# Mellanox OFED for FreeBSD for ConnectX-4/ConnectX-5

# User Manual

Rev 3.4.1

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# Document Revision History

***Table 1 - Document Revision History***

| Revision | Date | Description |
|---|---|---|
| 3.4.1 | March 1, 2018 | • Added the following:<br>  • Appendix A: "Sysctl Configuration and Counters," on page 35<br>  • Section 3.5, "Explicit Congestion Notification (ECN)", on page 27<br>  • Section 3.6, "Priority Flow Control", on page 28<br>  • Section 3.7, "Quality of Service", on page 29<br>  • Section 3.8, "Rx Hardware Time-Stamping", on page 30<br>  • Section 3.9, "Firmware Dump", on page 31<br>• Updated the following:<br>  • Section 3.4, "RDMA over Converged Ethernet (RoCE)", on page 24 |
| 3.4.0 | July 2017 | Added the following section:<br>• Section 3.4, "RDMA over Converged Ethernet (RoCE)", on page 24 |
| 3.3.0 | November 2016 | Added the following section:<br>• Section 3.3, "Packet Pacing", on page 20 |
| 3.0.0 | November 2015 | Initial release |

# About this Manual

This Preface provides general information concerning the scope and organization of this User's Manual.

## Intended Audience

This manual is intended for system administrators responsible for the installation, configuration, management and maintenance of the software and hardware of VPI (Infiniband, Ethernet) in ETH mode adapter cards.

### Common Abbreviations and Acronyms

***Table 2 - Abbreviations and Acronyms***

| Abbreviation / Acronym | Whole Word / Description |
|---|---|
| B | (Capital) 'B' is used to indicate size in bytes or multiples of bytes (e.g., 1KB = 1024 bytes, and 1MB = 1048576 bytes) |
| b | (Small) 'b' is used to indicate size in bits or multiples of bits (e.g., 1Kb = 1024 bits) |
| FW | Firmware |
| HCA | Host Channel Adapter |
| HW | Hardware |
| IB | InfiniBand |
| LSB | Least significant *byte* |
| lsb | Least significant *bit* |
| MSB | Most significant *byte* |
| msb | Most significant *bit* |
| NIC | Network Interface Card |
| SW | Software |
| VPI | Virtual Protocol Interconnect |
| PFC | Priority Flow Control |
| PR | Path Record |
| RDS | Reliable Datagram Sockets |
| RoCE | RDMA over Converged Ethernet |
| SL | Service Level |
| QoS | Quality of Service |
| ULP | Upper Level Protocol |
| VL | Virtual Lane |

## Support and Updates Webpage

Please visit http://www.mellanox.com > Products > Software > Ethernet Drivers > FreeBSD Drivers for downloads, FAQ, troubleshooting, future updates to this manual, etc.

# 1 Overview

This document provides information on the Mellanox driver for FreeBSD and instructions for installing the driver on Mellanox ConnectX® adapter cards supporting the following uplinks to servers:

***Table 3 - Supported Uplinks to Servers***

| HCA | Uplink Speed |
|---|---|
| ConnectX®-4 | • Ethernet: 10GigE, 25GigE, 40GigE, 50GigE and 100GigE<br>• InfiniBand (**at beta level**): SDR, QDR, FDR, FDR10, EDR |
| ConnectX®-4 Lx | • Ethernet: 10GigE, 25GigE, 40GigE and 50GigE |
| ConnectX®-5/ ConnectX®-5 Ex | • Ethernet: 10GigE, 25GigE, 40GigE, 50GigE and 100GigE<br>• InfiniBand (**at beta level**): SDR, QDR, FDR, FDR10, EDR |

The driver release introduces the following capabilities:

- Single/Dual port
- Number of RX queues per port - according to number of CPUs
- Number of TX queues per port - according to number of CPUs
- MSI-X or INTx
- Hardware Tx/Rx checksum calculation
- Large Send Offload (i.e., TCP Segmentation Offload)
- Large Receive Offload
- VLAN Tx/Rx acceleration (Hardware VLAN stripping/insertion)
- ifnet statistics

## 1.1 Mellanox OFED for FreeBSD Package Contents

### 1.1.1 Tarball Package

Mellanox OFED for FreeBSD package includes the following directories:

- sys - kernel space
- contrib - user space
- user.sbin - mlx5tool

### 1.1.2 mlx5 driver

mlx5 is the low level driver implementation for the ConnectX-4 and above adapter cards designed by Mellanox Technologies.

#### 1.1.2.1 Software Components

Mellanox OFED for FreeBSD contains the following software components:

***Table 4 - Mellanox OFED for FreeBSD Software Components***

| Components | Description |
|---|---|
| mlx5ib | Implementation of ibcore interface to support RoCE and InfiniBand in ConnectX-4/ConnectX-5 adapter cards. |
| mlx5 | Acts as a library of common functions required by ConnectX®-4/ConnectX-4 Lx adapter cards. For example: initializing the device after reset. |
| mlx5en | Handles Ethernet specific functions and plugs into the ifnet mid-layer. |
| Documentation | Release Notes, User Manual |

# 2 Installation

This chapter describes how to install and test the Mellanox driver for FreeBSD package on a single host machine with Mellanox adapter hardware installed.

## 2.1 Software Dependencies

- To install the driver software, kernel sources must be installed on the machine.
- To load mlx5, linuxkpi must be loaded as well.
  - Compile and install linuxkpi module under /sys/modules/linuxkpi.

## 2.2 Downloading Mellanox Driver for FreeBSD

1. Verify that the system has a Mellanox network adapter (HCA/NIC) installed.

   The following example shows a system with an installed Mellanox HCA:

```
mlx5_core0@pci0:6:0:0:       class=0x020000 card=0x000815b3 chip=0x101315b3 rev=0x00 hdr=0x00
    vendor     = 'Mellanox Technologies'
    device     = 'MT27620 Family'
    class      = network
    subclass   = ethernet
mlx5_core1@pci0:6:0:1:       class=0x020000 card=0x000815b3 chip=0x101315b3 rev=0x00 hdr=0x00
    vendor     = 'Mellanox Technologies'
    device     = 'MT27620 Family'
    class      = network
    subclass   = ethernet
```

2. Download the tarball image to your host.
   The image name has the format `MLNX_OFED_FreeBSD-<ver>.tgz`. You can download it from http://www.mellanox.com > Products > Software > Ethernet Drivers > FreeBSD
3. Use the md5sum utility to confirm the file integrity of your tarball image.

## 2.3 Installing Mellanox Driver for FreeBSD

Mellanox FreeBSD v3.x.x supports adapter cards based on the Mellanox ConnectX®-4 family of adapter IC devices only. If you have ConnectX-3 and ConnectX-3 Pro on your server, you will need to install Mellanox FreeBSD v2.1.6 driver.
For details on how to install FreeBSD v2.1.6 driver, please refer to FreeBSD v2.1.6 User Manual.

1. Extract the tarball.
2. Compile and load needed modules in the following order of dependencies:

**mlx5-core**

a. Go to the mlx5 directory. Run:

```
# cd mlx5_modules/mlx5
```

b. Clean any previous dependencies. Run:

```
# make -m $HEAD/share/mk SYSDIR=$HEAD/sys clean cleandepend
```

c. Compile the mlx5_core module. Run:

```
# make -m $HEAD/share/mk SYSDIR=$HEAD/sys
```

d. Install the mlx5_core module. Run:

```
# make -m $HEAD/share/mk SYSDIR=$HEAD/sys KMODDIR=/boot/kernel install
```

e. Load the mlx5_core module. Run:

```
# kldload mlx5
```

**mlx5ib**

a. Go to the mlx5ib directory. Run:

```
# cd mlx5_modules/mlx5ib
```

b. Clean any previous dependencies. Run:

```
# make -m $HEAD/share/mk SYSDIR=$HEAD/sys clean cleandepend
```

c. Compile the mlx5ib module. Run:

```
# make -m $HEAD/share/mk SYSDIR=$HEAD/sys
```

d. Install the mlx5ib module. Run:

```
# make -m $HEAD/share/mk SYSDIR=$HEAD/sys KMODDIR=/boot/kernel install
```

e. Load the mlx5ib module. Run:

```
# kldload mlx5ib
```

It is recommended to load mlx5ib prior to mlx5en, and unload mlx5en prior to mlx5ib.

**mlx5en**

a. Go to the mlx5en directory. Run:

```
# cd mlx5_modules/mlx5en
```

b. Clean any previous dependencies. Run:

```
# make -m $HEAD/share/mk SYSDIR=$HEAD/sys clean cleandepend
```

c. Compile the mlx5en module. Run:

```
# make -m $HEAD/share/mk SYSDIR=$HEAD/sys
```

d. Install the mlx5en module. Run:

```
# make -m $HEAD/share/mk SYSDIR=$HEAD/sys KMODDIR=/boot/kernel install
```

e. Load the mlx5en module. Run:

```
# kldload mlx5en
```

To load a module on reboot, add "mlx5_load="YES"/mlx5en_load="YES" to the '/boot/loader.conf' file (create it in case it does not exist).

Run "kldstat" in order to verify which modules are loaded on your server.

## 2.4 Firmware Programming

The adapter card was shipped with the most current firmware available. This section is intended for future firmware upgrades, and provides instructions for (1) installing Mellanox firmware update tools (MFT), (2) downloading FW, and (3) updating adapter card firmware.

