Running RoCE Over L2 Network Enabled with PFC

Application Guide

Rev. 1.5

www.mellanox.com

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About this Manual

This manual describes how to configure RoCE on Mellanox adapters with a lossless transport layer (PFC or global pause).

Audience

This manual is intended for server and network administrators who intend to configure RoCE applications.

Document Conventions

The following lists conventions used in this document.

NOTE: Identifies important information that contains helpful suggestions.

CAUTION: Alerts you to the risk of personal injury, system damage, or loss of data.

WARNING: Warns you that failure to take or avoid a specific action might result in personal injury or a malfunction of the hardware or software. Be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents before you work on any equipment.

Revision History

Table 1: Document Revision History

Revision	Date	Description
1.5	Nov 2014	Added Force10 S4810 Dell switch configuration example
1.4	Sep 2014	Added Comware 7 HP switch configuration example
1.3	May 2014	Minor updates related to the need of MLNX_OFED for RoCE.
1.2	January 2014	Updated configuration flows and description.
1.1	2011	First revision

1 Overview

RDMA over Converged Ethernet (RoCE) enables InfiniBand transport over Ethernet networks. It encapsulates InfiniBand transport and GRH headers in Ethernet packets using an IEEE assigned Ethertype.

Classic Ethernet is a best-effort protocol in the event of congestion. Ethernet discards packets and relies on higher level protocols to provide retransmission and other reliability mechanisms. IEEE 802.3x pause allows a congested receiver to signal the other side of the link to pause transmission for a short period of time. Pause functionality is applied to all the traffic on the link.

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).

This document focuses on the configuration of RoCE with a lossless transport layer.

1.1 Software Dependencies

To use RoCE over Mellanox ConnectX® hardware, the MLNX_OFED is recommended to be installed.

Inbox drivers:

In RHEL 6.* “High Performance Network” add on can be installed instead of the MLNX-OFED. Refer to the following link to additional information http://www.redhat.com/products/enterprise-linux-add-ons/high-performance-network/

In RHEL 7 / SLES 12 / Ubuntu 14.04 the RoCE support is inbox.

1.2 Firmware Dependencies

It is recommended to use the latest firmware available at Mellanox.com site to use RoCE over Mellanox ConnectX adapter card family hardware.

1.3 General Guidelines

Since RoCE encapsulates InfiniBand traffic in Ethernet frames, the corresponding net device must be up and running. In case of Mellanox hardware, MLNX_OFED must be installed and mlx4_en must be loaded and the corresponding interface configured.

Step 1: Make sure that MLNX_OFED is installed.

Step 2: Verify that the field `link_layer` is “Ethernet”

```
# ibv_devinfo
hca_id: mlx4_0
        transport:                      InfiniBand (0)
        fw_ver:                         2.30.8000
        node_guid:                      0002:c903:00ef:f4a0
        sys_image_guid:                 0002:c903:00ef:f4a3
        vendor_id:                      0x02c9
        vendor_part_id:                 4099
        hw_ver:                         0x1
```

```
        board_id:                       MT_1090120019
        phys_port_cnt:                  2
                port:   1
                        state:                  PORT_ACTIVE (4)
                        max_mtu:                4096 (5)
                        active_mtu:             1024 (3)
                        sm_lid:                 0
                        port_lid:               0
                        port_lmc:               0x00
                        link_layer:             Ethernet

                port:   2
                        state:                  PORT_ACTIVE (4)
                        max_mtu:                4096 (5)
                        active_mtu:             4096 (5)
                        sm_lid:                 4
                        port_lid:               3
                        port_lmc:               0x00
                        link_layer:             InfiniBand
```

If it is InfiniBand, then run `connectx_port_config` to change the ports designation to Ethernet.

Step 3: Configure the IP address of the interface so that the link becomes active.

All InfiniBand verb applications running over InfiniBand verbs must work on RoCE links if they use GRH headers (if the use of GRH is specified in the address vector).

1.4 Transport Modes

RDMA encapsulated in an Ethernet frame can be configured as 802.1qq tagged or untagged.

Global pause and PFC cannot run together on the same host. If running one server with two adapter cards, each with 2 ports – all ports work in PFC or global pause.

PFC and global configuration may mislead. If PFC is enabled, global pause does not work even though it could also be enabled. To make sure global pause is working, make sure PFC is disabled and global pause is enabled.

Unlike PFC, global pause is cannot be configured globally.

Table 2: PFC/Global Pause Configuration Relation

PFC Configuration	Global Pause	Status
Enabled per host	Enabled per interface (e.g. eth1)	PFC operates on all VLAN interfaces
Enabled per host	Disabled on all interfaces	PFC operates on all VLAN interfaces
Disabled per host	Enabled per interface (e.g. eth1)	Global pause operates on the enabled interface (eth1). PFC does not operate. Note: This is the default configuration for all Ethernet interfaces.
Disabled per host	Disabled on all interfaces	Neither global pause nor PFC operate.

