Mellanox ConnectX®-3 Poll-Mode Driver
Quick Start Guide
2.7.4
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# Document Revision History

## Table 1: Document Revision History

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| 2.7.4    | Added the following Performance Configuration sections:  
          | General Settings  
          | KVM Settings  
          | Updated the following sections:  
          | Bare Metal  
          | Hypervisor |
| 2.6.9    | Added section Sending and Receiving Jumbo Frames  
          | Updated the following sections:  
          | Bare Metal  
          | Hypervisor  
          | Compilation Script  
          | Running DPDK Application with Mellanox ConnectX®-3 Poll-Mode Driver |
| 2.6.8    | Added the following sections:  
          | Compilation Script  
          | Configuration Script  
          | Updated the following sections:  
          | Mellanox ConnectX®-3 Poll-Mode Driver (PMD) Overview  
          | Bare Metal  
          | Hypervisor  
          | Running DPDK Application with Mellanox ConnectX®-3 Poll-Mode Driver  
          | Sanity Check  
          | Removed the VMware section |
| 2.5      | The Quick Start Guide was completely re-structured and re-written |
| 2.0      | Updated the following sections:  
          | DPDK Poll-Mode Driver Configuration  
          | Sanity Check |
| 1.1      | Updated the following sections:  
          | DPDK Poll-Mode Driver (PMD) Overview  
          | Internal Compilation  
          | External Compilation  
          | Sanity Check  
          | Added the following sections:  
          | Automatic Installation  
          | mlxsofa_kernel-2.0  
          | libibverbs-1.1.6mlx1  
          | libmlx4-1.0.4mlx1  
<pre><code>      | DPDK Poll-Mode Driver Configuration |
</code></pre>
<table>
<thead>
<tr>
<th>Revision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Initial Release</td>
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</table>

### Related Documents

The following table lists the documents referenced in this User Manual.

#### Table 2: Reference Documents

<table>
<thead>
<tr>
<th>Document Name</th>
<th>Description</th>
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<tbody>
<tr>
<td>Mellanox OFED Linux Release Notes</td>
<td>Describes the new features and changes of the latest MLNX_OFED release.</td>
</tr>
<tr>
<td>Mellanox OFED Linux User Manual</td>
<td>Provides general information on the installation, configuration, management and maintenance of the software and hardware of VPI (InfiniBand, Ethernet) adapter cards.</td>
</tr>
<tr>
<td>Mellanox ConnectX-3 DPDK PMD Release Notes</td>
<td>Describes the new features and changes of the latest DPDK PMD</td>
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</table>
1 Mellanox ConnectX®-3 Poll-Mode Driver (PMD) Overview

librte_pmd_mlx4 is the DPDK Poll-Mode Driver (PMD) for Mellanox ConnectX®-3 Ethernet adapters. This driver is based on libibverbs and currently supports:

- Scattering/gathering RX/TX packets
- Multiple RX (with RSS/RCA) and TX queues
- Multiple MAC addresses
- VLAN filtering
- Link state information
- Software counters/statistics
- Start/stop/close operations
- Multiple physical ports host adapter
- Hardware TX and RX checksum offloading
- DPDK 1.7.0 or above from dpdk.org <http://dpdk.org/>
2 Mellanox ConnectX®-3 Poll-Mode Driver Installation and Configuration

2.1 Bare Metal

1. Install MLNX_OFED-2.4-1.0.0

   MLNX_OFED 2.4-1.0.0 can be downloaded from Mellanox site:

2. Set all the ports to Ethernet.

   connectx_port_config

   And follow the instructions on the screen.

   For further instructions on how to run the script, please refer to the MLNX_OFED User Manual.