### 2.4.1 Installing Firmware Tools

**Step 1.** Download the current Mellanox Firmware Tools package (MFT) from www.mellanox.com > Products > Adapter IB/VPI SW > Firmware Tools.
The tools package to download is "MFT_SW for FreeBSD" (tarball name is mft-X.X.X.tgz). For ConnectX®-4, you will need at least MFT-4.1.X.X.X.

**Step 2.** Extract the tarball and run the installation script.

### 2.4.2 Downloading Firmware

1. Retrieve device's PCI slot (i.e. pci0:x:0:0). Run:

```
#> mst status
```

2. Verify your card's PSID.

```
#> flint -d pci0:<x>:0:0 q
```

3. Download the desired firmware from the Mellanox website.

http://www.mellanox.com/page/firmware_download

### 2.4.3 Updating Firmware Using flint

1. Before burning a new firmware, make sure the modules are unloaded. To unload the modules, run:

```
#> kldunload mlx5en
#> kldunload mlx5ib
#> kldunload mlx5
#> kldstat | grep mlx5
```

2. Unzip the firmware binary file.
3. Burn the firmware on your server:

```
$flint -d pci0:<x>:0:0 -i <img.bin> b
```

4. Reboot the server.

### 2.4.4 Setting the Ports to ETH

If you have a VPI HCA, you will need to set the ports to ETH. This is done by using the mlxconfig tool (part of the MFT).

1. If you have a card with two ports, run:

```
#> mlxconfig -d pci0:<x>:0:0 set  LINK_TYPE_P1=2 (For the first port)
#> mlxconfig -d pci0:<x>:0:0 set  LINK_TYPE_P2=2 (For the second port)
```

2. Reboot the server.

## 2.5 Driver Usage and Configuration

Interface name has changed from mlx5en to mce. Note that ifconfig and sysctl commands were updated accordingly.

- ***To assign an IP address to the interface:***

```
#> ifconfig mce<N> <ip>
```

**Note:** <N> is the OS assigned interface number

- ***To check driver and device information:***

```
#> pciconf -lv | grep mlx
#> flint -d pci0:<x>:0:0 q
```

Example:

```
#> flint -d pci0:6:0:0 dc | grep Description
```

Example:

```
#> pciconf -lv  | grep mlx -C 3
mlx5_core0@pci0:33:0:0:     class=0x020000 card=0x001415b3 chip=0x101315b3 rev=0x00 hdr=0x00
    vendor     = 'Mellanox Technologies'
    device     = 'MT27620 Family'
    class      = network
    subclass   = ethernet
mlx5_core1@pci0:33:0:1:     class=0x020000 card=0x001415b3 chip=0x101315b3 rev=0x00 hdr=0x00
    vendor     = 'Mellanox Technologies'
    device     = 'MT27620 Family'
    class      = network
#> flint -d pci0:33:0:0: q
Image type:      FS3
FW Version:      12.12.0610
FW Release Date: 3.9.2015
Description:     UID                GuidsNumber
Base GUID:       e41d2d03006094ec        20
Base MAC:        0000e41d2d6094ec        20
Image VSD:
Device VSD:
PSID:             MT_2190110032
#> flint -d pci0:6:0:0 dc | grep Description
;;Description = ConnectX-4 VPI adapter card; EDR IB (100Gb/s) and 100GbE; dual-port QSFP28;
PCIe3.0 x16; ROHS R6
```

➢ ***To check driver version:***

```
#>sysctl -a
```

Example:

```
sysctl -a | grep Mellanox
dev.mlx5_core.1.%desc: Mellanox Ethernet driver (3.0.0-RC2)
dev.mlx5_core.0.%desc: Mellanox Ethernet driver (3.0.0-RC2)
```

➢ ***To check firmware version:***

- dmesg

  ```
  #> dmesg
  ```

  Example:

  ```
  Mlx5_core0: INFO: firmware version: 12.12.2008
  ```

- sysctl

  ```
  #> sysctl -a
  ```

  Example:

  ```
  dev.mlx5_core.0.hw.fw_version: 12.12.2008
  ```

➢ ***To query stateless offload status:***

```
#> ifconfig mce<x>
```

**Note:** <x> is the OS assigned interface number

- ***To set stateless offload status:***

```
#> ifconfig mce<x> [rxcsum|-rxcsum] [txcsum|-txcsum] [tso|-tso] [lro|-lro]
```

**Note:** <x> is the OS assigned interface number

- ***To query and set interrupt coalescing modes:***

```
#> sysctl -a | grep coalesce_mode
```

Example:

```
#> sysctl -a | grep coalesce_mode
dev.mce.0.conf.rx_coalesce_mode: 1
dev.mce.1.conf.rx_coalesce_mode: 1
```

- coalesce mode '0' indicates interrupt timer is resetting with each interrupt event.
- coalesce mode '1' indicates interrupt timer is resetting with each received packet.

- ***To query and modify values for timer initialization between interrupts:***

```
#> sysctl -a |  grep tx_coalesce_usecs
#> sysctl -a |  grep rx_coalesce_usecs
```

- ***To query and modify values for number of received packets between interrupts:***

```
#> sysctl -a | grep tx_coalesce_pkts
#> sysctl -a | grep rx_coalesce_pkts
```

Example:

```
#> sysctl -a | grep rx_coalesce_usecs
dev.mce.1.conf.rx_coalesce_usecs: 3
dev.mce.0.conf.rx_coalesce_usecs: 3
#> sysctl -a | grep rx_coalesce_pkts
dev.mce.1.conf.rx_coalesce_pkts: 32
dev.mce.0.conf.rx_coalesce_pkts: 32
```

- ***To query ring size values:***

```
#> sysctl -a | grep mce| grep _size
```

Example:

```
#> sysctl -a | grep mlx | grep _size
dev.mce.1.conf.rx_queue_size: 1024
dev.mce.1.conf.tx_queue_size: 1024
dev.mce.1.conf.rx_queue_size_max: 8192
dev.mce.1.conf.tx_queue_size_max: 8192
```

- ***To modify rings size:***

```
#> sysctl dev.mce.0.conf.rx_queue_size=[N]
#> sysctl dev.mce.0.conf.tx_queue_size=[N]
```

**Note:** <x> is the OS assigned interface number

- ***To obtain device statistics:***

```
#> sysctl -a | grep mce | grep stat
```

- ***To obtain additional device statistics:***

```
#> sysctl dev.mce.0.conf.debug_stats=1
#> sysctl -a | grep mce | grep stats
```

- ***To show out of receive buffers counter:***

```
sysctl dev.mce.0.vstats.rx_out_of_buffer
dev.mce.0.vstats.rx_out_of_buffer: 0
```

- ***To verify support for Rx/Tx pause frames:***
  - ifconfig

```
#> ifconfig
media: Ethernet autoselect (100GBase-CR4 <full-duplex,rxpause,txpause>)
```

  - sysctl

```
#> sysctl dev.mce.0.rx_pauseframe_control
dev.mce.0.rx_pauseframe_control: 1
#> sysctl dev.mce.0.tx_pauseframe_control
dev.mce.0.tx_pauseframe_control: 1
```

- ***To enable/disable Rx/Tx pause frames:***

```
sysctl dev.mce.0.rx_pauseframe_control=1
sysctl dev.mce.0.tx_pauseframe_control=1
```

**Note:** 0 = disable, 1 = enable

- ***To show all supported media:***

```
#> ifconfig -m mce<x>
supported media:
 media autoselect
 media 50GBase-CR2 mediaopt full-duplex
 media 25GBase-SR mediaopt full-duplex
 media 25GBase-CR mediaopt full-duplex
 media 100GBase-LR4 mediaopt full-duplex
 media 100GBase-SR4 mediaopt full-duplex
 media 100GBase-CR4 mediaopt full-duplex
 media 40Gbase-LR4 mediaopt full-duplex
```

**Note:** <x> is the OS assigned interface number

The list of supported media is different in ConnectX-4 and ConnectX-4 Lx.

- ***To set new media:***

```
#> ifconfig -m mce<x> media <y> mediaopt full-duplex
```

**Note:** <x> is the OS assigned interface number. <y> is the relevant media

When updating the media, make sure to choose the right cable type.

Once the driver is loaded, both ports will be activated, meaning that an ifnet will be created for each port.

# 3 Features Overview and Configuration

## 3.1 Hardware Large Receive Offload (HW LRO)

HW LRO is supported in ConnectX®-4 only.

Large Receive Offload (LRO) increases inbound throughput of high-bandwidth network connections by reducing CPU overhead. It works by aggregating multiple incoming packets from a single stream into a larger buffer before they are passed higher up the networking stack, thus reducing the number of packets that have to be processed.

- ***In order to turn on the LRO device, run:***

```
#> ifconfig mce<x> lro
```

- ***In order to turn off the LRO device, run:***

```
#> ifconfig mce<x> -lro
```

When the LRO device is on, HW LRO can be turned on. HW LRO is off by default.

- ***In order to turn on HW LRO run:***

```
#> sysctl dev.mce.0.conf.hw_lro=1
```

- ***In order to turn off HW LRO run:***

```
#> sysctl dev.mce.0.conf.hw_lro=0
```

## 3.2 EEPROM Cable Information Reader

EEPROM is supported in ConnectX®-4 only.

EEPROM cable reading feature allows reading important information about the plugged cable, such as cable type, cable speed, vendor and more.