1.4.1 Untagged Ethernet

In case of untagged Ethernet frames (without a VLAN), the port should be enabled with global pause flow-control.

Verify that /sys/module/mlx4_en/parameters/pfctx and pfcrx are set to 0 to enable global pause.

- ***To enable or disable global pause, run:***

```
# ethtool -A eth<x> [rx on|off] [tx on|off]

//For example:
# ethtool -A eth1 rx on tx on
```

- ***To check the global pause status, run:***

```
# ethtool -a eth<x>

//For example:
# ethtool -a eth1
Pause parameters for eth1:
Autonegotiate:  off
RX:             on
TX:             on
#
```

1.4.2 802.1Q VLANs

Tagged Ethernet frames carry a 3-bit priority field. The value of this field is derived from the InfiniBand Service Level (SL) field by taking the 3 least significant bits of the SL field (4 bits).

For RoCE traffic to use VLAN tagged frames, you need to specify the GID table entries that are derived from the VLAN devices when creating address vectors.

If the interface is configured to work with 802.1q VLAN tags, it is possible to enable flow-control either with global pause, or with PFC.

- ***To configure a VLAN interface:***

Step 1: Verify VLAN support is enabled by the kernel. Usually this requires loading the 802.1q module. Run:

```
# modprobe 8021q
```

Step 2: Add a VLAN device (PFC cannot be used when using an interface without VLAN). Run:

```
# vconfig add [interface name] [vlan id]

// For example: # vconfig add eth1 100
```

Step 3: Assign an IP address to the VLAN interface. This creates a new entry in the GID table (as index 1).

```
# ifconfig [interface name].[vlan id] [ip]/[netmask]

// For example: # ifconfig eth1.100 10.10.10.10/24 up
```

Step 4: For rdma_cm applications, specify only the IP address of a VLAN device in order for the traffic to go with the VLAN tagged frames.

➢ ***To configure the mlx4_en Ethernet driver to support PFC:***

Priority-based Flow Control policy on TX and RX [7:0]. The parameters of `mlx4_en`:

- `pfctx` – PFC policy on TX[7:0]. Per priority bit mask (default is 0).
- `pfcrx` – PFC policy on RX[7:0]. Per priority bit mask (default is 0).

Each bit of the pfctx and pfcrx represents a priority level (0..7).
To turn on PFC on priority 0, use 0x1, to turn on PFC on priority 1 use 0x2, to turn on PFC on all priorities use 0xff.

Step 1: Change the values of pfctx and pfcrx in the line below in the file /etc/modprobe.d/mlx4_en.conf (create the file if it does not exist),

```
options mlx4_en pfctx=0x08 pfcrx=0x08
```

Step 2: Restart the network driver. Run:

```
#/etc/init.d/openibd restart
```

➢ ***To show the value of the PFC parameters in the driver, run:***

```
# RX=`cat /sys/module/mlx4_en/parameters/pfcrx`;printf "0x%x\n" $RX
0x8

# TX=`cat /sys/module/mlx4_en/parameters/pfctx`;printf "0x%x\n" $TX
0x8
```

The values of `pfctx` and `pfcrx` should be set according to the priority you need the flow control to have.

1.5 Priority Mapping

There are two ways to map the kernel priority (skb_prio) to the user priority (UP) that is attached to the VLAN tag on the Ethernet frame.

1. RoCE traffic priority mapping – kernel bypass
2. TCP/IP traffic priority mapping

Both mapping are required in case there are two flows from the host.

➢ ***Map SKB priority to user priority***

Step 1: Map SKB priority to User priority (UP) for RoCE applications.

16 SKB priority values are available and each is mapped to a single value in the range of 0-7.

This command will be applied for all ROCE traffic for all VLANs configured on the host.

For example:

```
# tc_wrap.py -i eth1 -u 0,1,2,3,4,5,6,7,0,1,2,3,4,5,6,7
```

Therefore, to map all SKB priorities to a specific egress VLAN priority (e.g. 3):

```
# tc_wrap.py -i eth1 -u 3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3
UP  0
UP  1
```

```
UP  2
UP  3
        skprio: 0
        skprio: 1
        skprio: 2 (tos: 8)
        skprio: 3
        skprio: 4 (tos: 24)
        skprio: 5
        skprio: 6 (tos: 16)
        skprio: 7
        skprio: 8
        skprio: 9
        skprio: 10
        skprio: 11
        skprio: 12
        skprio: 13
        skprio: 14
        skprio: 15
        skprio: 0 (vlan 100)
        skprio: 1 (vlan 100)
        skprio: 2 (vlan 100 tos: 8)
        skprio: 3 (vlan 100)
        skprio: 4 (vlan 100 tos: 24)
        skprio: 5 (vlan 100)
        skprio: 6 (vlan 100 tos: 16)
        skprio: 7 (vlan 100)
UP  4
UP  5
UP  6
UP  7
#
```

Step 2: For TCP/IP application, map the user priority to the VLAN priority egress from the device using the command vconfig set_egress_map (`vconfig set_egress_map [vlan-device] [skb-priority] [vlan-qos]`).