3. Download DPDK 1.7.1 or DPDK 1.8.0 from http://dpdk.org/

4. Compile DPDK:

   make install T=x86_64-native-linuxapp-gcc

   For more advanced DPDK compilation options, please refer to dpdk.org documentation:

5. Extract the PMD package mlx4_pmd_v2.7.4.tar.gz.

6. Run the compilation script.

   ./compile_mlx4_pmd.sh -s <RTE_SDK> -t <RTE_TARGET>

   For example:

   ./compile_mlx4_pmd.sh -s /var/soft/dpdk-1.7.1 -t x86_64-native-linuxapp-gcc

   See section 2.4 for all compilation script options.

7. Run the configuration script.

   ./configure_mlx4_pmd.sh -s nosriov

   See section 2.5 for all configuration script options.

   **NOTE:** If hugepage reconfiguration is needed after rebooting the machine, you can re-run the configuration script.

   Performance can be improved by running the configuration script with the “-o” flag (optimized steering mode).

   Example:

   ./configure_mlx4_pmd.sh -s nosriov -o
NOTE: Please be aware, running this option will prevent the PMD port from receiving packets with the port MAC as DST MAC. To add additional MAC and receive packets with this destination MAC use the rte_eth_dev_mac_addr_add DPDK API.

NOTE: If promiscuous mode is used, PMD port will receive all packets with all DST MACs except for port’s MAC.

8. Restart MLNX_OFED.
   `/etc/init.d/openibd restart`

9. Verify that ConnectX-3 firmware is 2.33.5000. (Use ibstat command)

2.2 KVM

2.2.1 Hypervisor

1. Install MLNX_OFED-2.4-1.0.0.
   MLNX_OFED 2.4-1.0.0 can be downloaded from Mellanox site:

2. Add the following line to `/etc/modprobe.d/mlx4_core.conf`
   `options mlx4_core log_num_mgm_entry_size=-1`

   **Note:** To improve performance you can set `log_num_mgm_entry_size=-7`

   **Note:** Please be aware, running this option will prevent the PMD port over VF on VM from receiving packets with the port MAC as DST MAC.

   When running DPDK on VM, use the DPDK API, `rte_eth_dev_mac_addr_add`, to add additional MAC and receive packets with this destination MAC.

3. Restart MLNX_OFED.
   `/etc/init.d/openibd restart`

4. Verify that ConnectX-3 firmware is v2.33.5000. (Use ibstat command)

2.3 Virtual Machine

1. Download DPDK 1.7 or DPDK 1.8 from [http://dpdk.org/](http://dpdk.org/)

2. Compile DPDK:
   ```
   make install T=x86_64-native-linuxapp-gcc
   ```

   For more advanced DPDK compilation options please refer to dpdk.org documentation:

3. Extract the PMD package mlx4_pmd_v2.7.4.tar.gz

4. Run the compilation script. See section 2.4 for all compilation script options.
   ```
   ./compilemlx4_pmd.sh -s <RTE_SDK> -t <RTE_TARGET>
   ```

   For example:
2.4 Compilation Script

```bash
./compile_mlx4_pmd.sh -s /var/soft/dpdk-1.7.1 -t x86_64-native-linuxapp-gcc
```

5. Run the configuration script. See section 2.5 for all configuration script options.

```bash
./configure_mlx4_pmd.sh -s kvm
```

**NOTE:** If hugepage reconfiguration is needed after rebooting the machine, you can re-run the configuration script.

### Parameter | Description
---|---
-s `<RTE_SDK>` | This parameter is mandatory, need to specify full path to DPDK compiled sources
-t `<RTE_TARGET>` | This parameter is mandatory and needs to be specified according to the `RTE_TARGET` that DPDK was compiled with
-d | Optional parameter which enables PMD debug prints
-m | When compiled with this option, multi-segment send and receive can be used
-c | Enable hardware checksum offloading

**NOTE:** Multi-segment send/recv is not required. Please do not use this flag as it reduces PMD performance.

**NOTE:** Please do not use “-c” flag (hardware checksum offloading) if it is not required as it can reduce PMD performances.

