APPS035-Codensity™ T408 NVMe-oF RDMA and TCP Measurements

V2.0

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1 Table of Abbreviations

Abbreviation:	Full Form:
NVMe-oF	NVME over Fabrics
RDMA	Remote DMA
IB	InfiniBand
TCP	Transmission Control Protocol
MLNX_OFED	Mellanox OpenFabrics Enterprise Distribution for Linux
RoCE	RDMA over Converged Ethernet
AI	Artificial Intelligence
API	Application Programming Interface
AUD	Access Unit Delimiters
AV	Audio Video
AV1	Alliance Open Media Video 1 Codec
CABAC	Context Adaptive Binary Arithmetic Coding
CBR	Constant Bit Rate
CPU	Central Processing Unit
CRF	Constant Rate Factor
DSP	Digital Signal Processing
EOF	End Of File
FIXQB	Fixed Quantization Parameter
FF	Form Factor
FPS	Frames Per Second
GOP	Group of pictures
HDR	High Dynamic Range
HHHL	Half Height, Half Length
HHFL	Half Height, Full Length
HLG	Hybrid Log Gamma
HRD	Hypothetical Reference Decoder
IE	Inference Engine
Mbps	Mega Bit per second
MBps	Mega Byte per second
NLP	Natural Language Processing
NPU	Neural Processing Unit
NVMe	Non-Volatile Memory express
PCIe	Peripheral Component Interconnect express
PPS	Picture Parameter Set
QP	Quoted Printable

RGB	Red Green Blue
RGBA	Red Green Blue Alpha
RDO	Optimization
ROI	Region of interest
SDK	Software Development Kit
SEI	Supplemental Enhancement Information
SRIOV	Single Root I/O Virtualization
SPS	Sequence Parameter Set
VBR	Variable Bit Rat
VCL	Video Coding Layer
VPS	Video Parameter Set
VUI	Video Usability Information

2 References

Technical Notes:

Specifications:

3 Background

This document demonstrates the configuration and measurements using a T408 device over a NVMe-oF connection. The latency measurements over a RDMA/RoCE connection and over a TCP connection are performed for a NULL device, and a T408 device.

The installation and configuration of drivers for the NICs used in a typical NVMe-oF host and target is not in scope of this document.

3.1 Intended Audience

This document is intended to help engineers/technicians/developers operating NETINT transcoders better understand the usage of T408 in a NVMe-oF Host and Target environment.

3.2 Compatibility

Software Compatibility

This guide is intended to be used with NETINT Codensity T408 Video Transcoder software Release 2.5.0 or newer.

Hardware Compatibility

Release 1.6.0 or newer supports NETINT Codensity T408 Video Transcoder hardware.

Operation system

All OS supporting T408 Video Transcoder.

4 NVMe-oF

4.1 Intro

The NVMe-oF is a protocol specification that helps server Host connect to remote server Targets using the NVMe protocol. The Host to Target connection can be over Ethernet, Fiber Channel, or InfiniBand.

NMVe-oF is typically used in storage area networks to help extend the seamless access to a SSD farm.

4.2 Connectivity

The interconnectivity between a Host and a Target requires characteristics of low latency and high speeds.

The connection type can be TCP or RDMA.

Nvidia Mellanox CX653106A is one of many adapter cards available for data center applications and provides up to 200 Gbps connectivity per port.

Configuration and usage of the Mellanox adapter cards for NVMe-oF is explained in detail at link - https://community.mellanox.com/s/article/howto-configure-nvme-over-fabrics#jive_content_id_Setup

4.3 Typical Block Diagram

Two servers, one configured as NVMe Host (initiator), and the remote server used as NVMe Target.

Above diagram is courtesy of Mellanox.

4.4 Useful Links

1] https://searchstorage.techtarget.com/definition/NVMe-over-Fabrics-Nonvolatile-Memory-Express-over-Fabrics

2] https://www.mellanox.com/files/doc-2020/pb-connectx-6-vpi-card.pdf

3] https://www.mellanox.com/products/infiniband-drivers/linux/mlnx_ofed

4] https://community.mellanox.com/s/article/howto-configure-nvme-over-fabrics#jive_content_id_Setup

5] https://fio.readthedocs.io/en/latest/fio_doc.html

5 Latency Measurements over a NVMe-oF RDMA and TCP Connection

5.1 Scope

Scope of this section is to demonstrate a transcoding operation on a remote Target NVMe T408 device and perform latency and FPS measurements.

Measurements will be demonstrated with:

1] NULL device on Target

2] NVMe T408 transcoder on Target

5.2 Setup Environment

The Host and Target used for the measurements have the following OS and environment.

Architecture: x86_64

CPU(s): 4

Model name: Intel(R) Xeon(R) E-2124 CPU @ 3.30GHz

Kernel: 5.4.0-42-generic

OS: Ubuntu 20.04.2 LTS

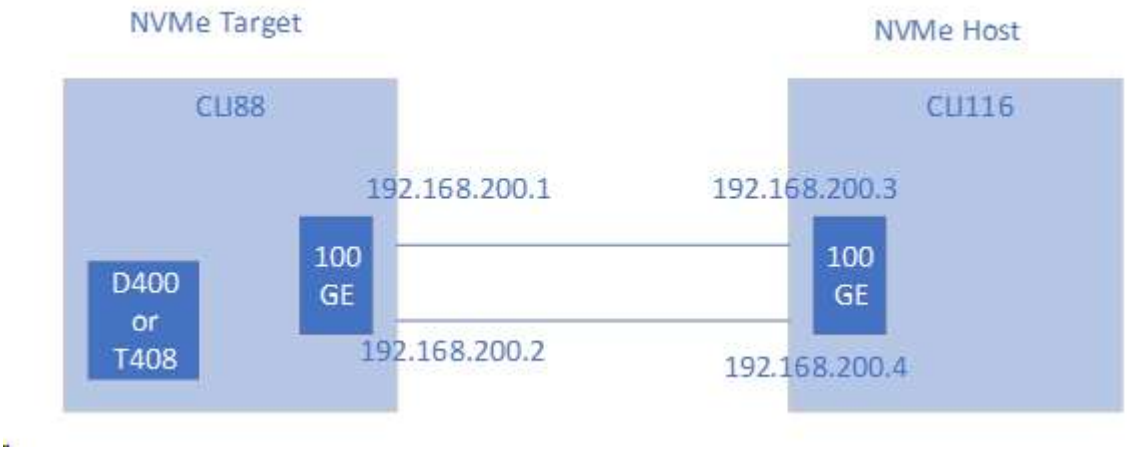
Mellanox adaptors installed on Target are as follows.

```
nvme@nvme-cli88:~$ lspci -nnk |grep -i Mella
0a:00.0 Ethernet controller [0200]: Mellanox Technologies MT28908 Family [ConnectX-6] [15b3:101b]
        Subsystem: Mellanox Technologies MT28908 Family [ConnectX-6] [15b3:0008]
0a:00.1 Ethernet controller [0200]: Mellanox Technologies MT28908 Family [ConnectX-6] [15b3:101b]
        Subsystem: Mellanox Technologies MT28908 Family [ConnectX-6] [15b3:0008]
```

Mellanox adaptors installed on Host are as follows.

```
nvme@nvme-cli116:~$ lspci -nnk |grep -i Mella

01:00.0 Ethernet controller [0200]: Mellanox Technologies MT28908
Family [ConnectX-6] [15b3:101b]

        Subsystem: Mellanox Technologies MT28908 Family
[ConnectX-6] [15b3:0008]

01:00.1 Ethernet controller [0200]: Mellanox Technologies MT28908
Family [ConnectX-6] [15b3:101b]

        Subsystem: Mellanox Technologies MT28908 Family
[ConnectX-6] [15b3:0008]
```

5.3 Lab Diagram



In the above diagram, the link 192.168.200.1 ←→192.168.200.3 is for RDMA (RoCE) connection and the link 192.168.200.2←→192.168.200.4 is for TCP connection. A user can use either of the links for communicating from Host to a Target NVMe device.