In order to read the cable EEPROM info:

1. Read the cable information by enabling the following sysctl parameter. Output will be printed in dmesg:

```
#> sysctl dev.mce.<X>.conf.eeprom_info=1
```

**Example:**

```
#>sysctl dev.mce.1.conf.eeprom_info=1
dev.mce.1.conf.eeprom_info: 0 -> 0

 #>dmesg
   Offset          Values
```

```
------          ------
0x0000          0d 05 06 00 00 00 00 00 00 00 00 00 00 00 00 00
0x0010          00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x0020          00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x0030          00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x0040          00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x0050          00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x0060          00 00 00 00 00 00 00 00 00 00 00 00 01 00 04 00
0x0070          00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x0080          0d 00 23 88 00 00 00 00 00 00 00 00 ff 00 00 00
0x0090          00 00 01 a0 4d 65 6c 6c 61 6e 6f 78 20 20 20 20
0x00a0          20 20 20 20 1f 00 02 c9 4d 43 50 31 36 30 30 2d
0x00b0          45 30 30 41 20 20 20 20 41 32 02 03 04 07 00 3f
0x00c0          0b 00 00 00 4d 54 31 35 32 31 56 53 30 36 34 38
0x00d0          34 20 20 20 31 35 30 35 32 36 20 20 00 00 67 5e
0x00e0          31 32 38 38 35 35 32 33 38 44 33 33 00 00 00 00
0x00f0          00 00 00 00 00 00 00 00 00 00 00 00 00 30 00 00
```

2. Another option for reading cable information is by using the ifconfig:

```
#>ifconfig -v mce<X>
#>ifconfig -vv mce<X>
#>ifconfig -vvv mce<X>
```

**Example:**

```
#> ifconfig -vvv mce1
plugged: QSFP+ 40GBASE-CR4 (No separate connector)
vendor: Mellanox PN: MCP1600-E00A SN: MT1521VS06484 DATE: 2015-05-26
compliance level: SFF-8636 rev <=1.5
nominal bitrate: 25750 Mbps

 SFF8436 DUMP (0xA0 128..255 range):
 0D 00 23 88 00 00 00 00 00 00 00 00 FF 00 00 00
 00 00 01 A0 4D 65 6C 6C 61 6E 6F 78 20 20 20 20
 20 20 20 20 1F 00 02 C9 4D 43 50 31 36 30 30 2D
 45 30 30 41 20 20 20 20 41 32 02 03 04 07 00 3F
 0B 00 00 00 4D 54 31 35 32 31 56 53 30 36 34 38
 34 20 20 20 31 35 30 35 32 36 20 20 00 00 67 5E
 31 32 38 38 35 35 32 33 38 44 33 33 00 00 00 00
 00 00 00 00 00 00 00 00 00 00 00 00 00 30 00 00

 SFF8436 DUMP (0xA0 0..81 range):
 0D 05 06 00 00 00 00 00 00 00 00 00 00 00 00 00
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

```
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00
```

## 3.3 Packet Pacing

This feature is supported in firmware v12.17.1016 and above.

Packet pacing, also known as “rate limit,” defines a maximum bandwidth allowed for a TCP connection. Limitation is done by hardware where each QP (transmit queue) has a rate limit value from which it calculates the delay between each packet sent.

➢ ***To enable Packet Pacing in firmware:***

1. Create a file with the following content:

```
# vim /tmp/enable_packet_pacing.txt
MLNX_RAW_TLV_FILE
0x00000004 0x0000010c 0x00000000 0x00000001
```

2. Update firmware configuration to enable Packing Pacing:

```
mlxconfig -d pci0:<x>:0:0 -f /tmp/enable_packet_pacing.txt set_raw
```

3. Reset the firmware:

```
mlxfwreset -d pci0:<x>:0:0 reset
```

Packet Pacing and Quality of Service (QoS) features do not co-exist.

### 3.3.1 Setting Rates for Packet Pacing

Rates that are being used with packet pacing must be defined in advance.

#### New Rates Configuration

- Newly configured rates must be within a certain range, determined by the firmware, and they can be read through sysctl.
  - For a minimum value, run:

```
sysctl dev.mce.<N>.rate_limit.tx_limit_min
```

  - For a maximum value, run:

```
sysctl dev.mce.<N>.rate_limit.tx_limit_max
```

- The number of configured rates is also determined by the firmware. In order to check how many rates can be defined, run:

```
sysctl dev.mce.<N>.rate_limit.tx_rates_max
```

- To add a new rate:

```
sysctl dev.mce.<N>.rate_limit.tx_limit_add=800000
```

This will add the defined rate to the next available index. If all rates were already defined with an index, the new rate will not be added.

Rates are determined and then saved in bits per second.
Rates requested for a new socket are added in bytes per second.

- To remove a rate limit, run:

```
sysctl dev.mce.<N>.rate_limit.tx_limit_clr=80000
```

**Deviation**:

The user can specify a maximum deviation of the rate via sysctl. If the rate limit table cannot satisfy the requirement, rate limiting will be disabled.

- For minimum value, run:

```
sysctl dev.mce.0.rate_limit.tx_allowed_deviation_min
```

- For maximum value, run:

```
sysctl dev.mce.0.rate_limit.tx_allowed_deviation_max
```

- For changing the deviation value, run:

```
sysctl dev.mce.0.rate_limit.tx_allowed_deviation=10000
```

- For reading the current deviation value, run:

```
sysctl dev.mce.0.rate_limit.tx_allowed_deviation
```

**Limitation:** Rate values must be multiples of 1000.

- Burst size is determined by the hardware, and can be configured via sysctl:
- For a minimum value, run:

```
sysctl dev.mce.<N>.rate_limit.tx_burst_size_min
```

- For a maximum value, run:

```
sysctl dev.mce.<N>.rate_limit.tx_burst_size_max
```

- For changing burst level, run:

```
sysctl dev.mce.<N>.rate_limit.tx_burst_size=150
```

- To read which burst level was defined, run:

```
sysctl dev.mce.<N>.rate_limit.tx_burst_size
```

- For displaying the packet pacing configuration, run:

```
sysctl dev.mce.<N>.rate_limit.tx_rate_show
                ENTRYBURST      RATE [bit/s]
                -----------------------------------
                  0150          800000
                  1150          40000
                  2150          1000000
                  3150          25000000000

                ENTRYBURST      RATE [bit/s]
                -----------------------------------
                  03            800000
                  13            40000
                  23            1000000
                  33            25000000000
```

where:

| | |
|---|---|
| Entry | Rate limit table entry |
| Burst | Burst size configured for rate limit traffic |
| Rate | Rate configured for the relevant index |

All rates are shown in bits per second.

### 3.3.2 Using Packet Pacing Sockets

1. Create a rate-limited socket according to the desired rate using the setsockopt() interface **based on the previous section:**

```
setsockopt(s, SOL_SOCKET, SO_MAX_PACING_RATE, pacing_rate, sizeof(pacing_rate))
```

| | |
|---|---|
| SO_MAX_PACING_RATE | Marks the socket as a rate limited socket |
| pacing_rate | Defined rate in bytes/sec. The type is unsigned int. **Note:** The same value entered via sysctl in bytes instead of bits. |

   - A rate-limited ring corresponding to the requested rate will be created and associated to the relevant socket.
   - Rate-limited traffic will be transmitted when data is sent via the socket.
2. Modify the rate-limited value using the same socket.
3. Destroy the relevant ring upon TCP socket completion.

#### 3.3.2.1 Error Detection

Detecting failures can be done using the getsockopt() interface to query a specific socket.

### 3.3.3 Feature Characteristics

- MLNX_OFED for FreeBSD supports up to 100,000 rate limited TCP connections.
- Each TCP connection is mapped to a specific SQ

### 3.3.4 Limitations

- Max rate limited rings is 100,000
- Min rate: 1 Kbps
- Max rate: 100 Gbps

```
#> sysctl -a | grep rate_limit
sysctl dev.mce.<N>.rate_limit.tx_limit_min: 1000
sysctl dev.mce.<N>.rate_limit.tx_limit_max: 100000000000
```

### 3.3.5 Performance Tuning

The following settings are recommended for a large number of connections to reduce the amount of overhead related to connection processing, as well as to handle the increased use of network buffers.

- Increase size of rate limit send queue:

```
# sysctl dev.mce.<N>.rate_limit.tx_queue_size=1024
```

- Reduce number of completion events per rate limit send queue:

```
# sysctl dev.mce.<N>.rate_limit.tx_completion_fact=-1
```

- Increase non-rate-limit send queue size:

```
# sysctl dev.mce.<N>.conf.tx_queue_size=16384
```

- Reduce number of completion events per send queue:

```
# sysctl dev.mce.<N>.conf.tx_completion_fact=-1
```

- Increase receive queue size and allow many packets to be accumulated.

  This gives better TX burst performance:

```
# sysctl dev.mce.<N>.conf.rx_queue_size=16384
# sysctl dev.mce.<N>.conf.rx_coalesce_usecs=250
# sysctl dev.mce.<N>.conf.rx_coalesce_pkts=4096
```

- Note for production. Allow high number of connections to terminate simultaneously:

```
# sysctl net.inet.icmp.icmplim=-1
```

- Increase memory pool for network buffers:

