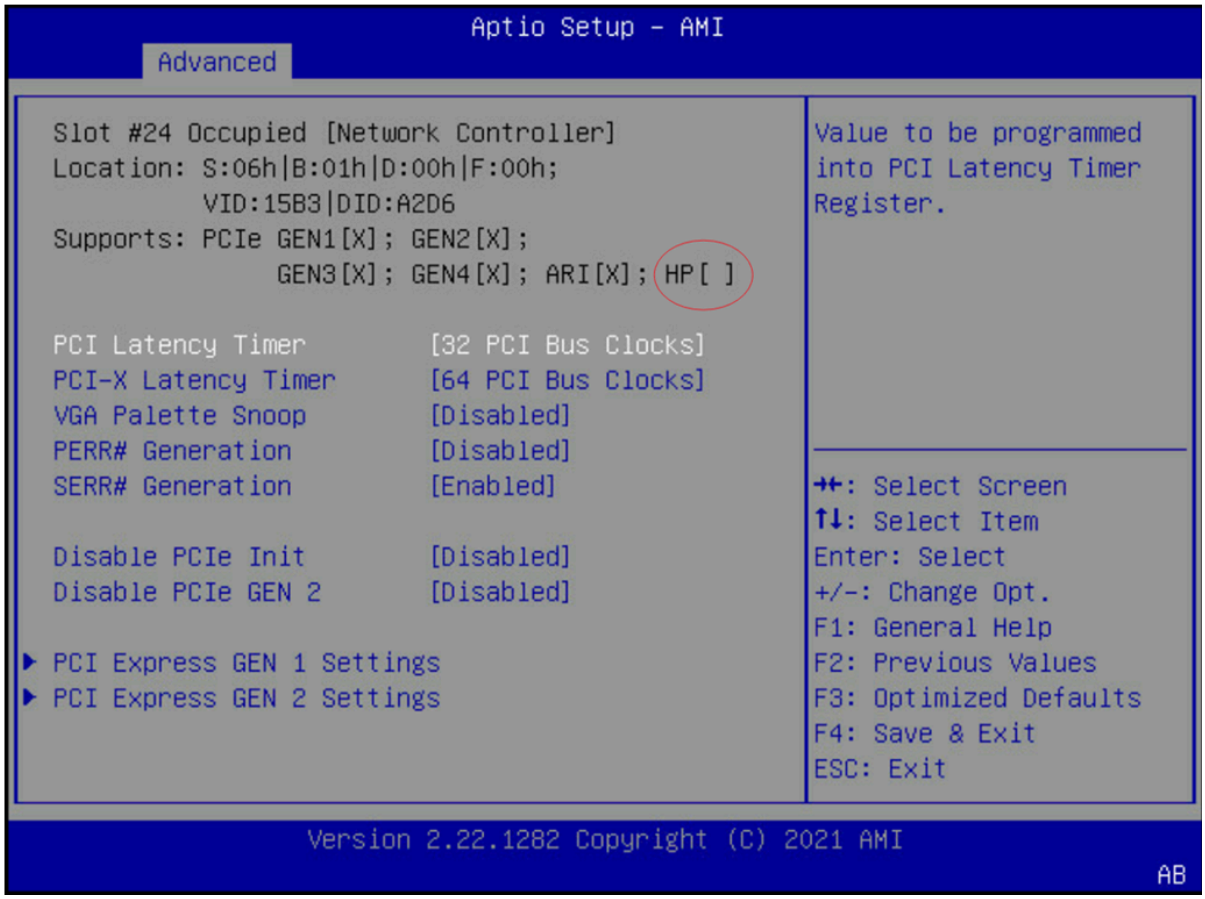
```
# echo 1>/sys/bus/pci/rescan
```

No Hotplug from BIOS

The server BIOS may not support hotplug device. This can be confirmed by looking at guest OS dmesg:

```
[8.209406] acpi PNP0A08:03: _OSC: platform does not support [PCIeHotplug PME]
```

Try to enable hotplug from the BIOS:



Force Hotplug

Guest OS may be running a kernel older than 4.19, the virtio device is not found by "lspci | grep -i virtio". Add the entry pciehp.pciehp_force=1 to the grub command line.