5.4 Connection Setup

TCP and RDMA connection modes are tested. Once with a NULL device and then with a NVMe device.

5.4.1 Target Setup

5.4.1.1 Configure with NULL device

```
sudo shutdown -r now
ibv_devinfo
sudo ./setup_null_rdma_target.sh
dmesg | grep nvme
sudo ./setup_null_tcp_target.sh
dmesg | grep nvme
```

5.4.1.2 Configure with SSD or T408 device

```
sudo shutdown -r now
sudo nvme list
sudo ./setup_rdma_target.sh /dev/nvme0n1
dmesg | grep nvme
sudo ./setup_tcp_target.sh /dev/nvme0n1
dmesg | grep nvme
```

Refer Appendix-A for details of the shell scripts for Target setup.

Logs for Target setup for NULL device and for T408 are posted to Appendix-B and Appendix-D respectively.

5.4.2 Host Setup

5.4.2.1 Configure with NULL device

RDMA (RoCE) connection

```
sudo shutdown -r now

sudo modprobe nvme-rdma

sudo nvme discover -t rdma -a 192.168.200.1 -s 4420

sudo nvme connect -t rdma -n nvmet-null-test -a 192.168.200.1 -s 4420
```

TCP connection

```
sudo modprobe nvme-tcp

sudo nvme discover -t tcp -a 192.168.200.2 -s 4420

sudo nvme connect -t tcp -n nvmet-null-tcp -a 192.168.200.2 -s 4420

sudo nvme list
```

Logs are posted to Appendix-C.

5.4.2.2 Configure with D408 SSD or T408 Transcoder device

RDMA (RoCE) connection

```
sudo shutdown -r now

sudo modprobe nvme-rdma

sudo nvme discover -t rdma -a 192.168.200.1 -s 4420

sudo nvme connect -t rdma -n nvmet-test -a 192.168.200.1 -s 4420

sudo nvme list
```

TCP connection

```
sudo modprobe nvme-tcp

sudo nvme discover -t tcp -a 192.168.200.2 -s 4420
```

```
sudo nvme connect -t tcp -n nvmet-test-tcp -a 192.168.200.2 -s
4420

sudo nvme list
```

Logs are posted to Appendix-E.

5.5 Measurements

Measurements will be collected for TCP and RDMA connections for following Target devices:

1] NULL device on Target

2] NVMe T408 transcoder on Target

5.5.1 NULL device test commands

RDMA (RoCE) connection

Commands –

```
sudo fio --filename=/dev/nvme0n1 --name=firstfill --
ioengine=libaio --iodepth=1 --rw=randread --bs=4k --numjobs=1 --
direct=1 --time_based --runtime=30
sudo fio --filename=/dev/nvme0n1 --name=firstfill --
ioengine=libaio --iodepth=1 --rw=randwrite --bs=4k --numjobs=1 --
direct=1 --time_based --runtime=30
```

TCP connection

Commands –

```
sudo fio --filename=/dev/nvme1n1 --name=firstfill --
ioengine=libaio --iodepth=1 --rw=randread --bs=4k --numjobs=1 --
direct=1 --time_based --runtime=30
sudo fio --filename=/dev/nvme1n1 --name=firstfill --
ioengine=libaio --iodepth=1 --rw=randwrite --bs=4k --numjobs=1 --
direct=1 --time_based --runtime=30
```

Logs are posted in Appendix-C.

5.5.2 NVMEe D408 SSD device test commands

RDMA (RoCE) connection

Commands –

```
sudo fio --filename=/dev/nvme0n1 --name=firstfill --
ioengine=libaio --iodepth=1 --rw=randread --bs=4k --numjobs=1 --
direct=1 --time_based --runtime=30
sudo fio --filename=/dev/nvme0n1 --name=firstfill --
ioengine=libaio --iodepth=1 --rw=randwrite --bs=4k --numjobs=1 --
direct=1 --time_based --runtime=30
```

TCP connection

Commands –

```
sudo fio --filename=/dev/nvme1n1 --name=firstfill --
ioengine=libaio --iodepth=1 --rw=randread --bs=4k --numjobs=1 --
direct=1 --time_based --runtime=30
sudo fio --filename=/dev/nvme1n1 --name=firstfill --
ioengine=libaio --iodepth=1 --rw=randwrite --bs=4k --numjobs=1 --
direct=1 --time_based --runtime=30
```

5.5.3 NVMe T408 device test commands

Only one connection was made on the Mellanox card at a time i.e. RDMA connection or TCP connection for this test.

RDMA (RoCE) connection

y2h Command for latency measurement –
ffmpeg -y -nostdin -hide_banner -vsync 0 -stream_loop 10 -f rawvideo -pix_fmt yuv420p -s:v 1920x1080 -r 25 -i dinner_1920x1080p30_300_br7500_b3__B265d.yuv -c:v h265_ni_enc -enc 0 -xcoder-params lowDelay=1:gopPresetIdx=2 -f null - 2>&1 |ts '%.s' > output-y2h-0-0.log

y2h Command for FPS measurement –
ffmpeg -y -nostdin -hide_banner -vsync 0 -f rawvideo -pix_fmt yuv420p -s:v 1920x1080 -r 25 -i dinner_1920x1080p30_300_br7500_b3__B265d.yuv -c:v h265_ni_enc -enc 0 -xcoder-params intraQP=27:intraPeriod=120 dinner_y2h_out.265

TCP connection

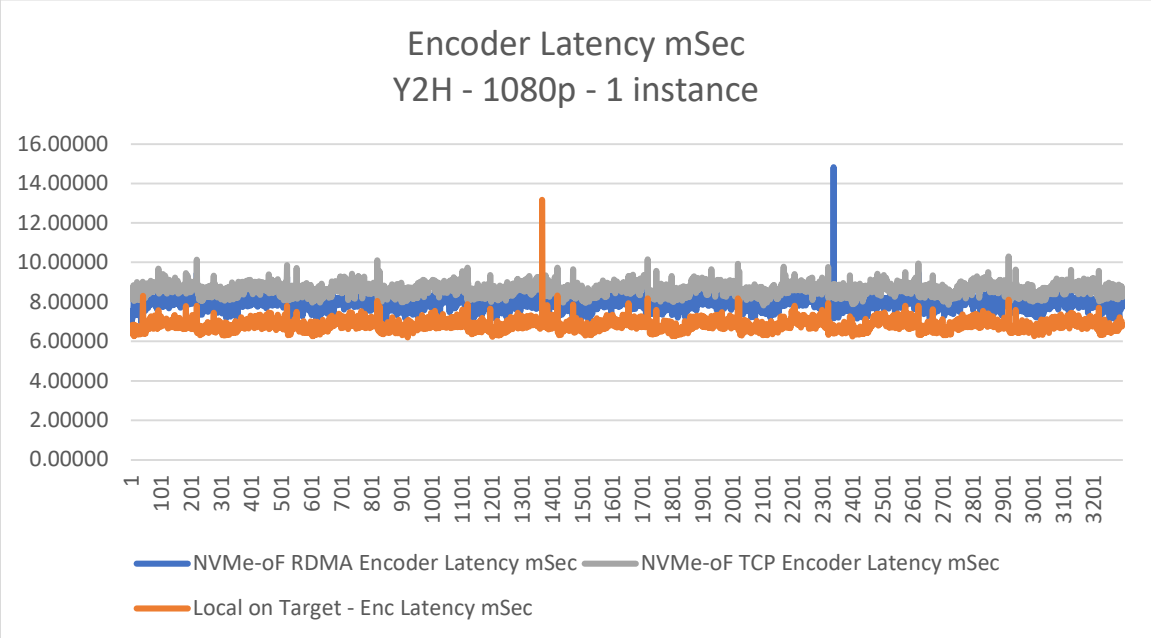
y2h Command for latency measurement –
ffmpeg -y -nostdin -hide_banner -vsync 0 -stream_loop 10 -f rawvideo -pix_fmt yuv420p -s:v 1920x1080 -r 25 -i dinner_1920x1080p30_300_br7500_b3__B265d.yuv -c:v h265_ni_enc -enc 0 -xcoder-params lowDelay=1:gopPresetIdx=2 -f null - 2>&1 |ts '%.s' > output-y2h-0-0.log