```
# sysctl kern.ipc.nmbufs=100000000
```

## 3.4 RDMA over Converged Ethernet (RoCE)

RoCE v2 is currently supported in FreeBSD v12-CURRENT only.

Remote Direct Memory Access (RDMA) is the remote memory management capability that allows server-to-server data movement directly between application memory without any CPU involvement. RDMA over Converged Ethernet (RoCE) is a mechanism to provide this efficient data transfer with very low latencies on lossless Ethernet networks. With advances in data center convergence over reliable Ethernet, ConnectX® Ethernet adapter cards family with RoCE uses the proven and efficient RDMA transport to provide the platform for deploying RDMA technology in mainstream data center application at 10GigE, 25GigE, 40GigE, 50GigE, and 100 GigE link-speed. ConnectX® Ethernet adapter cards family with its hardware offload support takes advantage of this efficient RDMA transport (InfiniBand) services over Ethernet to deliver ultra-low latency for performance-critical and transaction intensive applications such as financial, database, storage, and content delivery networks.

When working with RDMA applications over Ethernet link layer the following points should be noted:

- The presence of a Subnet Manager (SM) is not required in the fabric. Thus, operations that require communication with the SM are managed in a different way in RoCE. This does not affect the API but only the actions such as joining multicast group, that need to be taken when using the API
- Since LID is a layer 2 attribute of the InfiniBand protocol stack, it is not set for a port and is displayed as zero when querying the port
- With RoCE, the alternate path is not set for RC QP. Therefore, APM (another type of High Availability and part of the InfiniBand protocol) is not supported
- Since the SM is not present, querying a path is impossible. Therefore, the path record structure must be filled with the relevant values before establishing a connection. Hence, it is recommended working with RDMA-CM to establish a connection as it takes care of filling the path record structure
- VLAN tagged Ethernet frames carry a 3-bit priority field. The value of this field is derived from the IB SL field by taking the 3 least significant bits of the SL field
- RoCE traffic is not shown in the associated Ethernet device's counters since it is offloaded by the hardware and does not go through Ethernet network driver. RoCE traffic is counted in the same place where InfiniBand traffic is counted;
  sysctl sys.class.infiniband.<device>.ports.<port number>.counters

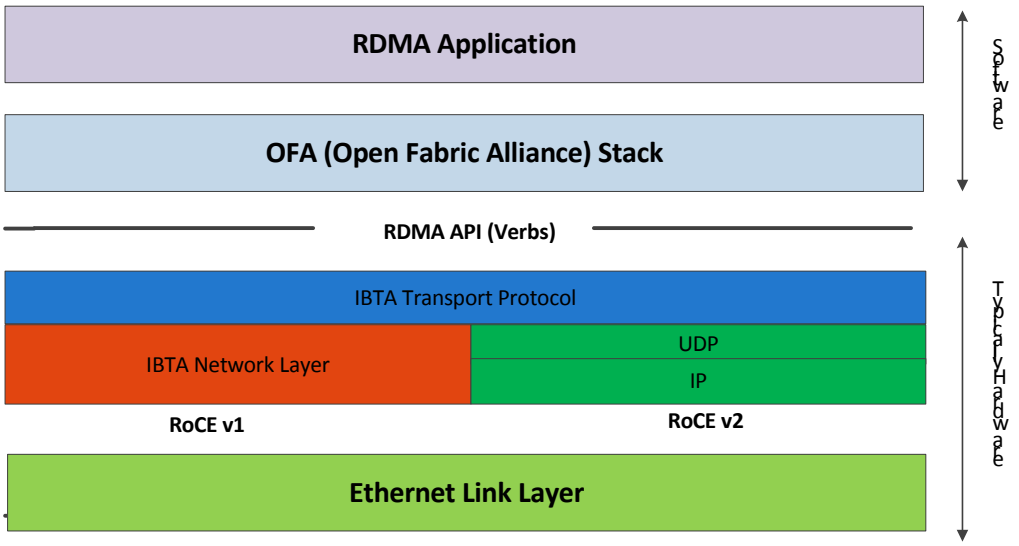
### 3.4.1 RoCE Modes

RoCE encapsulates IB transport in one of the following Ethernet packet

- RoCE v1 - dedicated ether type (0x8915)

- RoCE v2 - UDP and dedicated UDP port (4791)

*Figure 1: RoCE v1 and RoCE v2 Protocol Stack*




#### 3.4.1.1 RoCE v1

RoCE v1 protocol is defined as RDMA over Ethernet header (as shown in the figure above). It uses ethertype 0x8915 and can be used with or without the VLAN tag. The regular Ethernet MTU applies on the RoCE frame.

#### 3.4.1.2 RoCE v2

RoCE v2 is supported **ONLY** in ConnectX®-3 Pro adapter cards and above.

A straightforward extension of the RoCE protocol enables traffic to operate in IP layer 3 environments. This capability is obtained via a simple modification of the RoCE packet format. Instead of the GRH used in RoCE, IP routable RoCE packets carry an IP header which allows traversal of IP L3 Routers and a UDP header (RoCE v2 only) that serves as a stateless encapsulation layer for the RDMA Transport Protocol Packets over IP.

The proposed RoCE v2 packets use a well-known UDP destination port value that unequivocally distinguishes the datagram. Similar to other protocols that use UDP encapsulation, the UDP source port field is used to carry an opaque flow-identifier that allows network devices to implement packet forwarding optimizations (e.g. ECMP) while staying agnostic to the specifics of the protocol header format.

Furthermore, since this change exclusively affects the packet format on the wire, and due to the fact that with RDMA semantics packets are generated and consumed below the AP, applications can seamlessly operate over any form of RDMA service, in a completely transparent way.

#### 3.4.1.3 RoCE Modes Parameters

While ConnectX®-3 supports only RoCE v1, ConnectX®-3 Pro supports both RoCEv1 and RoCE v2. The RoCE mode can be set using the `'sys.class.infini-band.<device>.default_roce_mode_port<N>'` parameter in the `boot/loader.conf` file or by using the sysctl utility.

The following are the possible RoCE mode values:

- If set to 'IB/RoCE v1', the driver will use RoCE v1 by default
- If set to 'RoCE v2', the driver will use RoCEv 2 by default

ConnectX-4 adapter cards family and above supports both RoCE v1 and RoCE v2. By default, the driver associates all GID indexes to RoCE v1 and RoCE v2, thus, a single entry for each RoCE version.

### 3.4.2 GID Table Population

GID table entries are created whenever an IP address is configured on one of the Ethernet devices of the NIC's ports. Each entry in the GID table for RoCE ports has the following fields:

- GID value
- GID type
- Network device

For ports on devices that support two RoCE modes (ConnectX®-3 Pro and above) the table will be occupied with two GID entries, both with the same GID value but with different types. The Network device in an entry is the Ethernet device with the IP address that GID is associated with. The GID format can be of 2 types, IPv4 and IPv6. IPv4 GID is an IPv4-mapped IPv6 address while IPv6 GID is the IPv6 address itself. Layer 3 header for packets associated with IPv4 GIDs will be IPv4 (for RoCE v2) and IPv6/GRH for packets associated with IPv6 GIDs and IPv4 GIDs for RoCE v1.

The number of entries in the GID table is equal to $N^{1,2}(K+1)$ where N is the number of IP addresses that are assigned to all network devices associated with the port including VLAN devices, alias devices and bonding masters (for active slaves only). Link local IPv6 addresses are excluded from this count since the GID for them is always preset (the default GIDs) at the beginning of each table. K is the number of the supported RoCE types. Since the number of entries in the hardware is limited to 128 for each port, it is important to understand the limitations on N. MLNX_OFED provides a script called show_gids to view the GID table conveniently.

#### 3.4.2.1 GID Table in sysctl Tree

GID table is exposed to user space via the sysctrl tree.

1. When the mode of the device is RoCE v1/RoCE v2, each entry in the GID table occupies 2 entries in the hardware. In other modes, each entry in the GID table occupies a single entry in the hardware.
2. In multifunction configuration, the PF gets 16 entries in the hardware while each VF gets 112/F where F is the number of virtual functions on the port. If 112/F is not an integer, some functions will have 1 less entries than others. **Note** that when F is larger than 56, some VFs will get only one entry in the GID table.

- GID values can be read from:

```
sysctl sys.class.infiniband.{device}.ports.{port}.gids.{index}
```

- GID type can be read from:

```
sysctl sys.class.infiniband.{device}.ports.{port}.gid_attrs.types.{index}
```

- GID net_device can be read from:

```
sysctl sys.class.infiniband.{device}.ports.{port}.gid_attrs.ndevs.{index}
```

#### 3.4.2.2 GID Table Example

The following is an example of the GID table.

```
DEV      PORT   INDEX   GID                                     IPv4           VER       DEV
----     ----   -----   ----                                    -----          -----     -------
mlx5_0   1      0       fe80:0000:0000:0000:0202:c9ff:feb6:7c70                V2        mce1
mlx5_0   1      1       fe80:0000:0000:0000:0202:c9ff:feb6:7c70                V1        mce1
mlx5_0   1      2       0000:0000:0000:0000:0000:ffff:c0a8:0146 192.168.1.70   V2        mce1
mlx5_0   1      3       0000:0000:0000:0000:0000:ffff:c0a8:0146 192.168.1.70   V1        mce1
mlx5_0   1      4       0000:0000:0000:0000:0000:ffff:c1a8:0146 193.168.1.70   V2        mce1.100
mlx5_0   1      5       0000:0000:0000:0000:0000:ffff:c1a8:0146 193.168.1.70   V1        mce1.100
mlx5_0   1      6       1234:0000:0000:0000:0000:0000:0000:0070                V2        mce1
mlx5_0   1      7       1234:0000:0000:0000:0000:0000:0000:0070                V1        mce1
mlx5_0   2      0       fe80:0000:0000:0000:0202:c9ff:feb6:7c71                V2        mce1
mlx5_0   2      1       fe80:0000:0000:0000:0202:c9ff:feb6:7c71                V1        mce1
```

Where:

- Entries on port 1 index 0/1 are the default GIDs, one for each supported RoCE type
- Entries on port 1 index 2/3 belong to IP address 192.168.1.70 on eth1.
- Entries on port 1 index 4/5 belong to IP address 193.168.1.70 on eth1.100.
- Packets from a QP that is associated with these GID indexes will have a VLAN header (VID=100)
- Entries on port 1 index 6/7 are IPv6 GID. Packets from a QP that is associated with these GID indexes will have an IPv6 header

## 3.5 Explicit Congestion Notification (ECN)

ECN in ConnectX-4 and ConnectX-5 HCAs enables end-to-end congestion notifications between two end-points when a congestion occurs, and works over Layer 3. ECN must be enabled on all nodes in the path (nodes, routers, etc.) between the two end points and the intermediate devices (switches) between them to ensure reliable communication. ECN handling is supported only for RoCEv2 packets.

➢ ***To enable ECN on the hosts:***

**Step 1.** Load mlx5ib(4) and mlx5en(4):