2.5 Configuration Script

```bash
./configure_mlx4_pmd.sh -s kvm/nosriov [-p <PAGE_SIZE>] [-n <HUGE PAGES NUM>] [-o <enable optimized steering mode>]
```

### Parameter | Description
---|---
-s kvm/nosriov | This parameter is mandatory:
For bare metal environment please use ‘–s nosriov’
For KVM’s guest please specify ‘–s kvm’
-p `<PAGE_SIZE>` | This parameter is optional. If not specified, the default page size is 2K
-n `<HUGE PAGES NUM>` | This parameter is optional. If not specified, the default number of pages that will be configured is 2048
-o | This parameter is optional. If specified, optimized steering mode will be enabled. When used packet with DST MAC as port’s MAC will not be received With this option DPDK `rte_eth_dev_mac_addr_add` should be used to add “DPDK” MAC.
In case of Bare Metal, promiscuous mode can be used to receive
2.6 Sending and Receiving Jumbo Frames

- DPDK 1.6:
  a. Configure the ConnectX-3 MTU.
     
    Example: ifconfig eth0 MTU 4160
  b. Compile PMD with the “-m” option, if the mbuf size is smaller than the MTU size
     and you need to use scattered mbuf.

- DPDK 1.7:
  Use the rte_eth_dev_set_mtu API to set the appropriate MTU.

2.7 RX VLAN Filter

1. Make sure that regular steering mode is configured (on Bare Metal and KVM).

   cat /sys/module/mlx4_core/parameters/log_num_mgm_entry_size =1

2. Modify the /etc/modprobe.d/mlnx.conf file if required.

3. Configure VLAN interface on the port using standard Linux tools.

4. Use rte_eth_dev_vlan_filter() DPDK API to add or remove VLAN
3 System Performance Configuration

3.1 General Settings

- Disable pause frames on all network interfaces managed by mlx4_en.

```
ethtool -A eth16 rx off tx off
```

**NOTE:** There are systems that increase performance by enabling pause frames.

- Verify that both adapters are located on the same PCI bus (as each CPU socket on a Crown Pass platform manages its own PCI bus) in order to forward packets from one to the other without NUMA performance penalty.

```
lspci -vv | grep Mellanox  (To find out PCI slot)
cat /sys/devices/pci0000:80/0000:80:01.0/numa_node
or
lspci -tv
```

On a system with more than one NUMA node, it is recommended to use the CPU near local NUMA node to which the PCIe adapter is connected for better performance. For Virtual Machines (VM), verify that the right CPU and NUMA node are pinned for the VM according to the above.

- Use 1Gb huge pages
- Enable the hyper threading.
- Verify that the CPU is running in performance mode.

```
!/bin/bash
service cpuspeed stop
NUM_CPUS=32
for (( i=0; i<$NUM_CPUS;))
do
echo performance > /sys/devices/system/cpu/cpu$i/cpufreq/scaling_governor
i=$(($i+1))
done
```

- Verify the following BIOS configuration

```
setpci -s <NIC BIOS address> 68.w 5020
```

If the output is different than 5020, set it by:

```
setpci -s <NIC BIOS address> 68.w=5020
```

For example:

```
setpci -s 84:00.0 68.w=5020
```

- Make sure that unnecessary System Management Interrupts (SMIs) are disabled. (For example: SMI that are used for Power Monitoring and for Memory PreFailure)
Notification). Please refer to your server provider guides for recommended platform tuning.

- Isolate cores that are used
  Use isolcpus command for boot configuration
  
  For example, add the following to kernel boot parameters:
  
  ```
  isolcpus=2,3
  ```

- Stop irqbalancer
  
  ```
  service irqbalance stop
  ```

- Set all possible interrupts to different NUMA:
  
  Example: `echo '6-9' | sudo tee /proc/irq/*/smp_affinity_list`

- Set NIC interrupts to same NUMA:
  
  Example: `set_irq_affinity_cpulist.sh 0-1 ethX`

- Set other NIC interrupts to different NUMA:
  
  Example: `set_irq_affinity_cpulist.sh 6-9 ethY`

- Disable kernel memory compaction:
  