Hot-unplug Devices with Heavy Self-traffic, Guest OS Gets Call Trace

Problem

When the guest OS is running heavy traffic (e.g., iperf/iperf3) on a hotplug virtio-net device, unplugging those devices from BlueField side at the same time may results in the guest OS hanging.

The guest OS would print a call traffic similar like the following:

```
[  203.886218] CPU: 35 PID: 3077 Comm: iperf3 Not tainted 6.6.0 #1
[  203.886222] Hardware name: Dell Inc. PowerEdge R7525/0590KW, BIOS 2.2.5 04/08/2021
[  203.886224] RIP: 0010:free_old_xmit_skbs+0x5d/0xf0 [virtio_net]
[  203.886247] Code: 41 f6 c4 01 75 75 66 90 44 89 fe 4c 89 e7 45 03 6c 24 70 e8 65 1a 0a f0 83 c3 01 49
8b 3e 48 8d 75 cc e8 26 21 d1 ef 49 89 c4 <48> 85 c0 75 d1 85 db 74 0e 4d 01 ae 80 02 00 00 49 01 9e
78 02 00
[  203.886249] RSP: 0018:ffffac62cb837678 EFLAGS: 00000246
[  203.886253] RAX: 0000000000000000 RBX: 0000000000000000 RCX: ffff9a35e7dbc000
[  203.886255] RDX: 0000000000000000 RSI: ffffac62cb83767c RDI: ffff9a2e5e7d8900
[  203.886257] RBP: ffffac62cb8376b0 R08: 0000000000000000 R09: 000000000003b2f0
[  203.886259] R10: ffff9a2e4a570b00 R11: 000000000000000c R12: 0000000000000000
[  203.886261] R13: 0000000000000000 R14: ffff9a2e62a48800 R15: 0000000000000000
[  203.886263] FS:  00007f8444643400(0000) GS:ffff9a359f2c0000(0000) knlGS:0000000000000000
[  203.886266] CS:  0010 DS: 0000 ES: 0000 CR0: 0000000080050033
[  203.886268] CR2: 000056277998d028 CR3: 0000000127976000 CR4: 0000000000350ee0
[  203.886270] Call Trace:
[  203.886274]  <NMI>
[  203.886277]  ? show_regs+0x6e/0x80
[  203.886289]  ? nmi_cpu_backtrace+0xb1/0x120
[  203.886298]  ? nmi_cpu_backtrace_handler+0x15/0x20
[  203.886305]  ? nmi_handle+0x6b/0x180
[  203.886310]  ? default_do_nmi+0x45/0x120
[  203.886316]  ? exc_nmi+0x142/0x1c0
```

```
[ 203.886319] ? end_repeat_nmi+0x16/0x67
[ 203.886328] ? free_old_xmit_skbs+0x5d/0xf0 [virtio_net]
[ 203.886334] ? free_old_xmit_skbs+0x5d/0xf0 [virtio_net]
[ 203.886341] ? free_old_xmit_skbs+0x5d/0xf0 [virtio_net]
[ 203.886347] </NMI>
[ 203.886348] <TASK>