The outbound packets with a particular SKB priority are tagged with a particular VLAN priority. The default VLAN priority is 0.

This command is applied to specific VLAN.

For example:

```
# for i in {0..7}; do vconfig set_egress_map eth1.100 $i 3 ; done
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
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Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
#
```

To verify the configuration, run (see in boldface):

```
# cat /proc/net/vlan/eth1.100
Eth1.100  VID: 100       REORDER_HDR: 1  dev->priv_flags: 1
```

```
         total frames received             0
          total bytes received             0
      Broadcast/Multicast Rcvd             0

      total frames transmitted             6
       total bytes transmitted           468
            total headroom inc             0
           total encap on xmit             0
Device: eth4
INGRESS priority mappings: 0:0  1:0  2:0  3:0  4:0  5:0  6:0 7:0
EGRESS priority mappings: 0:3 1:3 2:3 3:3 4:3 5:3 6:3 7:3
#
```

1.5.1 Developing RDMA Applications

The application rdma_cm must choose a value for IP TOS according to the desired TC and call the rdma_set_option (id, RDMA_OPTION_ID, RDMA_OPTION_ID_TOS, &tos, sizeof tos) method.

Maping of IP ToS to SKB priority (kernel priority) is static and cannot be modified by the user.

Figure 1: IP ToS to SKB Priority Static Mapping

ToS	Prio	ToS	Prio	ToS	Prio	ToS	Prio	ToS	Prio	ToS	Prio	ToS	Prio	ToS	Prio	ToS	Prio	ToS	Prio
0	0	26	4	52	6	78	2	104	2	130	1	156	4	182	6	208	6	234	2
1	0	27	4	53	6	79	2	105	2	131	1	157	4	183	6	209	6	235	2
2	1	28	4	54	6	80	6	106	2	132	0	158	4	184	4	210	6	236	2
3	1	29	4	55	6	81	6	107	2	133	0	159	4	185	4	211	6	237	2
4	0	30	4	56	4	82	6	108	2	134	0	160	0	186	4	212	6	238	2
5	0	31	4	57	4	83	6	109	2	135	0	161	0	187	4	213	6	239	2
6	0	32	0	58	4	84	6	110	2	136	2	162	1	188	4	214	6	240	6
7	0	33	0	59	4	85	6	111	2	137	2	163	1	189	4	215	6	241	6
8	2	34	1	60	4	86	6	112	6	138	2	164	0	190	4	216	4	242	6
9	2	35	1	61	4	87	6	113	6	139	2	165	0	191	4	217	4	243	6
10	2	36	0	62	4	88	4	114	6	140	2	166	0	192	0	218	4	244	6
11	2	37	0	63	4	89	4	115	6	141	2	167	0	193	0	219	4	245	6
12	2	38	0	64	0	90	4	116	6	142	2	168	2	194	1	220	4	246	6
13	2	39	0	65	0	91	4	117	6	143	2	169	2	195	1	221	4	247	6
14	2	40	2	66	1	92	4	118	6	144	6	170	2	196	0	222	4	248	4
15	2	41	2	67	1	93	4	119	6	145	6	171	2	197	0	223	4	249	4
16	6	42	2	68	0	94	4	120	4	146	6	172	2	198	0	224	0	250	4
17	6	43	2	69	0	95	4	121	4	147	6	173	2	199	0	225	0	251	4
18	6	44	2	70	0	96	0	122	4	148	6	174	2	200	2	226	1	252	4
19	6	45	2	71	0	97	0	123	4	149	6	175	2	201	2	227	1	253	4
20	6	46	2	72	2	98	1	124	4	150	6	176	6	202	2	228	0	254	4
21	6	47	2	73	2	99	1	125	4	151	6	177	6	203	2	229	0	255	4
22	6	48	6	74	2	100	0	126	4	152	4	178	6	204	2	230	0		
23	6	49	6	75	2	101	0	127	4	153	4	179	6	205	2	231	0		
24	4	50	6	76	2	102	0	128	0	154	4	180	6	206	2	232	2		
25	4	51	6	77	2	103	0	129	0	155	4	181	6	207	2	233	2		

Refer to the *MLNX_OFED User Manual* for additional information.

1.6 Performance

To verify RoCE is working and performed as expected run a benchmark test such as ib_write_bw or any other test.