  ```
  echo never > /sys/kernel/mm/transparent_hugepage/defrag
  echo never > /sys/kernel/mm/transparent_hugepage/enabled
  echo 0 > /sys/kernel/mm/transparent_hugepage/numa/nr_hugepages
  ```

### 3.2 KVM Settings

- Make sure that Hypervisor kernel is 3.16 or newer (For example Ubuntu 14.10 or Fedora 20/21 can be used)

- Configure boot with “iommu=pt”

- Use 1G huge pages

- Make sure to allocate VM on huge pages:
  
  Example:
  
  ```
  qemu is started with the following commands:
  ```

  ```
  umount /mnt/huge 2>/dev/null
  mount -t hugetlbfs none /mnt/huge &&
  echo 8192 > /sys/kernel/mm/hugepages/hugepages-2048kB/nr_hugepages &&
  numactl --cpunodebind 1 --membind 1 --
  qemu-system-x86_64 --
  -smp 24 --
  -m 4G --
  -mem-path /mnt/huge --
  -mem-prealloc --
  -enable-kvm --
  -cpu host --
  -serial tcp:999,server,nowait --
  -nographic --
  -vga none --
  -device pci-assign,host=83:00.1 --
  -device pci-assign,host=84:00.1 --
  -drive snapshot=on,file=/opt/vm/ubuntu-14.04-template.qcow2 --
  ```
System Performance Configuration

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- drive file=/data/data.img

Since both adapters are installed on NUMA node 1 PCI slots (CPU socket 1), *numactl* is used to bind qemu to CPU threads and memory from that node only, which makes a virtual machine without NUMA internally.

All its memory is allocated from huge pages in /mnt/huge.

- After loading VM, verify huge pages on your Hypervisor is used by VM:

  ```
  cat /sys/devices/system/node/node<NUM>/hugepages/hugepages-<PAGE-SIZE>/free_hugepages
  ```

- Make sure to set CPU pining

  For example if you run qemu:

  ```
  (qemu) info cpus
  CPU #0: pc=0xffffffff81056306 (halted) thread_id=2719
  CPU #1: pc=0xffffffff81056306 (halted) thread_id=2720
  CPU #2: pc=0xffffffff81056306 (halted) thread_id=2723
  CPU #3: pc=0xffffffff81056306 (halted) thread_id=2724
  taskset -p 0x1 2719
  taskset -p 0x2 2720
  taskset -p 0x4 2723
  taskset -p 0x8 2724
  ```
4 Running DPDK Application with Mellanox ConnectX®-3 Poll-Mode Driver

The output of the PMD compilation is a shared object, librte_pmd_mlxitx4.so.

It is created under the mlx4_pmd_v2.7.4/librte_pmd_mlxitx4/librte_pmd_mlxitx4.so.

The librte_pmd_mlxitx4.so should be dynamically loaded during the DPDK application run with the -d flag.

For example:

```
app/testpmd -c 0xe000 -n 4 -b 0000:01:00.0 -b 0000:01:00.1 -d /tmp/mlx4_pmd_v2.7.4/librte_pmd_mlxitx4/librte_pmd_mlxitx4.so -- --i --numa --burst=64 --txd=256 --rxd=256 --mbcache=256 --coremask=0xc000 --rxq=1 --txq=1 --portmask 0xA
```

When running bi-directional traffic, for better performance, use the receive-inline feature that can be enabled by env variable MLX4_INLINE_RECV_SIZE.

Example: for 64B messages

```
MLX4_INLINE_RECV_SIZE=64 app/testpmd -c 0xe000 -n 4 -b 0000:01:00.0 -b 0000:01:00.1 -d /tmp/mlx4_pmd_v2.7.4/librte_pmd_mlxitx4/librte_pmd_mlxitx4.so -- --i --numa --burst=64 --txd=256 --rxd=256 --mbcache=256 --coremask=0xc000 --rxq=1 --txq=1 --portmask 0xA
```
5  Sanity Check

Provided that all software components have been successfully installed and at least one ConnectX® adapter is present in the host system, run testpmd to test PMD.