```
# kldload mlx5ib mlx5en
```

**Step 2.** Query the relevant attributes:

```
# sysctl -a sys.class.infiniband.mlx5_<devno>.cong.conf
```

**Step 3.** Modify the attributes:

```
# sysctl sys.class.infiniband.mlx5_<devno>.cong.conf.<attr>=<value>
```

ECN supports the following algorithms:

- `r_roce_ecn_rp - Reaction point`
- `r_roce_ecn_np - Notification point`

Each algorithm has a set of relevant parameters and statistics, which are defined per device. ECN and QCN are not compatible.

## 3.6 Priority Flow Control

Priority Flow Control (PFC), IEEE 802.1Qbb, applies pause functionality to specific classes of traffic on the Ethernet link. For example, PFC can provide lossless service for the RoCE traffic and best-effort service for the standard Ethernet traffic. PFC can provide different levels of service to specific classes of Ethernet traffic (using IEEE 802.1p traffic classes).

Currently, only layer 2 PFC (PCP) is supported.

### 3.6.1 PFC Local Configuration on ConnectX-4/ConnectX-5

**Step 1.** Disable global pauseframes. Example:

```
# ifconfig mce<N> media autoselect mediaopt full-duplex
```

**Step 2.** Enable PFC on the desired priority by using the sysctl utility:

```
dev.mce.<N>.rx_priority_flow_control_<prio>: <enabled:1 disabled:0>
dev.mce.<N>.tx_priority_flow_control_<prio>: <enabled:1 disabled:0>
```

**Step 3.** Enable VLAN interface and assign the desired priority to it:

```
# ifconfig mce<N>.<vlan> create
# ifconfig mce<N>.<vlan> vlanpcp <prio>
```

**Step 4.** Check PFC statistics:

```
# sysctl -a dev.mce.<N>.pstats | grep prio<prio>
```

## 3.7 Quality of Service

Quality of Service (QoS) is a mechanism of assigning a priority to a network flow and manage its guarantees, limitations and its priority over other flows. This is accomplished by mapping the User Priority (UP) to a hardware Traffic Class (TC). TC is assigned with the QoS attributes and the different flows behave accordingly.

**Note**: Packet Pacing and Quality of Service (QoS) features do not co-exist.

➢ ***To be able to work with QoS, make sure to disable Packet Pacing in firmware:***

1. Create a file with the following content:

```
# vim /tmp/disable_packet_pacing.txt
MLNX_RAW_TLV_FILE
0x00000004 0x0000010c 0x00000000 0x00000000
```

2. Update firmware configuration to disable Packing Pacing:

```
mlxconfig -d pci0:<x>:0:0 -f /tmp/disable_packet_pacing.txt set_raw
```

3. Reset the firmware:

```
mlxfwreset -d pci0:<x>:0:0 reset
```

### 3.7.1 Mapping User Priority to Traffic Class

This feature allows users to map a specific User Priority (UP) to a specific TC.

Note that this configuration is permanent and will not be reset to default unless manually changed.

#### Example

➢ ***To map UP 5 to TC 4 on device mce0:***

```
# sysctl dev.mce.0.conf.qos.prio_5_to_tc=4
dev.mce.0.conf.qos.prio_5_to_tc: 5 -> 4
```

**Note**: By default, UP 0 is mapped to TC 1, and UP 1 is mapped to TC 0:

```
dev.mce.0.conf.qos.prio_7_to_tc: 7
dev.mce.0.conf.qos.prio_6_to_tc: 6
dev.mce.0.conf.qos.prio_5_to_tc: 5
dev.mce.0.conf.qos.prio_4_to_tc: 4
dev.mce.0.conf.qos.prio_3_to_tc: 3
dev.mce.0.conf.qos.prio_2_to_tc: 2
dev.mce.0.conf.qos.prio_1_to_tc: 0
dev.mce.0.conf.qos.prio_0_to_tc: 1
```

### 3.7.2 Rate Limiting

This feature allows users to rate limit a specific TC. Rate limit defines a maximum bandwidth allowed for a TC. Please note that 10% deviation from the requested values is considered acceptable.

**Notes**:

- This configuration is permanent and will not be set to default unless manually changed
- Rate is specified in kilobits, where kilo=1000.
- Rate must be divisible by 100,000, meaning that values must be in 100Mbs units.
  Examples for valid values:
  - 200000 - 200Mbs
  - 1000000 - 1Gbs
  - 3400000 - 3.4Gbs
- 0 value = unlimited rate

#### Example

➢ ***To "rate limit" TC 4 on device mce1 to 2.4Gbits:***

```
# sysctl dev.mce.1.conf.qos.tc_4_max_rate=2400000
dev.mce.1.conf.qos.tc_4_max_rate: 0 -> 2400000
```

## 3.8 Rx Hardware Time-Stamping

Time-stamping is the process of keeping track of the creation of a packet. A time-stamping service supports assertions of proof that a datum existed before a particular time. Incoming packets are time-stamped before they are distributed on the PCI, depending on the congestion in the PCI buffers. Outgoing packets are time-stamped very close to placing them on the wire.

ConnectX-4 and above adapter cards support high quality internal timer that can provide time-stamps on each received packet. Resulting quality of time-stamp is much higher than software can provide, and can be transparently utilized by applications that use standard BSD socket features such as SO_TIMESTAMP.

To verify that your HCA and operating system support time-stamping, check the presence of HWRXTSTMP option in the ifconfig(8) output of the interface:

```
# ifconfig mce4
mce4: flags=8802<BROADCAST,SIMPLEX,MULTICAST> metric 0 mtu 1500
options=2ed07bb<RXCSUM,TXCSUM,VLAN_MTU,VLAN_HWTAGGING,JUMBO_MTU,VLAN_HWCSUM,TSO4,TSO6,LRO,VLAN_H
WFILTER,VLAN_HWTSO,LINKSTATE,RXCSUM_IPV6,TXCSUM_IPV6,HWRXTSTMP>
```

➢ ***To disable the feature, run:***

```
# ifconfig mce<N> -hwrxtsmp
```

➢ ***To re-enable the feature, run:***

```
# ifconfig mce<N> hwrxtsmp
```

This feature is only supported using the firmware version compatible with your FreeBSD driver version.

## 3.9 Firmware Dump

This feature introduces the ability to dump hardware registered data upon demand. Data that is dumped is stored in a kernel buffer, and can be later manually copied to userspace using mlx-5tool. It can be maintained until explicitly cleared.

mlx5tool is a simple program which utilizes the mlx5io interface and allows executing the following firmware dump commands:

- `MLX5_FWDUMP_FORCE` - forces dump unless one was already stored in the kernel buffer
- `MLX5_FWDUMP_GET` - copies the recorded dump from kernel into user mode
- `MLX5_FWDUMP_RESET` - clears the kernel buffer, in preparation for storing another dump

Commands are communicated with the driver using ioctl interface over the devfs device /dev/mlx5ctl.

➢ ***To build the mlx5tool, run the following command from the driver's top-level directory:***

```
cd usr.sbin/mlx5tool && make all install clean
```

### mlx5tool Usage

| | |
|---|---|
| `mlx5tool -d pci0:<x>:0:0 -e` | Force dump, storing it into the kernel buffer |
| `mlx5tool -d pci0:<x>:0:0 -w [-o dump.file]` | Store the recorded dump into file dump.file. If -o is omitted, the dump is streamed into standard output. |
| `mlx5tool -d pci0:<x>:0:0 -r` | Reset dump |

# 4 Performance Tuning

In order to improve performance, please make sure the HW LRO is enabled.

## 4.1 Receive Queue Interrupt Moderation

An armed CQ will generate an event when either of the following conditions is met:

- The number of completions generated since the one which trigged the last event generation reached a set in advance number.
- The timer has expired and an event is pending.

The timer can be set to be restarted either upon event generation or upon completion generation.

Setting the timer to be restarted upon completion generation affects the interrupt receiving rate. When receiving a burst of incoming packets, the timer will not reach its limit, therefore, the interrupt rate will be associated to the size of the packets.

➢ ***In order to modify the timer restart mode, run:***

```
#> sysctl dev.mce.1.conf.rx_coalesce_mode=[0/1]
```

0: For timer restart upon event generation.

1: For timer restart upon completion generation.

➢ ***In order to modify the number of completions generated between interrupts, run:***

```
#> sysctl dev.mce.1.conf.rx_coalesce_pkts=<x>
```

➢ ***In order to modify the time for the timer to finish, run:***

```
#> sysctl dev.mce.1.conf.rx_coalesce_usecs=<x>
```

**Note:** The default values are:

- dev.mce.1.conf.rx_coalesce_mode: 1 - Timer restarts upon completion generation.
- dev.mce.1.conf.rx_coalesce_pkts: 32 - 32 completions generate interrupts.
- dev.mce.1.conf.rx_coalesce_usecs: 3 - Timer count down 3 micro sec.

## 4.2 Tuning for NUMA Architecture

### 4.2.1 Single NUMA Architecture

When using a server with single NUMA, no tuning is required. Also, make sure to avoid using core number 0 for interrupts and applications.

1. Find a CPU list:

```
#> sysctl -a | grep "group level=\"2\"" -A 1
<group level="2" cache-level="2">
<cpu count="12" mask="fff">0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11</cpu>
```

2. Tune Mellanox NICs to work on desirable cores
   a. Find the device that matches the interface:

```
#> sysctl -a | grep mce | grep mlx
dev.mce.1.conf.device_name: mlx5_core1
dev.mce.0.conf.device_name: mlx5_core0
```

   b. Find the device interrupts.