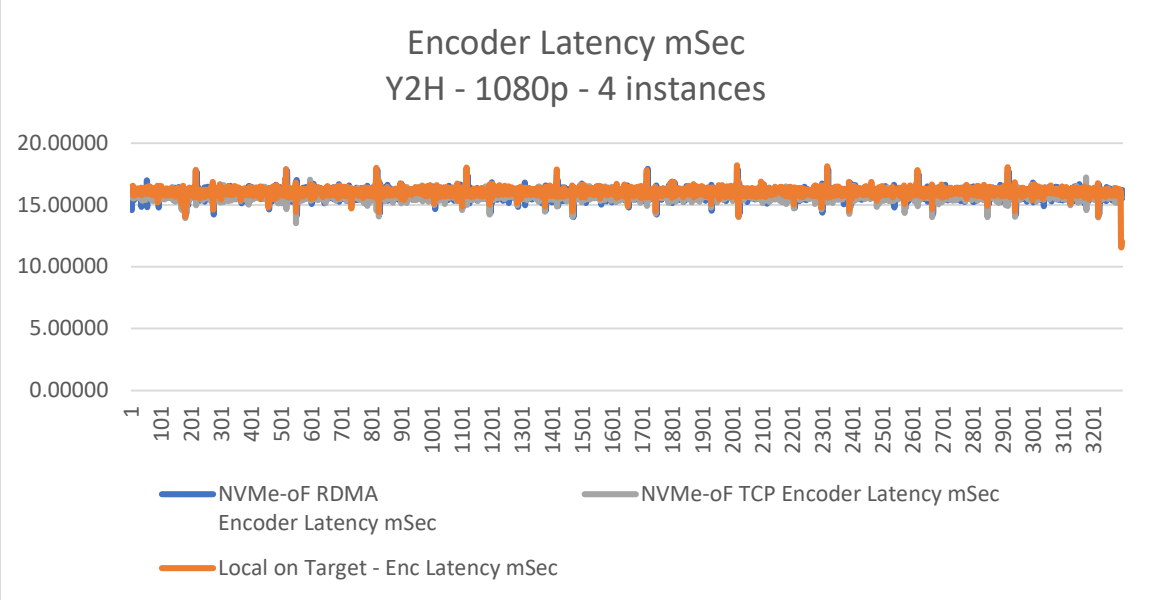
y2h Command –
ffmpeg -y -nostdin -hide_banner -vsync 0 -f rawvideo -pix_fmt yuv420p -s:v 1920x1080 -r 25 -i dinner_1920x1080p30_300_br7500_b3__B265d.yuv -c:v h265_ni_enc -enc 0 -xcoder-params intraQP=27:intraPeriod=120 dinner_y2h_out.265