These examples assume that there is a host with two dual port adapters that:

- First port of each NIC is linked to another similar host
- Second port of each NIC is linked with each other

1. Run *testpmd* interactively from the DPDK build tree (for more information about its command-line options, please refer to its documentation: http://www.dpdk.org/doc/guides/testpmd_app_ug/index.html):

```
root# ~/DPDK/x86_64-native-linuxapp-gcc/app/test-pmd/testpmd -c 0xf000f000 -n 4 -d ./librte_pmd_mlx4.so -- -i
EAL: Detected lcore 0 as core 0 on socket 0
EAL: Detected lcore 1 as core 1 on socket 0
EAL: Detected lcore 2 as core 2 on socket 0
EAL: Detected lcore 3 as core 3 on socket 0
EAL: Detected lcore 4 as core 4 on socket 0
 [...]
EAL: Detected lcore 27 as core 3 on socket 1
EAL: Detected lcore 28 as core 4 on socket 1
EAL: Detected lcore 29 as core 5 on socket 1
EAL: Detected lcore 30 as core 6 on socket 1
EAL: Detected lcore 31 as core 7 on socket 1
EAL: Support maximum 64 logical core(s) by configuration.
EAL: Detected 32 lcore(s)
EAL: cannot open VFIO container, error 2 (No such file or directory)
EAL: VFIO support could not be initialized
EAL: Setting up memory...
EAL: PCI device 0000:83:00.0 on NUMA socket 1
EAL: probe driver: 15b3:1007 librte_pmd_mlx4
PMD: librte_pmd_mlx4: PCI information matches, using device "mlx4_0" (VF: false)
PMD: librte_pmd_mlx4: 2 port(s) detected
PMD: librte_pmd_mlx4: bad state for port 1: "down" (1)
PMD: librte_pmd_mlx4: port 1 MAC address is 00:02:c9:b5:b7:50
PMD: librte_pmd_mlx4: bad state for port 2: "down" (1)
PMD: librte_pmd_mlx4: port 2 MAC address is 00:02:c9:b5:b7:51
EAL: PCI device 0000:84:00.0 on NUMA socket 1
EAL: probe driver: 15b3:1007 librte_pmd_mlx4
```
PMD: librte_pmd_mlx4: PCI information matches, using device "mlx4_1" (VF: false)
PMD: librte_pmd_mlx4: 2 port(s) detected
PMD: librte_pmd_mlx4: bad state for port 1: "down" (1)
PMD: librte_pmd_mlx4: port 1 MAC address is 00:02:c9:b5:ba:b0
PMD: librte_pmd_mlx4: bad state for port 2: "down" (1)
PMD: librte_pmd_mlx4: port 2 MAC address is 00:02:c9:b5:ba:b1
Interactive-mode selected
Configuring Port 0 (socket 0)
PMD: librte_pmd_mlx4: 0x7f35e0: TX queues number update: 0 -> 1
PMD: librte_pmd_mlx4: 0x7f35e0: RX queues number update: 0 -> 1
Port 0: 00:02:C9:B5:B7:50
Configuring Port 1 (socket 0)
PMD: librte_pmd_mlx4: 0x7f3620: TX queues number update: 0 -> 1
PMD: librte_pmd_mlx4: 0x7f3620: RX queues number update: 0 -> 1
Port 1: 00:02:C9:B5:B7:51
Configuring Port 2 (socket 0)
PMD: librte_pmd_mlx4: 0x7f3660: TX queues number update: 0 -> 1
PMD: librte_pmd_mlx4: 0x7f3660: RX queues number update: 0 -> 1
Port 2: 00:02:C9:B5:BA:B0
Configuring Port 3 (socket 0)
PMD: librte_pmd_mlx4: 0x7f36a0: TX queues number update: 0 -> 1
PMD: librte_pmd_mlx4: 0x7f36a0: RX queues number update: 0 -> 1
Port 3: 00:02:C9:B5:BA:B1
Checking link statuses...
Port 0 Link Up - speed 10000 Mbps - full-duplex
Port 1 Link Up - speed 40000 Mbps - full-duplex
Port 2 Link Up - speed 10000 Mbps - full-duplex
Port 3 Link Up - speed 40000 Mbps - full-duplex
Done
testpmd>

The following commands are typed from the *testpmd* interactive prompt.