```
vmstat -ia | grep mlx5_core0 | awk '{print $1}' | sed s/irq// | sed s/:://
269
270
271
…
```

   c. Bind each interrupt to a desirable core.

```
cpuset -x 269 -l  1
cpuset -x 270 -l  2
cpuset -x 271 -l  3
…
```

   d. Bind the application to the desirable core.

```
cpuset -l 1-11 <app name> <sever flag>
cpuset -l 1-11 <app name> <client flag> <IP>
```

Specifying a range of CPUs when using the cpuset command will allow the application to choose any of them. This is important for applications that execute on multiple threads.
The range argument is not supported for interrupt binding.

### 4.2.2 Dual NUMA Architecture

1. Find the CPU list closest to the NIC
   a. Find the device that matches the interface:

```
#> sysctl -a | grep mce | grep mlx
dev.mce.3.conf.device_name: mlx5_core3
dev.mce.2.conf.device_name: mlx5_core2
dev.mce.1.conf.device_name: mlx5_core1
dev.mce.0.conf.device_name: mlx5_core0
```

   b. Find the NIC's PCI location:

```
#> sysctl -a | grep mlx5_core.0 | grep parent
dev.mlx5_core.0.%parent: pci3
```

   Usually, low PCI locations are closest to NUMA number 0, and high PCI locations are closest to NUMA number 1. Here is how to verify the locations:

   c. Find the NIC's pcib by PCI location:

```
#> sysctl -a | grep pci.3.%
parent dev.pci.3.%parent: pcib3
```

d. Find the NIC's pcib location:

```
#> sysctl -a | grep pcib.3.%location

dev.pcib.3.%location: pci0:0:2:0 handle=\_SB_.PCI0.PEX2
```

In "handle", PCI0 is the value for locations near NUMA0, and PCI1 is the value for locations near NUMA1.

e. Find the cores list of the closest NUMA:

```
#> sysctl -a | grep "group level=\"2\"" -A 1
<group level="2" cache-level="2">
<cpu count="12" mask="fff">0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11</cpu>
--
<group level="2" cache-level="2">
<cpu count="12" mask="fff000">12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23</cpu>
```

**Note**: Each list of cores refers to a different NUMA.

2. Tune Mellanox NICs to work on desirable cores.

a. Pin both interrupts and application processes to the relevant cores.

b. Find the closest NUMA to the NIC

c. Find the device interrupts.

```
vmstat -ia | grep mlx5_core0 | awk '{print $1}' | sed s/irq// | sed s/://
304
305
306
…
```

d. Bind each interrupt to a core from the closest NUMA cores list
**Note**: It is best to avoid core number 0.

```
cpuset -x 304 -l 1
cpuset -x 305 -l 2
cpuset -x 306 -l 3
...
```

e. Bind the application to the closest NUMA cores list.
**Note**: It is best to avoid core number 0