[ 203.886349] ? free_old_xmit_skbs+0x8c/0xf0 [virtio_net]
[ 203.886356] start_xmit+0x149/0x500 [virtio_net]
[ 203.886364] dev_hard_start_xmit+0x95/0x1e0
[ 203.886370] ? validate_xmit_skb_list+0x51/0x80
[ 203.886374] sch_direct_xmit+0x10c/0x3a0
[ 203.886381] __dev_queue_xmit+0xa47/0xda0
[ 203.886387] ip_finish_output2+0x2ef/0x5a0
[ 203.886393] ? srso_return_thunk+0x5/0x10
[ 203.886400] ? nf_conntrack_in+0xeb/0x6c0 [nf_conntrack]
[ 203.886428] __ip_finish_output+0xb7/0x190
[ 203.886433] ip_finish_output+0x32/0x100
[ 203.886437] ip_output+0x63/0xf0
[ 203.886441] ? __pfx_ip_finish_output+0x10/0x10
[ 203.886446] ip_local_out+0x62/0x70
[ 203.886449] __ip_queue_xmit+0x18e/0x4b0
[ 203.886454] ip_queue_xmit+0x19/0x20
[ 203.886456] __tcp_transmit_skb+0xb2d/0xcd0
[ 203.886462] ? srso_return_thunk+0x5/0x10
[ 203.886469] tcp_write_xmit+0x565/0x1620
[ 203.886474] tcp_push_one+0x40/0x50
[ 203.886476] tcp_sendmsg_locked+0x350/0xee0
[ 203.886481] ? tcp_current_mss+0x75/0xd0
[ 203.886488] tcp_sendmsg+0x31/0x50
[ 203.886491] inet_sendmsg+0x47/0x80
[ 203.886498] sock_write_iter+0x163/0x190
[ 203.886507] vfs_write+0x342/0x3f0
[ 203.886517] ksys_write+0xb9/0xf0
[ 203.886520] __x64_sys_write+0x1d/0x30
[ 203.886522] do_syscall_64+0x60/0x90
[ 203.886528] ? srso_return_thunk+0x5/0x10
[ 203.886531] ? ksys_write+0xb9/0xf0
[ 203.886532] ? srso_return_thunk+0x5/0x10
[ 203.886535] ? exit_to_user_mode_prepare+0x35/0x180
[ 203.886542] ? srso_return_thunk+0x5/0x10
[ 203.886544] ? syscall_exit_to_user_mode+0x38/0x50
[ 203.886549] ? __x64_sys_write+0x1d/0x30
[ 203.886551] ? srso_return_thunk+0x5/0x10
[ 203.886553] ? do_syscall_64+0x6d/0x90
```

```
[ 203.886556] ? srso_return_thunk+0x5/0x10
[ 203.886558] ? syscall_exit_to_user_mode+0x38/0x50
[ 203.886561] ? srso_return_thunk+0x5/0x10
[ 203.886564] ? do_syscall_64+0x6d/0x90
[ 203.886566] ? __x64_sys_write+0x1d/0x30
[ 203.886568] ? srso_return_thunk+0x5/0x10
[ 203.886570] ? do_syscall_64+0x6d/0x90
[ 203.886572] ? srso_return_thunk+0x5/0x10
[ 203.886575] ? sysvec_apic_timer_interrupt+0x52/0x90
[ 203.886578] entry_SYSCALL_64_after_hwframe+0x6e/0xd8
```