- ***To run ib_write_bw, run the following on the server side:***

```
# ib_write_bw

//For example

# ib_write_bw -d mlx4_0 -i 1 -R --report_gbits
```

And the following command on the client side:

```
# ib_write_bw <server-name>

//For example

#ib_write_bw 11.11.0.1 -R -d mlx4_0 --report_gbits
---------------------------------------------------------------------------------
                    RDMA Write BW Test
 Dual-port       : OFF          Device         : mlx4_0
 Number of qps   : 1            Transport type : IB
 Connection type : RC           Using SRQ      : OFF
 TX depth        : 128
 CQ Moderation   : 100
 Mtu             : 1024[B]
 Link type       : Ethernet
 Gid index       : 0
 Max inline data : 0[B]
 rdma cm QPs     : ON
 Data ex. method : rdma cm
---------------------------------------------------------------------------------
 local address: LID 0000 QPN 0x05a8 PSN 0x8bf4f2
 GID: 254:128:00:00:00:00:00:00:246:82:20:255:254:23:31:225
 remote address: LID 0000 QPN 0x059f PSN 0x42dea9
 GID: 254:128:00:00:00:00:00:00:246:82:20:255:254:23:27:129
---------------------------------------------------------------------------------
 #bytes     #iterations    BW peak[Gb/sec]    BW average[Gb/sec]   MsgRate[Mpps]
 65536      5000           36.58              36.58                0.069764
--------------------------------------------------------------------------------- #
```

For additional information on this command and other performance commands, refer to the Performance Tuning guide on Mellanox.com located at: http://www.mellanox.com/page/products_dyn?product_family=27&mtag=linux_driver

Additional options to test RoCE is via ibv_rc_pingpong command:

- ***To run ibv_rc_pingpong run the following on the server side:***

```
# ibv_rc_pingpong [options]

//For example
# ibv_rc_pingpong -d mlx4_0 -i 1 -g 0
```

And the following command on the client side:

```
# ibv_rc_pingpong [options] <server-name>

//For example
# ibv_rc_pingpong -d mlx4_0 -i 1  -p 20000 -g 0 reg-r-vrt-001
  local address:  LID 0x0000, QPN 0x0005af, PSN 0xcb5e18, GID
fe80::f652:14ff:fe17:1fe1
  remote address: LID 0x0000, QPN 0x0005a3, PSN 0x86a929, GID fe80::f652:14ff:fe17:1b81
8192000 bytes in 0.01 seconds = 10400.89 Mbit/sec
1000 iters in 0.01 seconds = 6.30 usec/iter
#
```

For additional information, refer to Performance Tuning Guidelines on Mellanox.com.

1.7 Port Statistics

It is possible to read port statistics in the same manner as regular InfiniBand ports. The information is available from the sysfs at `/sys/class/infiniband/<device>/ports/<port number>/counters`.

The supported counters are:

- `port_rcv_packets`
- `port_xmit_packets`
- `port_rcv_data`
- `port_xmit_data`

These counters count only InfiniBand data and are not account for Ethernet traffic.

➢ ***To read the number of transmitted packets, run:***

```
# cat /sys/class/infiniband/<dev>/ports/<port>/counters/port_xmit_packets

//for example
# cat /sys/class/infiniband/mlx4 0/ports/1/counters/port xmit packets
1740380
#
```

RoCE traffic is not shown in the associated Etherent device's counters since it is offloaded by the hardware and does not go through Ethernet network driver.

1.8 DCBX Consideration

It is possible to turn on LLDP with DCBX TLVs for auto PFC configuration from the switch to the host. To do that the LLDP protocol should be turned on, on the switch and on the host, in addition DCBX TLVs should be enabled on both switch and host.

2 RoCE and PFC Example Setup

The objective of the example in this chapter is to run RoCE over L2 with PFC enabled.

(This example configured PFC with priority 3 enabled).

Note: the solution in this chapter is described and discussed in Mellanox Community – Solutions space.

http://community.mellanox.com/docs/DOC-1414

More enhanced solution for RoCE (lossless) and TCP (lossy) flows configured over L2 Ethernet network enabled with PFC can be found in this link:

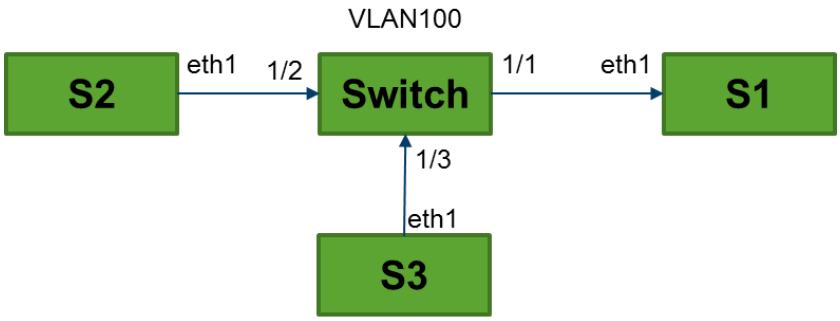
http://community.mellanox.com/docs/DOC-1415

2.1 Best Test-Bed Configuration

It is recommended to set up the network as follows:

- Mellanox Ethernet switch (e.g. SX1036) , MLNX-OS® version 3.3.4304
- 3x Hosts, OS RH6.4
- 3x ConnectX®-3, MLNX_OFED 2.1