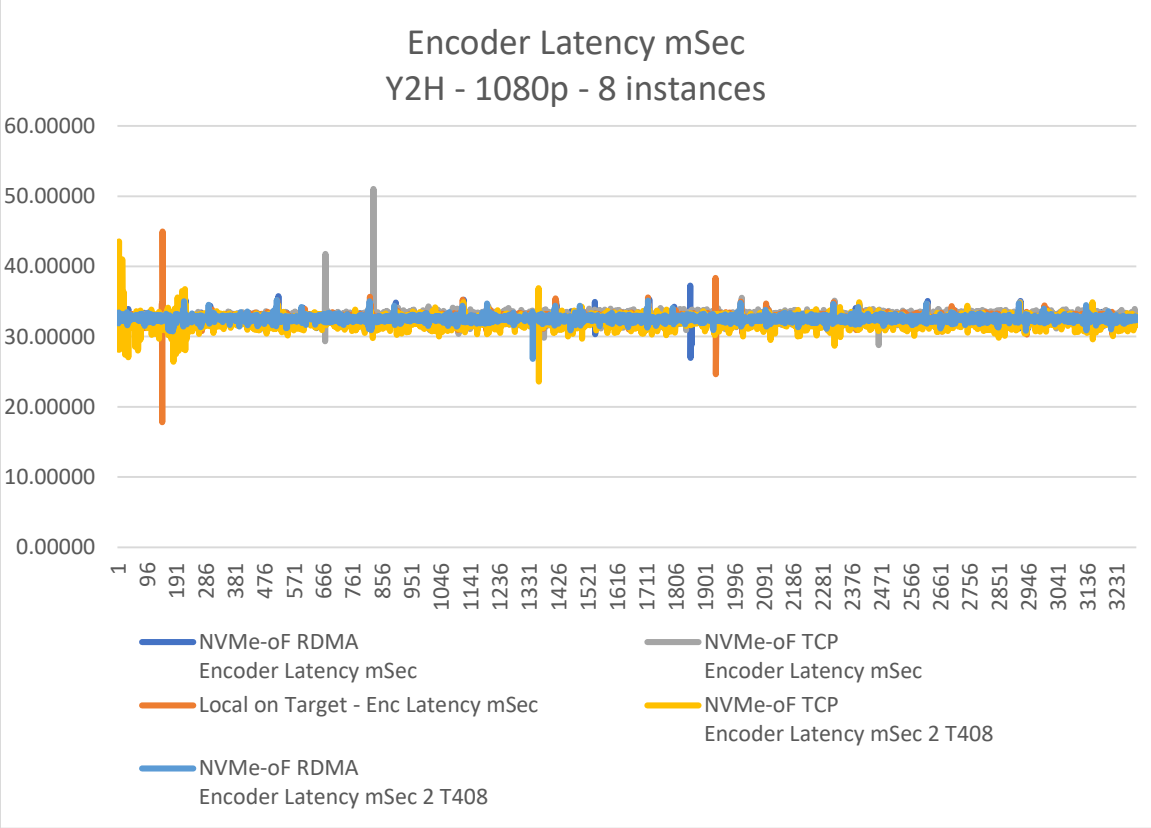
5.5.4 Results Summary

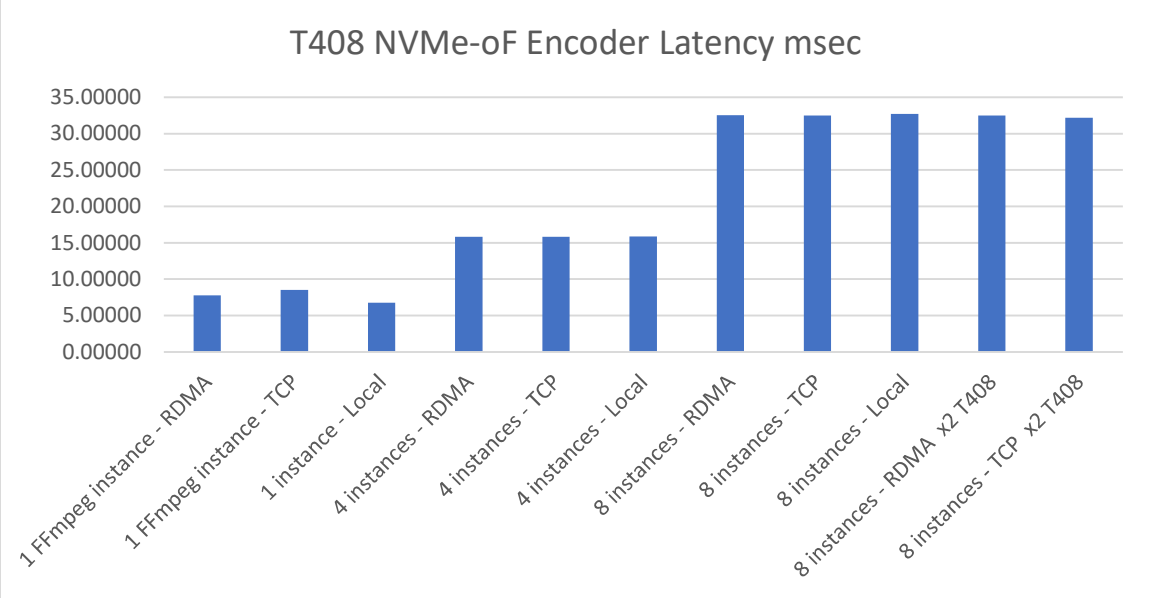
Device-Connection	READ µsec			WRITE µsec		
	Average	50th percentile	99th percentile	Average	50th percentile	99th percentile
NULL RDMA	25.46	13.76	45.32	23.98	14	20.4
NULL TCP	26.70	23	46	24.63	22	123

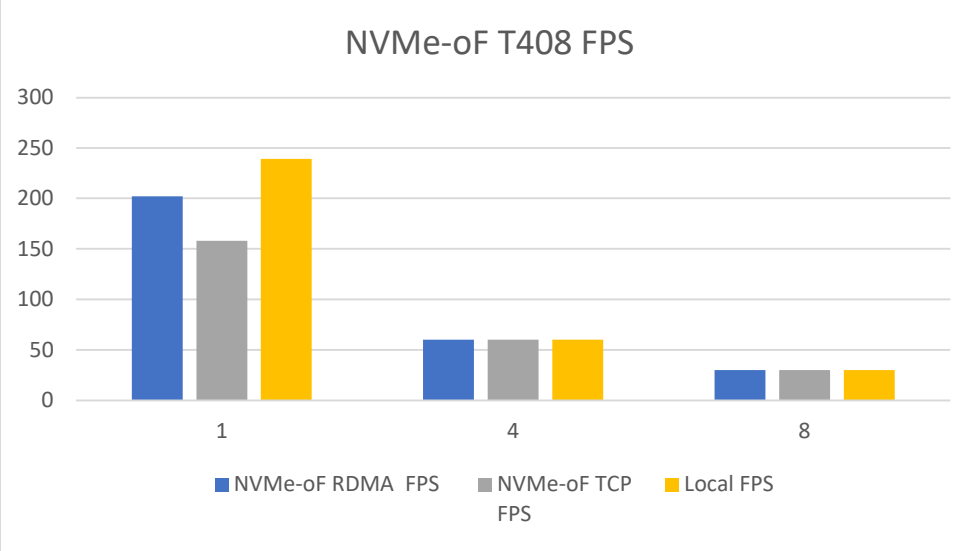
Device-Connection for running FFmpeg session	ENCODING LATENCY AND FPS Y2H dinner_1920x1080p30_300_br7500_b3__B265d.yuv			
	1 instance (1 T408 card)	4 instances (1 T408 card)	8 instances (1 T408 card)	8 instances (2 T408 cards)
T408 Host ←RDMA Connection → Target	Latency: 7.76 msec FPS: 202	15.81 msec FPS: 60	32.55 msec FPS: 30	32.51 msec
T408 Host ←TCP Connection → Target	8.51 msec FPS: 158	15.80 msec FPS: 60	32.49 msec FPS: 30	32.17 msec
FFmpeg command run locally on Target	6.74 msec FPS: 239	15.87 msec FPS: 60	32.69 msec FPS: 30	




Encoder Latency mSec
Y2H - 1080p - 4 instances
20.00000
15.00000
10.00000
5.00000
0.00000
1
101
201
301
401
501
601
701
801
901
1001
1101
1201
1301
1401
1501
1601
1701
1801
1901
2001
2101
2201
2301
2401
2501
2601
2701
2801
2901
3001
3101
3201
NVMe-oF RDMA Encoder Latency mSec
NVMe-oF TCP Encoder Latency mSec
Local on Target - Enc Latency mSec


Encoder Latency mSec
Y2H - 1080p - 8 instances
60.00000
50.00000
40.00000
30.00000
20.00000
10.00000
0.00000
1
96
191
286
381
476
571
666
761
856
951
1046
1141
1236
1331
1426
1521
1616
1711
1806
1901
1996
2091
2186
2281
2376
2471
2566
2661
2756
2851
2946
3041
3136
3231
NVMe-oF RDMA Encoder Latency mSec
NVMe-oF TCP Encoder Latency mSec
Local on Target - Enc Latency mSec
NVMe-oF TCP Encoder Latency mSec 2 T408
NVMe-oF RDMA Encoder Latency mSec 2 T408


T408 NVMe-oF Encoder Latency msec
35.00000
30.00000
25.00000
20.00000
15.00000
10.00000
5.00000
0.00000
1 FFmpeg instance - RDMA
1 FFmpeg instance - TCP
1 instance - Local
4 instances - RDMA
4 instances - TCP
4 instances - Local
8 instances - RDMA
8 instances - TCP
8 instances - Local
8 instances - RDMA x2 T408
8 instances - TCP x2 T408


NVMe-oF T408 FPS
300
250
200
150
100
50
0
1
4
8
NVMe-oF RDMA FPS
NVMe-oF TCP FPS
Local FPS

6 Appendix-A – Target Configuration Shell script

6.1 Target – NULL device – RDMA setup

nvme@nvme-cli88:~$ cat setup_null_rdma_target.sh

#!/bin/bash

modprobe nvmet

modprobe nvmet-rdma

mkdir /sys/kernel/config/nvmet/subsystems/nvmet-null-test

echo 1 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-null-test/attr_allow_any_host > /dev/null

mkdir /sys/kernel/config/nvmet/subsystems/nvmet-null-test/namespaces/1

modprobe null_blk nr_devices=1

echo -n /dev/nullb0 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-null-test/namespaces/1/device_path > /dev/null

echo 1 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-null-test/namespaces/1/enable > /dev/null

mkdir /sys/kernel/config/nvmet/ports/3

echo 192.168.200.1 |tee -a /sys/kernel/config/nvmet/ports/3/addr_traddr > /dev/null

echo rdma |tee -a /sys/kernel/config/nvmet/ports/3/addr_trtype > /dev/null

echo 4420 |tee -a /sys/kernel/config/nvmet/ports/3/addr_trsvcid > /dev/null

echo ipv4 |tee -a /sys/kernel/config/nvmet/ports/3/addr_adrfam > /dev/null

ln -s /sys/kernel/config/nvmet/subsystems/nvmet-null-test/ /sys/kernel/config/nvmet/ports/3/subsystems/nvmet-test