Root Cause

From kernel 5.14, the following patch introduced a while loop for the virtio-net TX path which may enter infinite when VQ is broken (e.g., device is removed) under heavy traffic:

```
commit a7766ef18b33674fa164e2e2916cef16d4e17f43
Author: Michael S. Tsirkin <mst@redhat.com>
Date:   Tue Apr 13 01:30:45 2021 -0400

    virtio_net: disable cb aggressively

    There are currently two cases where we poll TX vq not in response to a
    callback: start xmit and rx napi.  We currently do this with callbacks
    enabled which can cause extra interrupts from the card.  Used not to be
    a big issue as we run with interrupts disabled but that is no longer the
    case, and in some cases the rate of spurious interrupts is so high
    linux detects this and actually kills the interrupt.

    Fix up by disabling the callbacks before polling the tx vq.

    Signed-off-by: Michael S. Tsirkin <mst@redhat.com>
```

Solution

Currently, there is no official fix from the kernel side, some The following workarounds may be employed:

- Use kernel without the offending kernel patches

- Stop heavy traffic while performing unplug

Ubuntu Guest OS Hangs with Kernel 5.15.0-88/89-generic

Problem

When probing the virtio-pci and virtio-net kernel modules while running Ubuntu 22.04 with kernel 5.15.0-88/89-generic with any virtio function (i.e, PF or VF), the guest OS hangs and prints call traces as follows:

```
[ 2052.109566] CPU: 0 PID: 1183 Comm: systemd-udevd Tainted: P          O L    5.15.0-88-generic #98-
Ubuntu
[ 2052.109568] Hardware name: Red Hat KVM, BIOS 1.15.0-2.module+el8.6.0+14757+c25ee005
04/01/2014
[ 2052.109570] RIP: 0010:virtqueue_is_broken+0x9/0x20
[ 2052.109579] RSP: 0018:ffffc206423a79c0 EFLAGS: 00000246
[ 2052.109581] RAX: 0000000000000000 RBX: ffff9e8980bfa980 RCX: 0000000000000a20
[ 2052.109582] RDX: 0000000000000000 RSI: ffffc206423a79cc RDI: ffff9e89847b9000
[ 2052.109583] RBP: ffffc206423a7a60 R08: 0000000000000000 R09: 0000000000000003
[ 2052.109584] R10: 0000000000000003 R11: 0000000000000002 R12: ffffc206423a79f0
[ 2052.109585] R13: 0000000000000002 R14: 0000000000000004 R15: ffff9e8984667400
[ 2052.109586] FS:  00007f3e295388c0(0000) GS:ffff9e89bbc00000(0000) knlGS:0000000000000000
[ 2052.109588] CS:  0010 DS: 0000 ES: 0000 CR0: 0000000080050033
[ 2052.109590] CR2: 0000555613432be0 CR3: 0000000116af0002 CR4: 0000000000170ef0
[ 2052.109593] Call Trace:
[ 2052.109595]  <IRQ>
[ 2052.109598]  ? show_trace_log_lvl+0x1d6/0x2ea
[ 2052.109605]  ? show_trace_log_lvl+0x1d6/0x2ea
[ 2052.109609]  ? _virtnet_set_queues+0xbb/0x100 [virtio_net]
[ 2052.109615]  ? show_regs.part.0+0x23/0x29
[ 2052.109618]  ? show_regs.cold+0x8/0xd
[ 2052.109621]  ? watchdog_timer_fn+0x1be/0x220
[ 2052.109625]  ? lockup_detector_update_enable+0x60/0x60
[ 2052.109627]  ? __hrtimer_run_queues+0x107/0x230
[ 2052.109631]  ? kvm_clock_get_cycles+0x11/0x20
[ 2052.109637]  ? hrtimer_interrupt+0x101/0x220
[ 2052.109640]  ? __sysvec_apic_timer_interrupt+0x61/0xe0
[ 2052.109644]  ? sysvec_apic_timer_interrupt+0x7b/0x90
```

```
[ 2052.109650]  </IRQ>
[ 2052.109650]  <TASK>
[ 2052.109651]  ? asm_sysvec_apic_timer_interrupt+0x1b/0x20
[ 2052.109655]  ? virtqueue_is_broken+0x9/0x20
[ 2052.109656]  ? virtnet_send_command+0x105/0x170 [virtio_net]
[ 2052.109660]  _virtnet_set_queues+0xbb/0x100 [virtio_net]
[ 2052.109670]  virtnet_probe+0x4ca/0xa10 [virtio_net]
[ 2052.109674]  virtio_dev_probe+0x1ae/0x260
[ 2052.109676]  really_probe+0x222/0x420
[ 2052.109679]  __driver_probe_device+0xe8/0x140
[ 2052.109681]  driver_probe_device+0x23/0xc0
[ 2052.109683]  __driver_attach+0xf7/0x1f0
[ 2052.109685]  ? __device_attach_driver+0x140/0x140
[ 2052.109687]  bus_for_each_dev+0x7f/0xd0
[ 2052.109691]  driver_attach+0x1e/0x30
[ 2052.109693]  bus_add_driver+0x148/0x220
[ 2052.109695]  driver_register+0x95/0x100
[ 2052.109697]  register_virtio_driver+0x20/0x40
[ 2052.109698]  virtio_net_driver_init+0x74/0x1000 [virtio_net]
[ 2052.109702]  ? 0xffffffffc0d6f000
[ 2052.109704]  do_one_initcall+0x49/0x1e0
[ 2052.109709]  ? kmem_cache_alloc_trace+0x19e/0x2e0
[ 2052.109713]  do_init_module+0x52/0x260
[ 2052.109716]  load_module+0xb2b/0xbc0
[ 2052.109718]  __do_sys_finit_module+0xbf/0x120
[ 2052.109721]  __x64_sys_finit_module+0x18/0x20
[ 2052.109722]  do_syscall_64+0x5c/0xc0
[ 2052.109725]  ? do_syscall_64+0x69/0xc0
[ 2052.109726]  ? syscall_exit_to_user_mode+0x35/0x50
[ 2052.109729]  ? __x64_sys_newfstatat+0x1c/0x30
[ 2052.109733]  ? do_syscall_64+0x69/0xc0
[ 2052.109735]  entry_SYSCALL_64_after_hwframe+0x62/0xcc
```