Figure 2: Network Setup



2.2 MLNX-OS Switch Configuration

➢ ***Configure the SX1036 as follows:***

Step 1: Create and configure the required VLAN interface on the switch

```
switch (config) # interface ethernet 1/1-1/3 switchport mode hybrid
switch (config) # interface ethernet 1/1 switchport hybrid allowed-vlan
all
switch (config) # interface ethernet 1/2 switchport hybrid allowed-vlan
all
switch (config) # interface ethernet 1/3 switchport hybrid allowed-vlan
all
```

Step 2: The following switch configuration should be added to the Switch

```
switch (config) # dcb priority-flow-control enable
switch (config) # dcb priority-flow-control priority 3 enable
switch (config) #  interface ethernet 1/1-1/3 dcb priority-flow-control
mode on force
```

Step 3: Verify your configuration. Run:

```
switch (config)# show dcb priority-flow-control

PFC enabled
Priority Enabled List    :3
Priority Disabled List   :0 1 2 4 5 6 7

TC     Lossless
---    ----------
0           N
1           Y
2           Y
3           N

Interface      PFC admin        PFC oper
------------   --------------   -------------
…
1/1             On               Enabled
1/2             On               Enabled
1/3             On               Enabled
…
switch (config) #
```

2.3 Host Configuration

- ***To configure the servers in the network, the following switch configuration should be applied to each host in the setup:***

Step 1: Enable PFC. Add the following to the file /etc/modprobe.d/mlx4_en.conf:

```
options mlx4_en pfctx=0x08 pfcrx=0x08
```

Step 2: Restart openidb daemon. Run:

```
#/etc/init.d/openibd restart
```

Step 3: Verify PFC is enabled. Run:

```
#RX=`cat /sys/module/mlx4_en/parameters/pfcrx`;printf "0x%x\n" $RX
0x08
```

Step 4: Configure VLAN interface. Run:

```
# modprobe 8021q
# vconfig add eth1 100
# ifconfig eth1.100 11.11.100.1/24 up
```

Step 5: Map skb_prio to UP. Run:

```
# tc_wrap.py -i eth1 -u 3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3
UP  0
UP  1
UP  2
UP  3
        skprio: 0
        skprio: 1
        skprio: 2 (tos: 8)
        skprio: 3
        skprio: 4 (tos: 24)
        skprio: 5
        skprio: 6 (tos: 16)
        skprio: 7
        skprio: 8
        skprio: 9
        skprio: 10
        skprio: 11
        skprio: 12
```

```
        skprio: 13
        skprio: 14
        skprio: 15
        skprio: 0 (vlan 100)
        skprio: 1 (vlan 100)
        skprio: 2 (vlan 100 tos: 8)
        skprio: 3 (vlan 100)
        skprio: 4 (vlan 100 tos: 24)
        skprio: 5 (vlan 100)
        skprio: 6 (vlan 100 tos: 16)
        skprio: 7 (vlan 100)
UP  4
UP  5
UP  6
UP  7
#
```

Step 6: Set Egress map of the VLAN

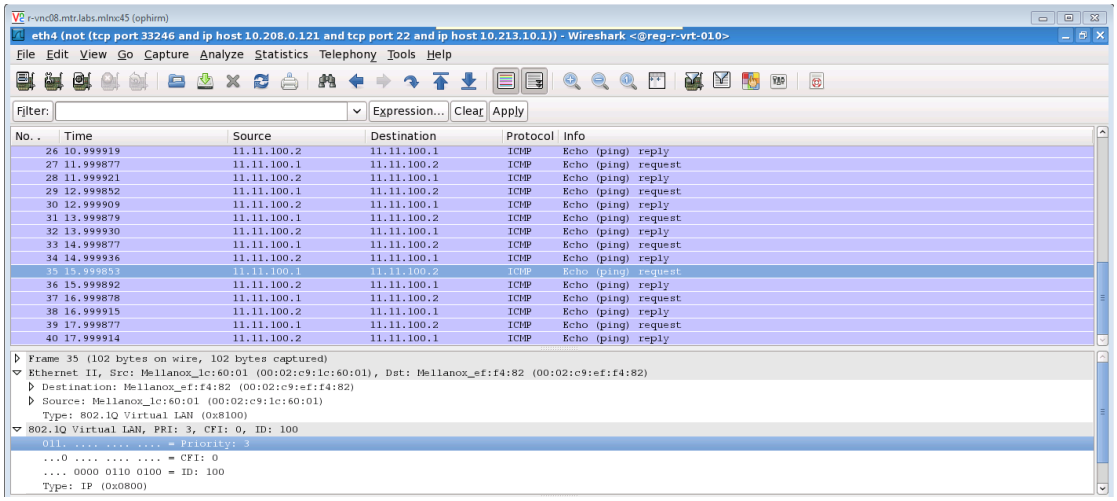
```
# for i in {0..7}; do vconfig set_egress_map eth1.100 $i 3 ; done
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
Set egress mapping on device -:eth1.100:- Should be visible in
/proc/net/vlan/eth1.100
#
```

2.4 Verification Procedures

2.4.1 Network Protocol – ICMP

A basic sanity test would be to ping two servers and see that the ping (ICMP) is running over the desired priority on the network. In Figure 3 you can see the ICMP packets carrying VLAN 100 and priority bit 3.