6.2 Target – NULL device – TCP setup

nvme@nvme-cli88:~$ cat setup_null_tcp_target.sh

#!/bin/bash

modprobe nvmet

modprobe nvmet-tcp

mkdir /sys/kernel/config/nvmet/subsystems/nvmet-null-tcp

echo 1 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-null-tcp/attr_allow_any_host > /dev/null

mkdir /sys/kernel/config/nvmet/subsystems/nvmet-null-tcp/namespaces/1

modprobe null_blk nr_devices=1

echo -n /dev/nullb0 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-null-tcp/namespaces/1/device_path > /dev/null

echo 1 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-null-tcp/namespaces/1/enable > /dev/null

mkdir /sys/kernel/config/nvmet/ports/2

echo 192.168.200.2 |tee -a /sys/kernel/config/nvmet/ports/2/addr_traddr > /dev/null

echo tcp |tee -a /sys/kernel/config/nvmet/ports/2/addr_trtype > /dev/null

echo 4420 |tee -a /sys/kernel/config/nvmet/ports/2/addr_trsvcid > /dev/null

echo ipv4 |tee -a /sys/kernel/config/nvmet/ports/2/addr_adrfam > /dev/null

ln -s /sys/kernel/config/nvmet/subsystems/nvmet-null-tcp/ /sys/kernel/config/nvmet/ports/2/subsystems/nvmet-null-tcp

6.3 Target – SSD or T408 - RDMA setup

nvme@nvme-cli88:~$ cat setup_rdma_target.sh

#!/bin/bash

modprobe nvmet

modprobe nvmet-rdma

mkdir /sys/kernel/config/nvmet/subsystems/nvmet-test

echo 1 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-test/attr_allow_any_host > /dev/null

mkdir /sys/kernel/config/nvmet/subsystems/nvmet-test/namespaces/1

echo -n $1 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-test/namespaces/1/device_path > /dev/null

echo 1 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-test/namespaces/1/enable > /dev/null

mkdir /sys/kernel/config/nvmet/ports/1

echo 192.168.200.1 |tee -a /sys/kernel/config/nvmet/ports/1/addr_traddr > /dev/null

echo rdma |tee -a /sys/kernel/config/nvmet/ports/1/addr_trtype > /dev/null

echo 4420 |tee -a /sys/kernel/config/nvmet/ports/1/addr_trsvcid > /dev/null

echo ipv4 |tee -a /sys/kernel/config/nvmet/ports/1/addr_adrfam > /dev/null

ln -s /sys/kernel/config/nvmet/subsystems/nvmet-test/ /sys/kernel/config/nvmet/ports/1/subsystems/nvmet-test

6.4 Target – SSD or T408 - TCP setup

nvme@nvme-cli88:~$ cat setup_tcp_target.sh

#!/bin/bash

modprobe nvme-tcp

modprobe nvmet

modprobe nvmet-tcp

mkdir /sys/kernel/config/nvmet/subsystems/nvmet-test-tcp

echo 1 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-test-tcp/attr_allow_any_host > /dev/null

mkdir /sys/kernel/config/nvmet/subsystems/nvmet-test-tcp/namespaces/1

echo -n $1 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-test-tcp/namespaces/1/device_path > /dev/null

echo 1 |tee -a /sys/kernel/config/nvmet/subsystems/nvmet-test-tcp/namespaces/1/enable > /dev/null

mkdir /sys/kernel/config/nvmet/ports/2

echo 192.168.200.2 |tee -a /sys/kernel/config/nvmet/ports/2/addr_traddr > /dev/null

```
echo tcp |tee -a /sys/kernel/config/nvmet/ports/2/addr_trtype > /dev/null

echo 4420 |tee -a /sys/kernel/config/nvmet/ports/2/addr_trsvcid > /dev/null

echo ipv4 |tee -a /sys/kernel/config/nvmet/ports/2/addr_adrfam > /dev/null

ln -s /sys/kernel/config/nvmet/subsystems/nvmet-test-tcp/
/sys/kernel/config/nvmet/ports/2/subsystems/nvmet-test-tcp
```

7 Appendix B – Target – NULL Device - Logs

nvme@nvme-cli88:~$ sudo ./setup_null_rdma_target.sh

[sudo] password for nvme:

nvme@nvme-cli88:~$ dmesg |grep nvme

[1.123007] nvme nvme0: pci function 0000:06:00.0

[4.136320] nvme nvme0: missing or invalid SUBNQN field.

[4.136341] nvme nvme0: Shutdown timeout set to 10 seconds

[4.136972] nvme nvme0: 4/0/0 default/read/poll queues

[4.460769] systemd[1]: Set hostname to <nvme-cli88>.

[76.780345] nvmet: adding nsid 1 to subsystem nvmet-null-test

[76.810408] nvmet_rdma: enabling port 3 (192.168.200.1:4420)

nvme@nvme-cli88:~$ sudo ./setup_null_tcp_target.sh

nvme@nvme-cli88:~$ dmesg |grep nvme

[1.123007] nvme nvme0: pci function 0000:06:00.0

[4.136320] nvme nvme0: missing or invalid SUBNQN field.

[4.136341] nvme nvme0: Shutdown timeout set to 10 seconds

[4.136972] nvme nvme0: 4/0/0 default/read/poll queues

[4.460769] systemd[1]: Set hostname to <nvme-cli88>.

[76.780345] nvmet: adding nsid 1 to subsystem nvmet-null-test

[76.810408] nvmet_rdma: enabling port 3 (192.168.200.1:4420)

[86.238760] nvmet: connect request for invalid subsystem nvmet-test!

[96.477142] nvmet: connect request for invalid subsystem nvmet-test!

[105.462713] nvmet: adding nsid 1 to subsystem nvmet-null-tcp

[105.469622] nvmet_tcp: enabling port 2 (192.168.200.2:4420)

[106.717034] nvmet: connect request for invalid subsystem nvmet-test!

nvme@nvme-cli88:~$

8 Appendix C – Host – RDMA and TCP connection to NULL Device – Latency Measurement Logs

NULL

RDMA and TCP – Host connection to Target

```
nvme@nvme-cli116:~$ sudo modprobe nvme-rdma
[sudo] password for nvme:
nvme@nvme-cli116:~$ sudo modprobe nvme-tcp
nvme@nvme-cli116:~$ sudo nvme discover -t rdma -a 192.168.200.1 -s 4420

Discovery Log Number of Records 1, Generation counter 4
=====Discovery Log Entry 0======
trtype:  rdma
adrfam:  ipv4
subtype: nvme subsystem
treq:    not specified, sq flow control disable supported
portid:  3
trsvcid: 4420
subnqn:  nvmet-null-test
traddr:  192.168.200.1
rdma_prtype: not specified
rdma_qptype: connected
rdma_cms:    rdma-cm
rdma_pkey: 0x0000
nvme@nvme-cli116:~$ sudo nvme connect -t rdma -n nvmet-null-test -a 192.168.200.1 -s 4420
nvme@nvme-cli116:~$ sudo nvme list
Node          SN                   Model                                    Namespace Usage                  Format
FW Rev
----------------- -------------------- ---------------------------------------- --------- -------------------------- ----------------
-------- --------
/dev/nvme0n1     0ef8ea0d0817ac61     Linux                                    1         268.44  GB / 268.44  GB
512   B +  0 B   5.4.0-42
nvme@nvme-cli116:~$ sudo nvme discover -t tcp -a 192.168.200.2 -s 4420

Discovery Log Number of Records 1, Generation counter 4
=====Discovery Log Entry 0======
trtype:  tcp
adrfam:  ipv4
subtype: nvme subsystem
```

```
treq:    not specified, sq flow control disable supported
portid:  2
trsvcid: 4420
subnqn:  nvmet-null-tcp
traddr:  192.168.200.2
sectype: none
nvme@nvme-cli116:~$ sudo nvme connect -t tcp -n nvmet-null-tcp -a 192.168.200.2 -s 4420
nvme@nvme-cli116:~$ sudo nvme list
Node          SN                Model                                    Namespace Usage                 Format
FW Rev
----------------- -------------------- ---------------------------------------- --------- -------------------------- ----------------
-------- --------
/dev/nvme0n1     0ef8ea0d0817ac61     Linux                                    1         268.44  GB / 268.44  GB
512   B +  0 B   5.4.0-42
/dev/nvme1n1     c340ea3880021d49     Linux                                    1         268.44  GB / 268.44  GB
512   B +  0 B   5.4.0-42
nvme@nvme-cli116:~$
```