```
cpuset -l 1-11 <app name> <sever flag>
cpuset -l 1-11 <app name> <client flag> <IP>
```

For best performance, change CPU's BIOS configuration to performance mode.

Due to FreeBSD internal card memory allocation mechanism on boot, it is preferred to insert the NIC to a NUMA-0 slot for max performance.

# Appendix A: Sysctl Configuration and Counters

This appendix provides detailed information about configuration options and statistics exposed in Mellanox FreeBSD driver.

## A.1 Configuration Options

### A.1.1 Ethernet

***Table 5 - Configuration Options - Ethernet***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| dev.<ifnet_name><ifnet_name>.conf.eeprom_info | Enable the dump of the inserted modules' EEPROM info (in hex) | RW |
| dev.<ifnet_name>.conf.device_name | IB device name associated with the ethernet device | RO |
| dev.<ifnet_name>.conf.uc_local_lb | Enable/Disable local loopback support for unicast | RW |
| dev.<ifnet_name>.conf.mc_local_lb | Enable/Disable local loopback support for multicast | RW |
| dev.<ifnet_name>.conf.hw_mtu | The current MTU value set for the adapter | RW |
| dev.<ifnet_name>.conf.modify_rx_dma | Enable/Disable the ability to receive packets | RW |
| dev.<ifnet_name>.conf.modify_tx_dma | Enable/Disable the ability to transmit packets | RW |
| dev.<ifnet_name>.conf.cqe_zipping | Enables/Disables CQE compression. Compressing reduces PCI overhead by coalescing and compressing multiple CQEs into a single merged CQE. Successful compressing improves message rate especially for small packet traffic | RW |
| dev.<ifnet_name>.conf.hw_lro | Enables/Disables hardware LRO support | RW |
| dev.<ifnet_name>.conf.tx_completion_fact_max | The max completion factor that can be used | RW |
| dev.<ifnet_name>.conf.tx_completion_fact | The number TX packets to send before receiving a completion interrupt | RW |
| dev.<ifnet_name>.conf.tx_bufring_disable | Enables/Disables the allocation of the TX DRBR | RW |
| dev.<ifnet_name>.conf.tx_coalesce_mode | Sets the TX Coalesce mode to EQE or CQE. EQE mode causes the coalesce timer to restart on event generation. CQE mode causes the coalesce timer to restart on CQE generation | RW |

***Table 5 - Configuration Options - Ethernet***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| dev.<ifnet_name>.conf.tx_coalesce_pkts | The maximum number of TX packets to coalesce before transmitting the data | RW |
| dev.<ifnet_name>.conf.tx_coalesce_usecs | The maximum number of usecs to wait prior to transmitting the current coalesced TX packets | RW |
| dev.<ifnet_name>.conf.rx_coalesce_mode | Sets the RX Coalesce mode to EQE or CQE. EQE mode causes the coalesce timer to restart on event generation. CQE mode causes the coalesce timer to restart on CQE generation | RW |
| dev.<ifnet_name>.conf.rx_coalesce_pkts | The maximum number of RX packets to coalesce before passing the data up the stack | RW |
| dev.<ifnet_name>.conf.rx_coalesce_usecs | The maximum number of usecs to wait prior to sending the current coalesced RX packets up the stack | RW |
| dev.<ifnet_name>.conf.coalesce_pkts_max | Maximum number of packets to coalese before processing | RW |
| dev.<ifnet_name>.conf.coalesce_usecs_max | Maximum number of usecs to wait before processing the coalesced packets | RW |
| dev.<ifnet_name>.conf.channels | The numer of RX and TX channels (rings) to create for driver utilization | RW |
| dev.<ifnet_name>.conf.rx_queue_size | The default number of RX buffers created per channel | RW |
| dev.<ifnet_name>.conf.tx_queue_size | The default number of TX buffers created per channel | RW |
| dev.<ifnet_name>.conf.rx_queue_size_max | The maximum value possible for rx_queue_size | RW |
| dev.<ifnet_name>.conf.tx_queue_size_max | The maximum value possible for tx_queue_size | RW |
| dev.<ifnet_name>.rx_pauseframe_control | Enables/Disables receive pause frames | RW |
| dev.<ifnet_name>.tx_pauseframe_control | Enables/Disables transmit pause frames | RW |

### A.1.2 InfiniBand/RDMA

*Table 6 - Configuration Options - InfiniBand/RDMA*

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| sys.class.infiniband.<device_name>.default_roce_mode_port1 | The default RoCE mode when attempting new connections. | RW |

## A.2 Statistical Counters

### A.2.1 Ethernet

*Table 7 - Statistical Counters - Ethernet*

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| dev.<ifnet_name><ifnet_name>.rxstat0.wqe_err | Total number of RX WQE errors encountered across all RX channels | RO |
| dev.<ifnet_name>.rxstat0.sw_lro_flushed | Total number of LRO packets sent to the OS networking stack across all RX channels | RO |
| dev.<ifnet_name>.rxstat0.sw_lro_queued | Total number of LRO packets aggregated by the driver across all RX channels. | RO |
| dev.<ifnet_name>.rxstat0.lro_bytes | Total number of LRO bytes successfully received across all RX channels | RO |
| dev.<ifnet_name>.rxstat0.lro_packets | Total number of LRO packets successfully received across all RX channels | RO |
| dev.<ifnet_name>.rxstat0.csum_none | Total number of RX packets with no checksum offload across all RX channels. | RO |
| dev.<ifnet_name>.rxstat0.packets | Total number of RX packets across all RX channels. | RO |
| dev.<ifnet_name>.txstat0tc0.nop | Total number of TX NOPs processed across all TX channels. | RO |
| dev.<ifnet_name>.txstat0tc0.dropped | Total number of TX packets dropped across all TX channels. | RO |
| dev.<ifnet_name>.txstat0tc0.defragged | Total number of defraggmented buffers across all TX channels. | RO |
| dev.<ifnet_name>.txstat0tc0.csum_offload_-none | Total number of TX packets processed without checksum offload across all TX channels. | RO |

***Table 7 - Statistical Counters - Ethernet***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| dev.<ifnet_name>.txstat0tc0.tso_bytes | Total number of TSO bytes across all TX channels. | RO |
| dev.<ifnet_name>.txstat0tc0.tso_packets | Total number of TSO packets across all TX channels | RO |
| dev.<ifnet_name>.txstat0tc0.packets | Total number of TX packets across all TX channels. | RO |
| dev.<ifnet_name>.pstats.collisions | Total number of collisions. | RO |
| dev.<ifnet_name>.pstats.jabbers | Total number of packets received that were longer than 1518 octets and had either a bad FCS or alignment error. | RO |
| dev.<ifnet_name>.pstats.fragments | Total number of packets received that were less than 64 octets and had either a bad FCS or alignment error. | RO |
| dev.<ifnet_name>.pstats.oversize_pkts | Total number of packets received that were longer than 1518 octets long | RO |
| dev.<ifnet_name>.pstats.undersize_pkts | Total number of packets received that were less than 64 octets long | RO |
| dev.<ifnet_name>.pstats.crc_align_errors | Total number of packets received that had either a bad FCS or alignment error. | RO |
| dev.<ifnet_name>.pstats.multicast_pkts | Total number of good multicast packets received. | RO |
| dev.<ifnet_name>.pstats.broadcast_pkts | Total number of good broadcast packets received. | RO |
| dev.<ifnet_name>.pstats.pkts | Total number of packets (including bad, broadcast, and multicast) received on the network | RO |
| dev.<ifnet_name>.pstats.octets | Total number of octets of data (including errors) received on the network | RO |
| dev.<ifnet_name>.pstats.drop_events | Total number of events in which packets were dropped by the probe due to lack of resources | RO |
| dev.<ifnet_name>.pstats.pause_ctrl_tx | Total number of pause control frames sent. | RO |
| dev.<ifnet_name>.pstats.pause_ctrl_rx | Total number of pause control frames received. | RO |
| dev.<ifnet_name>.pstats.unsupported_op_rx | The numbrer of mac control frames received that contain an opcode that is not supported. | RO |
| dev.<ifnet_name>.pstats.mac_control_rx | The number of mac control frames received | RO |
| dev.<ifnet_name>.pstats.mac_control_tx | The number of mac control frames transmitted. | RO |

***Table 7 - Statistical Counters - Ethernet***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| dev.<ifnet_name>.pstats.symbol_err | Total number of symbol errors | RO |
| dev.<ifnet_name>.pstats.too_long_errors | The number of frames received that exceeded the MTU size. | RO |
| dev.<ifnet_name>.pstats.out_of_range_len | The number of frames received with a length field value greater than the maximum allowed logical length control (LLC) data size. | RO |
| dev.<ifnet_name>.pstats.in_range_len_errors | A count of frames with a length/type field value between the minimum unpadded MAC client data size and the maximum allowed MAC client data size, inclusive, that does not match the number of MAC client data octets received. | RO |
| dev.<ifnet_name>.pstats.broadcast_rx | Total number of broadcast packets successfully received | RO |
| dev.<ifnet_name>.pstats.multicast_rx | Total number of multicast packets successfully received | RO |
| dev.<ifnet_name>.pstats.broadcast_xmitted | Total number of broadcast bytes successfully transmitted | RO |
| dev.<ifnet_name>.pstats.multicast_xmitted | Total number of multicast packets successfully transmitted | RO |
| dev.<ifnet_name>.pstats.octets_received | Total number of octets received | RO |
| dev.<ifnet_name>.pstats.octets_tx | Total number of octets transmitted | RO |
| dev.<ifnet_name>.pstats.alignment_err | Total number of packet alignment errors. i.e. The number of bits received is an uneven byte count, or there is a Frame Check Sequence (FCS) Error. | RO |
| dev.<ifnet_name>.pstats.check_seq_err | Total number of FCS errors | RO |
| dev.<ifnet_name>.pstats.frames_rx | Total number of frames received | RO |
| dev.<ifnet_name>.pstats.frames_tx | Total number of frames transmitted. | RO |
| dev.<ifnet_name>.vstats.rx_wqe_err | Total number of RX WQEs that completed in error. | RO |
| dev.<ifnet_name>.vstats.tx_defragged | The number of times the TX mbufs were unable to be loaded via bus_d-mamap_load due to an excessive amount of mbufs in the chain. | RO |
| dev.<ifnet_name>.vstats.tx_queue_dropped | Total number of TX packets dropped by the driver prior transmission due to an error. | RO |
| dev.<ifnet_name>.vstats.tx_csum_offload | Total number of transmit packets that successfully used checksum offloading | RO |

***Table 7 - Statistical Counters - Ethernet***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| dev.<ifnet_name>.vstats.rx_csum_none | Total number of received packets that did not have any checksum offload indication | RO |
| dev.<ifnet_name>.vstats.rx_csum_good | Total number of received packets that had the checksum successfully off-loaded. | RO |
| dev.<ifnet_name>.vstats.sw_lro_flushed | Total number of LRO packets sent to the OS networking stack. | RO |
| dev.<ifnet_name>.vstats.sw_lro_queued | Total number of LRO packets aggregated by the driver. | RO |
| dev.<ifnet_name>.vstats.lro_bytes | Total number of LRO bytes successfully received | RO |
| dev.<ifnet_name>.vstats.lro_packets | Total number of LRO packets successfully received | RO |
| dev.<ifnet_name>.vstats.tso_bytes | Total number of TSO bytes successfully transmitted | RO |
| dev.<ifnet_name>.vstats.tso_packets | Total number of TSO packets successfully transmitted | RO |
| dev.<ifnet_name>.vstats.rx_out_of_buffer | Total number of packets dropped due to lack of network buffers | RO |
| dev.<ifnet_name>.vstats.tx_broadcast_bytes | Total number of broadcast bytes successfully transmitted | RO |
| dev.<ifnet_name>.vstats.tx_broadcast_packets | Total number of broadcast packets successfully transmitted | RO |
| dev.<ifnet_name>.vstats.rx_broadcast_bytes | Total number of broadcast bytes successfully received | RO |
| dev.<ifnet_name>.vstats.rx_broadcast_packets | Total number of broadcast packets successfully received | RO |
| dev.<ifnet_name>.vstats.tx_multicast_bytes | Total number of multicast bytes successfully transmitted | RO |
| dev.<ifnet_name>.vstats.tx_multicast_packets | Total number of multicat packets successfully transmitted | RO |
| dev.<ifnet_name>.vstats.rx_multicast_bytes | Total number of multicast bytes successfully received | RO |
| dev.<ifnet_name>.vstats.rx_multicast_packets | Total number of multicast packets successfully received | RO |
| dev.<ifnet_name>.vstats.tx_unicast_bytes | Total number of unicast bytes successfully transmitted | RO |
| dev.<ifnet_name>.vstats.tx_unicast_packets | Total number of unicast packets successfully transmitted | RO |
| dev.<ifnet_name>.vstats.rx_unicast_bytes | Total number of unicast bytes successfully received | RO |
| dev.<ifnet_name>.vstats.rx_unicast_packets | Total number of unicast packets successfully received | RO |
| dev.<ifnet_name>.vstats.tx_error_bytes | Total number of transmit error bytes | RO |