Solution

There is a bug in upstream version v6.5-rc4, which is fixed in v6.5-rc7. Canonical backported the problematic patch to Ubuntu 5.15.0-88/89.generic, which triggers this Virtio-net deadlock issue:

```
commit 51b813176f098ff61bd2833f627f5319ead098a5
Author: Jason Wang <jasowang@redhat.com>
```

```
Date:   Wed Aug 9 23:12:56 2023 -0400

    virtio-net: set queues after driver_ok

    Commit 25266128fe16 ("virtio-net: fix race between set queues and
    probe") tries to fix the race between set queues and probe by calling
    _virtnet_set_queues() before DRIVER_OK is set. This violates virtio
    spec. Fixing this by setting queues after virtio_device_ready().

    Note that rtnl needs to be held for userspace requests to change the
    number of queues. So we are serialized in this way.

    Fixes: 25266128fe16 ("virtio-net: fix race between set queues and probe")
    Reported-by: Dragos Tatulea <dtatulea@nvidia.com>
    Acked-by: Michael S. Tsirkin <mst@redhat.com>
    Signed-off-by: Jason Wang <jasowang@redhat.com>
    Signed-off-by: David S. Miller <davem@davemloft.net>
```

Switch default kernel back to another version (e.g., 5.15.0-79-generic).

> **Note**
>
> From 5.15.0-90-generic, the Ubuntu official kernel has the issue fixed.

There are multiple ways to switch the default kernel. The following is only one example:

> **Note**
>
> Users must have root permission before proceeding.

1. Open /etc/default/grub and change GRUB_DEFAULT as follows:

```
GRUB_DEFAULT=saved
```

2. Save file.

3. Run the following to get the number of the kernel you want

```
# grep "menuentry 'Ubuntu," /boot/grub/grub.cfg
```

> **Info**
>
> Numbering starts from 0 (i.e., first entry is 0)

4. Run the following to set the default kernel:

```
# grub-set-default num_from_last_step
```

5. Reboot.

Document Revision History

Rev 24.07 – August 14, 2024

Added:

- Section "Stats"
- Section "Validate"
- Section "Error Code"
- Page "Link Aggregation"
- Page "Mergeable Rx Buffer"
- Page "Performance Tuning"

Updated:

- Page "Configuration File"
- Section "Hotplug"
- Section "List"
- Section "Query"
- Section "Modify Device"
- Section "Packet Counter"
- Page "Jumbo MTU"
- Page "Live Migration"
- Page "Transitional Device"

Rev 1.9.0 – May 07, 2024

First release

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