RDMA

READ

```
nvme@nvme-cli116:~$ sudo fio --filename=/dev/nvme0n1 --name=firstfill --ioengine=libaio --
iodepth=1 --rw=randread --bs=4k --numjobs=1 --direct=1 --time_based --runtime=30
firstfill: (g=0): rw=randread, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B,
ioengine=libaio, iodepth=1
fio-3.16
Starting 1 process
Jobs: 1 (f=1): [r(1)][100.0%][r=134MiB/s][r=34.3k IOPS][eta 00m:00s]
firstfill: (groupid=0, jobs=1): err= 0: pid=2209: Thu Mar 25 08:35:38 2021
  read: IOPS=35.9k, BW=140MiB/s (147MB/s)(4209MiB/30001msec)
    slat (nsec): min=1846, max=35833, avg=2035.09, stdev=112.17
    clat (usec): min=8, max=362, avg=25.46, stdev=13.70
     lat (usec): min=12, max=364, avg=27.53, stdev=13.66
    clat percentiles (nsec):
     |  1.00th=[11456],  5.00th=[11712], 10.00th=[12352], 20.00th=[13248],
     | 30.00th=[13376], 40.00th=[13504], 50.00th=[13760], 60.00th=[39168],
     | 70.00th=[39680], 80.00th=[39680], 90.00th=[41216], 95.00th=[44288],
     | 99.00th=[45312], 99.50th=[46848], 99.90th=[55552], 99.95th=[59648],
     | 99.99th=[93696]
   bw (  KiB/s): min=130592, max=163416, per=100.00%, avg=143749.78, stdev=6720.08,
samples=59
    iops        : min=32648, max=40854, avg=35937.47, stdev=1680.06, samples=59
  lat (usec)   : 10=0.01%, 20=56.02%, 50=43.77%, 100=0.20%, 250=0.01%
  lat (usec)   : 500=0.01%
```

```
  cpu        : usr=5.17%, sys=12.93%, ctx=1077556, majf=0, minf=12
  IO depths    : 1=100.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     issued rwts: total=1077544,0,0,0 short=0,0,0,0 dropped=0,0,0,0
     latency   : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):
   READ: bw=140MiB/s (147MB/s), 140MiB/s-140MiB/s (147MB/s-147MB/s), io=4209MiB
(4414MB), run=30001-30001msec

Disk stats (read/write):
  nvme0n1: ios=0/0, merge=0/0, ticks=0/0, in_queue=0, util=0.00%
nvme@nvme-cli116:~$
```

WRITE

```
nvme@nvme-cli116:~$ sudo fio --filename=/dev/nvme0n1 --name=firstfill --ioengine=libaio --
iodepth=1 --rw=randwrite --bs=4k --numjobs=1 --direct=1 --time_based --runtime=30
firstfill: (g=0): rw=randwrite, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B,
ioengine=libaio, iodepth=1
fio-3.16
Starting 1 process
Jobs: 1 (f=1): [w(1)][100.0%][w=132MiB/s][w=33.8k IOPS][eta 00m:00s]
firstfill: (groupid=0, jobs=1): err= 0: pid=2239: Thu Mar 25 08:36:53 2021
  write: IOPS=37.7k, BW=147MiB/s (155MB/s)(4422MiB/30001msec); 0 zone resets
    slat (nsec): min=1816, max=27604, avg=2066.39, stdev=133.63
    clat (nsec): min=681, max=2105.3k, avg=23985.39, stdev=14164.50
     lat (usec): min=11, max=2107, avg=26.09, stdev=14.14
    clat percentiles (usec):
     |  1.00th=[   11],  5.00th=[   11], 10.00th=[   11], 20.00th=[   12],
     | 30.00th=[   14], 40.00th=[   14], 50.00th=[   14], 60.00th=[   37],
     | 70.00th=[   40], 80.00th=[   40], 90.00th=[   42], 95.00th=[   45],
     | 99.00th=[   46], 99.50th=[   47], 99.90th=[   60], 99.95th=[   73],
     | 99.99th=[  104]
   bw (  KiB/s): min=134000, max=262968, per=100.00%, avg=151112.68, stdev=27047.54,
samples=59
    iops        : min=33500, max=65742, avg=37778.14, stdev=6761.89, samples=59
  lat (nsec)   : 750=0.01%
  lat (usec)   : 4=0.01%, 10=0.55%, 20=59.02%, 50=40.19%, 100=0.22%
  lat (usec)   : 250=0.01%
  lat (msec)   : 4=0.01%
  cpu        : usr=7.03%, sys=12.47%, ctx=1132054, majf=0, minf=13
```

```
  IO depths    : 1=100.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     issued rwts: total=0,1132029,0,0 short=0,0,0,0 dropped=0,0,0,0
     latency   : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):
  WRITE: bw=147MiB/s (155MB/s), 147MiB/s-147MiB/s (155MB/s-155MB/s), io=4422MiB
(4637MB), run=30001-30001msec

Disk stats (read/write):
  nvme0n1: ios=0/0, merge=0/0, ticks=0/0, in_queue=0, util=0.00%
nvme@nvme-cli116:~$
```

TCP

READ

```
nvme@nvme-cli116:~$ sudo fio --filename=/dev/nvme1n1 --name=firstfill --ioengine=libaio --
iodepth=1 --rw=randread --bs=4k --numjobs=1 --direct=1 --time_based --runtime=30
firstfill: (g=0): rw=randread, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B,
ioengine=libaio, iodepth=1
fio-3.16
Starting 1 process
Jobs: 1 (f=1): [r(1)][100.0%][r=100MiB/s][r=25.6k IOPS][eta 00m:00s]
firstfill: (groupid=0, jobs=1): err= 0: pid=2251: Thu Mar 25 08:38:06 2021
  read: IOPS=31.2k, BW=122MiB/s (128MB/s)(3654MiB/30001msec)
    slat (usec): min=3, max=486, avg= 4.55, stdev= 1.39
    clat (nsec): min=610, max=9241.8k, avg=26708.92, stdev=28321.09
     lat (usec): min=21, max=9256, avg=31.34, stdev=29.12
    clat percentiles (usec):
     |  1.00th=[   21],  5.00th=[   22], 10.00th=[   22], 20.00th=[   22],
     | 30.00th=[   22], 40.00th=[   23], 50.00th=[   23], 60.00th=[   23],
     | 70.00th=[   23], 80.00th=[   23], 90.00th=[   24], 95.00th=[   25],
     | 99.00th=[  204], 99.50th=[  227], 99.90th=[  235], 99.95th=[  237],
     | 99.99th=[  241]
   bw (  KiB/s): min=36640, max=147504, per=100.00%, avg=126136.31, stdev=26997.94,
samples=59
   iops        : min= 9160, max=36876, avg=31534.07, stdev=6749.48, samples=59
  lat (nsec)   : 750=0.01%
  lat (usec)   : 10=0.01%, 20=0.22%, 50=95.90%, 100=1.79%, 250=2.09%
  lat (usec)   : 500=0.01%
  lat (msec)   : 2=0.01%, 10=0.01%
  cpu          : usr=7.03%, sys=21.91%, ctx=937054, majf=0, minf=12
```

```
  IO depths    : 1=100.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     issued rwts: total=935441,0,0,0 short=0,0,0,0 dropped=0,0,0,0
     latency   : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):
   READ: bw=122MiB/s (128MB/s), 122MiB/s-122MiB/s (128MB/s-128MB/s), io=3654MiB
(3832MB), run=30001-30001msec

Disk stats (read/write):
  nvme1n1: ios=0/0, merge=0/0, ticks=0/0, in_queue=0, util=0.00%
nvme@nvme-cli116:~$
```