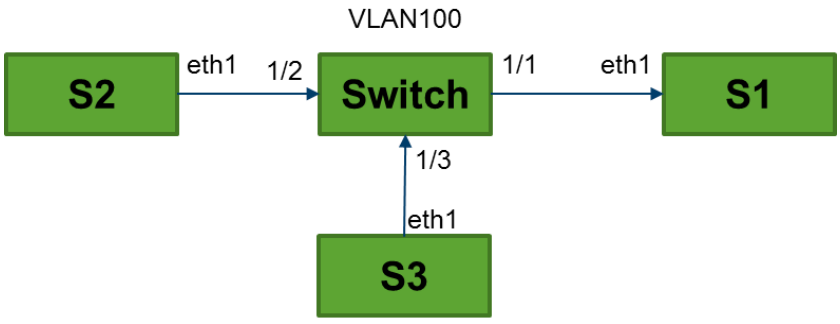
Figure 3: ICMP Packets



2.4.2 RoCE Performance Verification

To test that RoCE is running over the configuration setup. Direct RoCE traffic from two servers (S2 and S3) directed to one server (S1).

Figure 4: RoCE Test Setup



➢ ***Run the following performance tests:***

Step 1: On host S1, run:

```
# ib_write_bw -R --report_gbits --port=12500 -D 10 & ib_write_bw -R
--report_gbits --port=12510 -D 10
```

Step 2: On host S2, run:

```
# ib_write_bw -R --report_gbits 11.11.100.1  --port=12500 -D 10
```

Step 3: On host S3, run:

```
# ib_write_bw -R --report_gbits 11.11.100.1  --port=12510 -D 10
```

2.4.3 Port Priority Counters

- ***Check host port priority counters (traffic and pause counters – in boldface):***

```
# ethtool -S eth1 | grep prio 3
     rx prio 3 packets: 5152
     rx_prio_3_bytes: 424080
     tx_prio_3_packets: 328209
     tx_prio_3_bytes: 361752914
     rx_pause_prio_3: 14812
     rx pause duration prio 3: 0
     rx pause transition prio 3: 0
     tx_pause_prio_3: 0
     tx_pause_duration_prio_3: 47848
     tx_pause_transition_prio_3: 7406
#
```

- ***Check switch port priority counters (traffic and pause counters – in boldface):***

```
# show interfaces ethernet 1/1 counters priority 3
Rx
  333364               packets
  333364               unicast packets
  0                    multicast packets
  0                    broadcast packets
  362177148            bytes
  14814                pause packets
  49168                pause duration seconds
Tx
  333371               packets
  333362               unicast packets
  6                    multicast packets
  3                    broadcast packets
  368845148            bytes
  0                    pause packets
#
```

3 Various Switch Configuration

3.1 Mellanox SwitchX® Based Systems

The flow below describes how to configure PFC or global pause on Mellanox systems based MLNX-OS® (refer to http://www.mellanox.com/page/ethernet_switch_overview).

- ***To configure PFC on SwitchX based systems:***

Step 1: Enable PFC globally. Run:

```
switch (config) # dcb priority-flow-control enable
```

Step 2: Enable specific priority on the switch (all ports). Run:

```
switch (config) # dcb priority-flow-control priority <level> enable
```

Step 3: Enable specific PFC on specific interface. Run:

```
switch (config interface ethernet 1/1) # dcb priority-flow-control mode
on force
```

The following is an example for how to configure PFC enabled on port 1/1 for priority 3:

```
switch (config) # dcb priority-flow-control enable
switch (config) # dcb priority-flow-control priority 3 enable
switch (config) # interface ethernet 1/1 dcb priority-flow-control mode on force
switch (config) #
```

- ***To configure global pause on SwitchX based systems:***

Step 1: Enable global pause per interface (receive). Run:

```
switch (config interface ethernet 1/1) # flowcontrol receive on
```

Step 2: Enable global pause per interface (send). Run:

```
switch (config interface ethernet 1/1) # flowcontrol send on
```

The following is an example for how to configure global pause on port 1/1:

```
switch (config) # interface ethernet 1/1
switch (config interface ethernet 1/1) # flowcontrol receive on
switch (config interface ethernet 1/1) # flowcontrol send on
switch (config interface ethernet 1/1) #
```

PFC and Flow Control features cannot be configured together on the same interface.

Refer to the Ethernet Quality of Service (QoS) section *of the MLNX-OS User Manual* for more information.