1. Check port status:

testpmd> show port info all

*************** Infos for port 0 ***************
 MAC address: 00:02:C9:B5:B7:50
 Connect to socket: 0
 memory allocation on the socket: 0
 Link status: up
 Link speed: 10000 Mbps
 Link duplex: full-duplex
 Promiscuous mode: enabled
 Allmulticast mode: disabled
 Maximum number of MAC addresses: 128
 Maximum number of MAC addresses of hash filtering: 0
 VLAN offload:
   strip on
   filter on
   qinq(extend) off

*************** Infos for port 1 ***************
 MAC address: 00:02:C9:B5:B7:51
 Connect to socket: 0
 memory allocation on the socket: 0
 Link status: up
 Link speed: 40000 Mbps
 Link duplex: full-duplex
 Promiscuous mode: enabled
 Allmulticast mode: disabled
 Maximum number of MAC addresses: 128
 Maximum number of MAC addresses of hash filtering: 0
 VLAN offload:
   strip on
   filter on
2. Start IO forwarding between ports 1 and 3. The *tx_first* argument tells
   *testpmd* to send a single packet burst which will be always forwarded by both ports:

   testpmd> set fwd io
   Set io packet forwarding mode
   testpmd> set portlist 1,3
   previous number of forwarding ports 4 - changed to number of configured ports 2
   testpmd> start tx_first
   io packet forwarding - CRC stripping disabled - packets/burst=32
   nb forwarding cores=1 - nb forwarding ports=2
   RX queues=1 - RX desc=128 - RX free threshold=0
   RX threshold registers: pthresh=8 hthresh=8 wthresh=0
   TX queues=1 - TX desc=512 - TX free threshold=0
   TX threshold registers: pthresh=32 hthresh=0 wthresh=0
   TX RS bit threshold=0 - TXQ flags=0x0
   testpmd>

4. Display *testpmd* port statistics:

   testpmd> show port stats all

   ######################## NIC statistics for port 0 ########################
   RX-packets: 0 RX-missed: 0 RX-bytes: 0
   RX-badcrc: 0 RX-badlen: 0 RX-errors: 0
   RX-nombuf: 0
   TX-packets: 0 TX-errors: 0 TX-bytes: 0
   ######################## NIC statistics for port 1 ########################
   RX-packets: 60800584 RX-missed: 0 RX-bytes: 3891239534
   RX-badcrc: 0 RX-badlen: 0 RX-errors: 0
   RX-nombuf: 0
5. Stop forwarding:

```
>>> testpmd> stop
Telling cores to stop...
Waiting for lcores to finish...

----------------------
Forward statistics for port 1
----------------------
RX-packets: 78238689   RX-dropped: 0   RX-total: 78238689
TX-packets: 78681769   TX-dropped: 0   TX-total: 78681769

----------------------
Forward statistics for port 3
----------------------
RX-packets: 78681737   RX-dropped: 0   RX-total: 78681737
TX-packets: 78238721   TX-dropped: 0   TX-total: 78238721

+++++++++++++++ Accumulated forward statistics for all ports+++++++++++++++
RX-packets: 156920426   RX-dropped: 0   RX-total: 156920426
TX-packets: 156920490   TX-dropped: 0   TX-total: 156920490
```

Done.
```
>>> testpmd>
```


```
>>> testpmd> quit
Stopping port 0...done
Stopping port 1...done
Stopping port 2...done
Stopping port 3...done
by...
root#