***Table 7 - Statistical Counters - Ethernet***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| dev.<ifnet_name>.vstats.tx_error_packets | Total number of transmit error packets | RO |
| dev.<ifnet_name>.vstats.rx_error_bytes | Total number of received error bytes | RO |
| dev.<ifnet_name>.vstats.rx_error_packets | Total number of received error packets | RO |
| dev.<ifnet_name>.vstats.tx_bytes | Total number of bytes successfully transmitted | RO |
| dev.<ifnet_name>.vstats.tx_packets | Total number of packets successfully transmitted | RO |
| dev.<ifnet_name>.vstats.rx_bytes | Total number of bytes successfully received | RO |
| dev.<ifnet_name>.vstats.rx_packets | Total number of packets successfully received | RO |

***Table 7 - Statistical Counters - Ethernet***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| dev.<ifnet_name>.conf.debug_stats | Enables the additional debug_stats found below: | RW |
| | dev.<ifnet_name>.debug_stats.rs_corrected_symbols_lane3 | RO |
| | dev.<ifnet_name>.debug_stats.rs_corrected_symbols_lane2 | RO |
| | dev.<ifnet_name>.debug_stats.rs_corrected_symbols_lane1 | RO |
| | dev.<ifnet_name>.debug_stats.rs_corrected_symbols_lane0 | RO |
| | dev.<ifnet_name>.debug_stats.rs_corrected_symbols_total | RO |
| | dev.<ifnet_name>.debug_stats.rs_single_error_blocks | RO |
| | dev.<ifnet_name>.debug_stats.rs_no_errors_blocks | RO |
| | dev.<ifnet_name>.debug_stats.rs_uncorrectable_blocks | RO |
| | dev.<ifnet_name>.debug_stats.rs_corrected_blocks | RO |
| | dev.<ifnet_name>.debug_stats.fc_corrected_blocks_lane3 | RO |
| | dev.<ifnet_name>.debug_stats.fc_corrected_blocks_lane2 | RO |
| | dev.<ifnet_name>.debug_stats.fc_corrected_blocks_lane1 | RO |
| | dev.<ifnet_name>.debug_stats.fc_corrected_blocks_lane0 | RO |
| | dev.<ifnet_name>.debug_stats.edpl_bip_errors_lane3 | RO |
| | dev.<ifnet_name>.debug_stats.edpl_bip_errors_lane2 | RO |
| | dev.<ifnet_name>.debug_stats.edpl_bip_errors_lane1 | RO |

***Table 7 - Statistical Counters - Ethernet***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| | dev.<ifnet_name>.debug_stats.edpl_bip_errors_lane0 | RO |
| | dev.<ifnet_name>.debug_stats.sync_headers_errors | RO |
| | dev.<ifnet_name>.debug_stats.symbol_errors[a] | RO |
| | dev.<ifnet_name>.debug_stats.time_since_last_clear | RO |
| | dev.<ifnet_name>.debug_stats.out_broadcast_pkts | RO |
| | dev.<ifnet_name>.debug_stats.out_multicast_pkts | RO |
| | dev.<ifnet_name>.debug_stats.in_broadcast_pkts | RO |
| | dev.<ifnet_name>.debug_stats.in_multicast_pkts | RO |
| | dev.<ifnet_name>.debug_stats.out_errors | RO |
| | dev.<ifnet_name>.debug_stats.out_discards[b] | RO |
| | dev.<ifnet_name>.debug_stats.out_ucast_pkts | RO |
| | dev.<ifnet_name>.debug_stats.out_octets | RO |
| | dev.<ifnet_name>.debug_stats.in_unknown_protos | RO |
| | dev.<ifnet_name>.debug_stats.in_errors[c] | RO |
| | dev.<ifnet_name>.debug_stats.in_discards[d] | RO |
| | dev.<ifnet_name>.debug_stats.in_ucast_pkts | RO |
| | dev.<ifnet_name>.debug_stats.in_octets | RO |
| | dev.<ifnet_name>.debug_stats.p8192to10239octets | RO |
| | dev.<ifnet_name>.debug_stats.p4096to8191octets | RO |
| | dev.<ifnet_name>.debug_stats.p2048to4095octets | RO |
| | dev.<ifnet_name>.debug_stats.p1519to2047octets | RO |
| | dev.<ifnet_name>.debug_stats.p1024to1518octets | RO |
| | dev.<ifnet_name>.debug_stats.p512to1023octets | RO |

*Table 7 - Statistical Counters - Ethernet*

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| | dev.<ifnet_name>.debug_stats.p256to511octets | RO |
| | dev.<ifnet_name>.debug_stats.p128to255octets | RO |
| | dev.<ifnet_name>.debug_stats.p65to127octets | RO |
| | dev.<ifnet_name>.debug_stats.p64octets | RO |

a. The number of times the receiving media is non-idle (a carrier event) for a period of time equal to or greater than the minimum frame size and during which there was at least one occurrence of an event that causes the PHY to indicate a receive error.
b. The number of outbound packets which were chosen to be discarded, even though no errors had been detected to prevent their being transmitted.
c. The number of inbound packets which were chosen to be dis- carded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol.
d. The number of inbound packets which were chosen to be discarded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol.

### A.2.2 InfiniBand/RDMA

*Table 8 - Statistical Counters - InfiniBand/RDMA*

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| sys.class.infiniband.<device_name>.reg_pages | Total number of OS pages registered for IB/RoCE use | RO |
| sys.class.infiniband.<device_name><device_name>.fw_pages | Total number of OS pages used by firmware | RO |
| sys.class.infiniband.<device_name>.board_id | The PSID of the board | RO |
| sys.class.infiniband.<device_name>.hca_type | The device family of the adapter | RO |
| sys.class.infiniband.<device_name>.hw_rev | The hardware revision of the adapter | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>..<port_-num>.hw_counters.lifespan | | RO |
| sys.class.infiniband.<device_name>.ports.<port_-num>.hw_counters.local_ack_timeout_err | Total number of No ACK responses within the timer interval. Supported only for the XRC, DC and RC transports | RO |

***Table 8 - Statistical Counters - InfiniBand/RDMA***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| sys.class.infiniband.<device_name>.ports.<port_-num>.hw_counters.implied_nak_seq_err | Total number of times the requester detected an ACK with a PSN larger expected for an RDMA READ or ATOMIC response. Supported only for the XRC, DC and RC transports | RO |
| sys.class.infiniband.<device_name>.ports.<port_-num>.hw_counters.packet_seq_err | Total number of received NAK-Sequence error packets. Supported only for the XRC, DC and RC transports | RO |
| sys.class.infiniband.<device_name>.ports.<port_-num>.hw_counters.rnr_nak_retry_err | Total number of received RNR NAK packets on this port. Supported only for the XRC, DC and RC transports | RO |
| sys.class.infiniband.<device_name>.ports.<port_-num>.hw_counters.duplicate_request | Total number of duplicate request packets received on this port. Supported only for XRC, DC, and RC transports | RO |
| sys.class.infiniband.<device_name>.ports.<port_-num>.hw_counters.out_of_sequence | Total number of out of sequence packets received on this port. Supported only for XRC, DC, and RC transports | RO |
| sys.class.infiniband.<device_name>.ports.<port_-num>.hw_counters.out_of_buffer | Total number of packet drops that occurred due to lack of WQEs | RO |
| sys.class.infiniband.<device_name>.ports.<port_-num>.hw_counters.rx_atomic_requests | Total number of Atomic operation requests on this port | RO |
| sys.class.infiniband.<device_name>.ports.<port_-num>.hw_counters.rx_read_requests | Total number of RDMA Read requests on this port | RO |
| sys.class.infiniband.<device_name>.ports.<port_-num>.hw_counters.rx_write_requests | Total number of RDMA Write requests on this port | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.pkeys.<pkey index> | The partion key defined at location <pkey index> | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.gids.<gid index> | The gid index defined at location <gid index> | RO |

***Table 8 - Statistical Counters - InfiniBand/RDMA***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.multicast_xmit_packets | Total number of IB/RoCE multicast packets transmitted by the port. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.multicast_rcv_packets | Total number of IB/RoCE multicast packets received by the port. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.unicast_xmit_packets | Total number of IB/RoCE unicast packets transmitted by the port. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.unicast_rcv_packets | Total number of IB/RoCE unicast packets received by the port. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_rcv_packets | Total number of ticks the port is unable to send data due to insufficient credits or lack of arbitration. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_xmit_wait | Total number of IB/RoCE packets received by the port. Includes packets with errors. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_xmit_packets | Total number of IB/RoCE packets transmitted by the port. Includes packets with errors. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_rcv_data | Total number of IB/RoCE data octets received by the port. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_xmit_data | Total number of IB/RoCE data octets transmitted from the port. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.VL15_dropped | Total number of incoming VL15 packets discarded due to resource limitations. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.excessive_buffer_overrun_errors | Total number of times overrun errors occurred during consecutive flow control update periods. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.local_link_integrity_errors | Total number of times port physical errors exceeded the defined threshold | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_rcv_constraint_errors | Total number of IB/RoCE receive packets discarded by the port due to raw filter or partition enforcement | RO |

***Table 8 - Statistical Counters - InfiniBand/RDMA***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_xmit_constraint_errors | Total number of IB/RoCE packets not sent from the port due to raw filter or partition enforcement | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_xmit_discards | Total number of IB/RoCE transmit packets discarded because the port is down or congested | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_rcv_switch_relay_errors | Total number of IB/RoCE receive packets disarded because they could not be forwarded by the switch relay | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_rcv_remote_physical_errors | Total number of IB/RoCE packets received with the EBP delimiter marked. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.port_rcv_errors | Total number of IB/RoCE packets received that contained errors | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.link_downed | Total number of times the port training state machine failed link recovery and set the link down. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.link_error_recovery | Total number of times the port training state machine successfully completed link recovery | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.counters.symbol_error | Total number of physical link errors detected on the port. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.gid_attrs.types.<gid index> | The RoCE version associated with gid index <gid index> | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.gid_attrs.ndevs.<gid index> | The FreeBSD network device associated with gid index <gid index> | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.link_layer | The link layer mode configured for the specified port. Will be Ethernet or Infiniband. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.phys_state | Indicates the physical port state as defined in the IB spec. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.rate | Indicates the Infiniband port rate and speed. | RO |

***Table 8 - Statistical Counters - InfiniBand/RDMA***

| sysctrl Name | Description | Read/ Write |
|---|---|---|
| sys.class.infiniband.<device_name>.ports.<port_num>.cap_mask | The supported IB capabilities available for this port as defined by the IB spec. | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.sm_sl | Indicates the SL used to communicate with the subnet manager (IB only) | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.sm_lid | Indicates the LID of the subnet manager (IB only) | RO |
| sys.class.infiniband.<device_name>.ports.<port_-num>.lid_mask_count | The value assigned by the subnet manager that specifies the number of path bits in the LID (IB only) | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.lid | The lid assigned to the local adapter port by the subnet manager (IB only) | RO |
| sys.class.infiniband.<device_name>.ports.<port_num>.state | The current port state as defined by the IB spec. | RO |
| sys.class.infiniband.<device_name>.fw_ver | The current version of firmware running on the network adapter | RO |
| sys.class.infiniband.<device_name>.node_desc | The IB node description | RO |
| sys.class.infiniband.<device_name>.node_guid | The IB node GUID | RO |
| sys.class.infiniband.<device_name>.sys_image_guid | The IB system image GUID | RO |
| sys.class.infiniband.<device_name>.node_type | Indicates the node type as defined by the IB spec. Valid values are Channel Adapter (CA), Switch, or Router | RO |