3.2 Arista Switches (EoS)

The flow below describes how to configure PFC or global pause on Arista switches via EoS.

- ***To configure PFC on Arista switches:***

Step 1: Set DCBX mode. Run:

```
switch (config-if-Et10) # dcbx mode ieee
```

Step 2: Enable PFC on specific interface. Run:

```
switch (config-if-Et10) # priority-flow-control mode on
```

Step 3: Set priority X as lossless (no drop). Run:

```
switch (config-if-Et10) # priority-flow-control priority <X> no-drop
```

The following is an example for how to configure PFC with enabled on port Et10 for priority 3:

```
switch (config) # interface et1
switch (config-if-Et1)# dcbx mode ieee
switch (config-if-Et1)# priority-flow-control mode on
switch (config-if-Et1)# priority-flow-control priority 3 no-drop
switch (config-if-Et1)#
```

- ***To configure global pause on Arista switches:***

Step 1: Enable global pause per interface (receive). Run:

```
switch (config-if-Et10) # flowcontrol receive on
```

Step 2: Enable global pause per interface (send). Run:

```
switch (config-if-Et10) # flowcontrol send on
```

The following is an example for how to configure global pause on port 1/1:

```
switch (config) # interface et10
switch (config-if-Et10)# flowcontrol receive on
switch (config-if-Et10)# flowcontrol send on
```

PFC and Flow Control features cannot be configured together on the same interface.

3.3 Cisco Nexus 5020

The flow below describes how to configure PFC or global pause on Cisco Nexus 5020 switches.

- ***To configure PFC on Cisco Nexus 5020:***

Step 1: Enter configuration mode. Run:

```
switch # configure terminal
```

Step 2: Enter VLAN configuration sub-mode. If the VLAN does not exist, the system first creates the specified VLAN. Run:

```
switch (config) # vlan {vlan-id | vlan-range}
```

Step 3: Name the VLAN. Up to 32 alphanumeric characters may be used. Run:

```
switch (config) # vlan {vlan-id | vlan-range}
```

The names of VLAN1 or the internally allocated VLANs cannot be changed.

The default value is VLANxxxx where “xxxx” represents four numeric digits (including leading zeroes) equal to the VLAN ID number.

Step 4: Specify the interface to configure, and enters the interface configuration mode. The interface can be a physical Ethernet port or a port channel. Run:

```
switch (config) # interface {type slot/port | port-channel number}
```

Step 5: Configure the interface as a trunk port. Run:

```
switch (config-if) # switchport mode trunk
```

Step 6: (Optional) Configure necessary parameters for a trunk port. Run:

```
switch(config-if)# switchport trunk {allowed vlan vlan-id | native vlan
vlan-id}
```

Step 7: Set PFC mode for the selected interface. Specify auto to negotiate PFC capability. Specify on to force-enable PFC. Run:

```
switch(config-if)# priority-flow-control mode {auto | on }
```

Step 8: (Optional) Enable IEEE 802.3x link-level flow control for the selected interface. Set receive and/or transmit on or off. Run:

```
switch(config-if)# flowcontrol [receive {on|off}] [transmit {on|off}]
```

Step 9: Enable the VLAN. The default value is no shutdown (or enabled). You cannot shut down the default VLAN, VLAN1, or VLANs 1006 to 4094. Run:

```
switch(config-vlan)# no shutdown
```

The following is an example for how to configure two ports:

```
switch # configure terminal
switch (config) # vlan 50
switch (config-vlan) # name roce
switch (config) # interface ethernet 1/3
switch (config-if) # switchport mode trunk
switch (config-if) # switchport trunk allowed vlan 50
switch (config-if) # priority-flow-control mode on
switch (config-if) # flowcontrol receive on transmit on
switch (config-vlan) # state active
switch (config-vlan) # no shutdown
switch (config) # interface ethernet 1/11
switch (config-if) # switchport mode trunk
switch (config-if) # switchport trunk allowed vlan 50
switch (config-if) # priority-flow-control mode on
switch (config-if) # flowcontrol receive on transmit on
switch (config-vlan) # state active
switch (config-vlan) # no shutdown
```

- ***To configure global pause on Cisco Nexus 5020:***

Step 1: Enter configuration mode. Run:

```
switch # configure terminal
```

Step 2: Create the MAC ACL and enter ACL configuration mode. Run:

```
switch (config) # mac access-list name
```

Step 3: Creates a rule in the MAC ACL. Run:

```
switch (config-mac-acl) # [sequence-number] {permit | deny} source
destination protocol
```

Step 4: Create a named object that represents a class of traffic. Run:

```
switch (config) # class-map type qos class-name
```

Class-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 5: Configure a traffic class by matching packets based on the ACL name. Run:

```
switch (config-cmap-qos) # match access-group name acl-name
```

Step 6: Create a named object that represents a set of policies that are to be applied to a set of traffic classes. Run:

```
switch (config-cmap-qos) # policy-map type qos policy-name
```

Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 7: Create class, Run:

```
switch (config-cmap-qos) # class class-name
```

Step 8: Configure one or more QOS group values to match for classification of traffic into this class map. Run:

```
switch (config-pmap-c-qos) # set qos-group qos-group-value
```

The range of `qos-group-value` is 2-5. There is no default value.