WRITE

```
nvme@nvme-cli116:~$ sudo fio --filename=/dev/nvme1n1 --name=firstfill --ioengine=libaio --
iodepth=1 --rw=randwrite --bs=4k --numjobs=1 --direct=1 --time_based --runtime=30
firstfill: (g=0): rw=randwrite, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B,
ioengine=libaio, iodepth=1
fio-3.16
Starting 1 process
Jobs: 1 (f=1): [w(1)][100.0%][w=93.3MiB/s][w=23.9k IOPS][eta 00m:00s]
firstfill: (groupid=0, jobs=1): err= 0: pid=2260: Thu Mar 25 08:39:06 2021
  write: IOPS=33.2k, BW=130MiB/s (136MB/s)(3893MiB/30001msec); 0 zone resets
    slat (nsec): min=4019, max=167345, avg=4708.44, stdev=800.92
    clat (nsec): min=1107, max=7711.4k, avg=24631.28, stdev=21931.45
     lat (usec): min=23, max=7715, avg=29.43, stdev=22.58
    clat percentiles (usec):
     |  1.00th=[   21],  5.00th=[   22], 10.00th=[   22], 20.00th=[   22],
     | 30.00th=[   22], 40.00th=[   22], 50.00th=[   22], 60.00th=[   22],
     | 70.00th=[   23], 80.00th=[   23], 90.00th=[   24], 95.00th=[   25],
     | 99.00th=[  123], 99.50th=[  219], 99.90th=[  231], 99.95th=[  233],
     | 99.99th=[  239]
   bw (  KiB/s): min=46968, max=149880, per=99.98%, avg=132850.12, stdev=23003.59,
samples=59
   iops        : min=11742, max=37470, avg=33212.53, stdev=5750.91, samples=59
  lat (usec)   : 2=0.01%, 10=0.01%, 20=0.59%, 50=96.62%, 100=1.63%
  lat (usec)   : 250=1.16%, 500=0.01%
  lat (msec)   : 10=0.01%
  cpu          : usr=7.67%, sys=21.55%, ctx=996971, majf=0, minf=13
  IO depths    : 1=100.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
```

```
   complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
   issued rwts: total=0,996585,0,0 short=0,0,0,0 dropped=0,0,0,0
   latency   : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):
  WRITE: bw=130MiB/s (136MB/s), 130MiB/s-130MiB/s (136MB/s-136MB/s), io=3893MiB
(4082MB), run=30001-30001msec

Disk stats (read/write):
  nvme1n1: ios=0/0, merge=0/0, ticks=0/0, in_queue=0, util=0.00%
nvme@nvme-cli116:~$
```

9 Appendix D – Target – T408 device – Logs

nvme@nvme-cli88:~$ sudo ./setup_rdma_target.sh /dev/nvme0n1

nvme@nvme-cli88:~$ dmesg |grep nvme

[2.147986] nvme nvme0: pci function 0000:06:00.0

[2.449550] nvme nvme0: 4/0/0 default/read/poll queues

[3.152095] systemd[1]: Set hostname to <nvme-cli88>.

[373.193490] nvmet: adding nsid 1 to subsystem nvmet-test

[373.199163] nvmet_rdma: enabling port 1 (192.168.200.1:4420)

nvme@nvme-cli88:~$

nvme@nvme-cli88:~$ sudo ./setup_tcp_target.sh /dev/nvme0n1

nvme@nvme-cli88:~$ dmesg |grep nvme

[2.162068] nvme nvme0: pci function 0000:06:00.0

[2.814064] nvme nvme0: 4/0/0 default/read/poll queues

[3.152917] systemd[1]: Set hostname to <nvme-cli88>.

[59.054979] nvmet: adding nsid 1 to subsystem nvmet-test

[59.060696] nvmet_rdma: enabling port 1 (192.168.200.1:4420)

[98.991540] nvmet: creating controller 1 for subsystem nqn.2014-08.org.nvmexpress.discovery for NQN nqn.2014-08.org.nvmexpress:uuid:65af5e29-8c43-42f2-b8b0-64a5d4d46e93.

[113.043036] nvmet: creating controller 1 for subsystem nvmet-test for NQN nqn.2014-08.org.nvmexpress:uuid:65af5e29-8c43-42f2-b8b0-64a5d4d46e93.

[1704.802436] nvmet: ctrl 1 keep-alive timer (15 seconds) expired!

[1704.802438] nvmet: ctrl 1 fatal error occurred!

[2148.794503] nvmet: adding nsid 1 to subsystem nvmet-test-tcp

[2148.800227] nvmet_tcp: enabling port 2 (192.168.200.2:4420)

nvme@nvme-cli88:~$

10 Appendix E – Host – T408 Device RDMA and TCP connection – Logs

T408

RDMA

nvme@nvme-cli116:~$ sudo shutdown -r now

nvme@nvme-cli116:~$ sudo modprobe nvme-rdma

[sudo] password for nvme:

nvme@nvme-cli116:~$ sudo nvme discover -t rdma -a 192.168.200.1 -s 4420

Discovery Log Number of Records 1, Generation counter 2

=====Discovery Log Entry 0======

trtype: rdma

adrfam: ipv4

subtype: nvme subsystem

treq: unrecognized

portid: 1

trsvcid: 4420

subnqn: nvmet-test

traddr: 192.168.200.1

rdma_prtype: not specified

rdma_qptype: connected

rdma_cms: rdma-cm

rdma_pkey: 0x0000

nvme@nvme-cli116:~$ sudo nvme connect -t rdma -n nvmet-test -a 192.168.200.1 -s 4420

nvme@nvme-cli116:~$ sudo nvme list

Node SN Model Namespace Usage Format FW Rev

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/dev/nvme0n1 a00cb701e22de7f2 Linux 1 536.87 GB / 536.87 GB 512 B + 0 B 5.4.0-42

nvme@nvme-cli116:~$

nvme@nvme-cli116:~$ ni_rsrc_mon

NI resource not init'd, continue ..