Step 9: Associate a class map with the policy map, and enter configuration mode for the specified system class. Run:

```
switch (config) # class [type {network-qos}] class-name
```

Step 10: Configure the traffic class by matching packets based on a list of QoS group values. Run:

```
switch (config-cmap-nq) # match qos-group qos-group-value
```

QOS group values range: 0-5. QoS group 0 is equivalent to class-default, and QoS group 1 is equivalent to class-fcoe.

QoS groups 0 and 1 are reserved for default classes and cannot be configured.

Step 11: Create a named object that represents a set of policies that are to be applied to a set of traffic classes. Run:

```
switch (config-cmap-nq) # policy-map [type {network-qos}] policy-name
```

Step 12: Associate a class map with the policy map, and enters configuration mode for the specified system class. Run:

```
switch(config-cmap-nq) # class type network-qos class-name
```

Step 13: Configure a no-drop class. Run:

```
switch (config-pmap-nq-c) # pause no-drop [pfc-cos pfc-cos-value]
```

If no parameter is specified, the default policy is drop. The range of `pfc-cos-value`: 0-7. This option is supported only for an ACL-based system class.

The drop policy is a simple tail drop where arriving packets are dropped if the queue goes over its allocated size.

Step 14: Enter system class configuration mode. Run:

```
switch (config) # system qos
```

Step 15: Specify the policy map to use as the service policy for the system. Run:

```
switch (config-sys-qos) # service-policy type qos input policy-name
```

policy-map configuration has three modes:

- network-qos - network-wide (system QoS) mode
- qos – classification mode (system QoS input or interface input only)
- queuing - queuing mode (input and output at system QoS and interface)

Step 16: Create a policy. Run:

```
switch (config-sys-qos)# service-policy type network-qos policy-name
```

Step 17: Specify the interface to be changed. Run:

```
switch (config)# interface type slot/port
```

Step 18: Enables LLC for the selected interface. Set receive and/or transmit on or off. Run:

```
flowcontrol [receive {on | off}] [transmit {on | off}]
```

This example tags all traffic as lossless:

```
switch# configure terminal
switch(config)# mac access-list test
switch(config-mac-acl)# 10 permit any any
!
switch(config)# class-map type qos test1
switch(config-cmap-qos)# match access-group name test
switch(config-cmap-qos)# policy-map type qos test1
switch(config-cmap-qos)# class test1
switch(config-pmap-c-qos)# set qos-group 4
!
switch(config)# class-map type network-qos test1
switch(config-cmap-nq)# match qos-group 4
switch(config-cmap-nq)# policy-map type network-qos test1
switch(config-cmap-nq)# class type network-qos test1
switch(config-pmap-nq-c)# pause no-drop
!
switch(config)# system qos
switch(config-sys-qos)# service-policy type qos input test1
switch(config-sys-qos)# service-policy type network-qos test1
!
switch(config)# interface ethernet  1/2
switch(config-if)# flowcontrol receive on transmit on
```

3.4 HP Comware 7

To configure global pause on Comware 7 HP switch, follow this example:

```
interface FortyGigE2/0/7
port link-mode bridge
port link-type trunk
port trunk permit vlan all
flow-control
flow-interval 5
```

To configure PFC on Comware 7 HP switch, follow this example:

```
interface FortyGigE2/0/6
port link-mode bridge
port link-type trunk
port trunk permit vlan all
priority-flow-control auto
priority-flow-control no-drop dot1p 3
lldp tlv-enable dot1-tlv dcbx
qos trust dot1p
```

3.5 Dell Force10 S4810

To configure PFC on Force10 S4810 Dell switch, follow this example:

```
# configure terminal
(conf)# dcb enable
(conf)# service-class dynamic dot1p
(conf)# interface ten 1/1    {the port connected to the Mellanox adapter}
(conf-if-ten 1/1)# description to_NIC
(conf-if-ten 1/1)# mtu 12000
(conf-if-ten 1/1)# portmode hybrid
(conf-if-ten 1/1)# switchport
(conf-if-ten 1/1)# pfc priority 3 {or whatever priority you want to use 0 - 7}
(conf-if-ten 1/1)# protocol lldp
(conf-if-ten 1/1)# dcbx version ieee-v2.5 {you may try cee instead}
(conf-if-ten 1/1)# no shut
(conf-if-ten 1/1)# exit
(conf)# interface vlan 10  {vlan ID that you have the RoCE port setup for}
(conf-if-vl-10)# tagged ten 1/1  {the port connected to the Mellanox adapter}
```