Reading device file: nvme0

Compatible minimum FW ver: 250, FW API flavors: 1E, minimum API ver: 9

1. /dev/nvme0 /dev/nvme0n1 num_hw: 2

Creating shm_name: NI_SHM_CODERS lck_name: /dev/shm/NI_LCK_CODERS

0. nvme0

decoder h/w id 0 create

Creating shm_name: NI_shm_d0 , lck_name /dev/shm/NI_lck_d0

ni_rsrc_get_one_device_info written out.

decoder h/w id 0 update

encoder h/w id 1 create

Creating shm_name: NI_shm_e0 , lck_name /dev/shm/NI_lck_e0

ni_rsrc_get_one_device_info written out.

encoder h/w id 1 update

****

1 devices retrieved from current pool at start up

Thu Mar 25 11:46:12 2021 up 00:00:00 v250R1E09

Num decodes: 1

BEST INDEX LOAD MODEL_LOAD MEM INST DEVICE NAMESPACE

L 0 0 0 0 0 /dev/nvme0 /dev/nvme0n1

Num encodes: 1

BEST INDEX LOAD MODEL_LOAD MEM INST DEVICE NAMESPACE

L 0 0 0 0 0 /dev/nvme0 /dev/nvme0n1

****

nvme@nvme-cli116:~$ ni_rsrc_list

Num decoders: 1

Decoder #0

DeviceID: /dev/nvme0

BlockID: /dev/nvme0n1

H/W ID: 0

F/W rev: 250X1E09

F/W & S/W compatibility: yes

F/W branch: xcod-develop-revb-v1

F/W commit hash: 848b240441bc4a3ad6b76a8990b1f4654709fb69

F/W commit time: 2021-03-19_16:21:21_-0700

MaxNumInstances: 32

ActiveNumInstances: 0

Max1080pFps: 240

CurrentLoad: 0

H.264Capabilities:

Supported: yes

MaxResolution: 8192x5120

MinResolution: 32x32

```
    Profiles: Baseline, Constrained Baseline, Main, High, High10
    level: Level 6.2
    additional info:
  H.265Capabilities:
    Supported: yes
    MaxResolution: 8192x5120
    MinResolution: 32x32
    Profiles: Main, Main10
    level: Level 6.2 Main-Tier
    additional info:
  num. s/w instances: 0

Num encoders: 1
Encoder #0
  DeviceID: /dev/nvme0
  BlockID: /dev/nvme0n1
  H/W ID: 1
  F/W rev: 250X1E09
  F/W & S/W compatibility: yes
  F/W branch: xcod-develop-revb-v1
  F/W commit hash: 848b240441bc4a3ad6b76a8990b1f4654709fb69
  F/W commit time: 2021-03-19_16:21:21_-0700
  MaxNumInstances: 32
  ActiveNumInstances: 0
  Max1080pFps: 240
  CurrentLoad: 0
```

H.264Capabilities:

Supported: yes

MaxResolution: 8192x5120

MinResolution: 32x32

Profiles: Baseline, Extended, Main, High, High10

level: Level 6.2

additional info:

H.265Capabilities:

Supported: yes

MaxResolution: 8192x5120

MinResolution: 32x32

Profiles: Main, Main10

level: Level 6.2 Main-Tier

additional info:

num. s/w instances: 0

TCP

nvme@nvme-cli116:~$ sudo modprobe nvme-tcp

[sudo] password for nvme:

nvme@nvme-cli116:~$ modinfo nvme-tcp

filename: /lib/modules/5.4.0-42-generic/updates/host/nvme-tcp.ko

license: GPL v2

srcversion: 5EE48D30808A063277F8A91

depends: mlx_compat,nvme-core,nvme-fabrics

retpoline: Y

name: nvme_tcp

vermagic: 5.4.0-42-generic SMP mod_unload

parm: so_priority:nvme tcp socket optimize priority (int)

nvme@nvme-cli116:~$ sudo nvme discover -t tcp -a 192.168.200.2 -s 4420

Discovery Log Number of Records 1, Generation counter 4

=====Discovery Log Entry 0======

trtype: unrecognized

adrfam: ipv4

subtype: nvme subsystem

treq: unrecognized

portid: 2

trsvcid: 4420

subnqn: nvmet-test-tcp

traddr: 192.168.200.2

nvme@nvme-cli116:~$ sudo nvme connect -t tcp -n nvmet-test-tcp -a 192.168.200.2 -s 4420

nvme@nvme-cli116:~$ sudo nvme list

Node SN Model Namespace Usage Format FW Rev

---------------- -------------------- -- --------- -------------------------- ---------------- --------

/dev/nvme0n1 acb49c8611b5b34c Linux 1 536.87 GB / 536.87 GB 512 B + 0 B 5.4.0-42

nvme@nvme-cli116:~$

11 Appendix F – IP ADDRESS

Host

nvme@nvme-cli116:~$ ip add

1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000

link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00

inet 127.0.0.1/8 scope host lo

valid_lft forever preferred_lft forever

inet6 ::1/128 scope host

valid_lft forever preferred_lft forever

2: eno1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000

link/ether 6c:2b:59:90:bc:09 brd ff:ff:ff:ff:ff:ff

inet 10.[redacted]/23 brd 10.[redacted] scope global eno1

valid_lft forever preferred_lft forever

inet6 fe80::6e2b:59ff:fe90:bc09/64 scope link

valid_lft forever preferred_lft forever

3: eno2: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN group default qlen 1000

link/ether 6c:2b:59:90:bc:0a brd ff:ff:ff:ff:ff:ff

6: enp1s0f0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc mq state UP group default qlen 1000

link/ether 0c:42:a1:44:43:48 brd ff:ff:ff:ff:ff:ff

inet 192.168.200.3/24 brd 192.168.200.255 scope global enp1s0f0

valid_lft forever preferred_lft forever

inet6 fe80::e42:a1ff:fe44:4348/64 scope link

valid_lft forever preferred_lft forever

7: enp1s0f1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc mq state UP group default qlen 1000

link/ether 0c:42:a1:44:43:49 brd ff:ff:ff:ff:ff:ff

inet 192.168.200.4/24 brd 192.168.200.255 scope global enp1s0f1

valid_lft forever preferred_lft forever

inet6 fe80::e42:a1ff:fe44:4349/64 scope link

valid_lft forever preferred_lft forever

nvme@nvme-cli116:~$

Target

nvme@nvme-cli88:~$ ip add

1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000

link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00

inet 127.0.0.1/8 scope host lo

valid_lft forever preferred_lft forever

inet6 ::1/128 scope host

valid_lft forever preferred_lft forever

2: eno1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000

link/ether 08:f1:ea:af:1d:a4 brd ff:ff:ff:ff:ff:ff

inet 10.[redacted]/23 brd 10.[redacted] scope global eno1

valid_lft forever preferred_lft forever

inet6 fe80::af1:eaff:feaf:1da4/64 scope link

valid_lft forever preferred_lft forever

3: eno2: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN group default qlen 1000

link/ether 08:f1:ea:af:1d:a5 brd ff:ff:ff:ff:ff:ff

4: ens1f0np0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc mq state UP group default qlen 1000

link/ether 0c:42:a1:44:43:40 brd ff:ff:ff:ff:ff:ff

inet 192.168.200.1/24 brd 192.168.200.255 scope global ens1f0np0

valid_lft forever preferred_lft forever

inet6 fe80::e42:a1ff:fe44:4340/64 scope link

valid_lft forever preferred_lft forever

5: ens1f1np1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc mq state UP group default qlen 1000

link/ether 0c:42:a1:44:43:41 brd ff:ff:ff:ff:ff:ff

inet 192.168.200.2/24 brd 192.168.200.255 scope global ens1f1np1

valid_lft forever preferred_lft forever

inet6 fe80::e42:a1ff:fe44:4341/64 scope link

valid_lft forever preferred_lft forever

nvme@nvme-cli88:~$

12 Revision History

Version	Change	Create Date	Author
0.1	Document Created	March 24, 2021	Balwinder Sidhu
1.0	RDMA measurement results	March 29, 2021	Balwinder Sidhu
1.1	TCP measurement results	March 30, 2021	Balwinder Sidhu
1.2	Latency results with 2 T408 cards	May 02, 2021	Balwinder Sidhu
2.0	Updated as per new app note template	December 7, 2021	Balwinder Sidhu

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