Building GPU-enabled Kubernetes single node cluster for MLOps experiments with new+second hand components

1. **SUPERMICRO MBD-X11SAE-M-O Micro ATX Server Motherboard LGA 1151 Intel C236** from newegg.com - $200 (Link to Newegg)

2. **Intel Xeon E3-1275 V6 Kaby Lake 3.8 GHz (4.2 GHz Turbo) LGA 1151 Server Processor Intel HD Graphics P630** - $360 (Link to Newegg)

3. 64GB of RAM: four DIMMs of **16GB DDR4-2400 UDIMM 1.2V CL17 (SKU: CT16G4DFD824A)** from Crucial: $250 (Link to Crucial)

4. **Sabrent Rocket Q 1TB NVMe PCIe M.2 2280 Internal SSD High Performance Solid State Drive R/W 3200/2000MB/s (SB-RKTQ-1TB)**: $110 (Link to Amazon)

5. **Supermicro SNK-P0046A4 Heatsink 2U+ Active Heatsink LGA1156 & LGA1155**: $25 (Link to Supermicro store)

6. **Nvidia Tesla M40 12GB** (Second hand): $125(Link to Ebay)

7. Dual 8 to 8 Graphics Power Cable (SKU: 030-0571-000): $6 (Link to Ebay)

Really old components:

8. HDD and SSD: Western Digital HDD 250GB SATA3 6.0Gb/s 7.2K (Used): $0, SSD 120 GB SATA3 6.0 Gb/s 2.5” (Used): $0, SSD 120 GB SATA3 6.0 Gb/s 2.5” (Used): $0

9. SuperMicro Chassis 733I-500B with 500W PSU (Used): $0 (Link to SuperMicro)

Final configuration: 1 x Xeon E3-1275, 64GB RAM, 1.5TB storage with 1TB on NVMe, NVIDIA GPU (Maxwell architecture) with 12GB GDDR5 for **total: $1076.0 (Ouch!)**

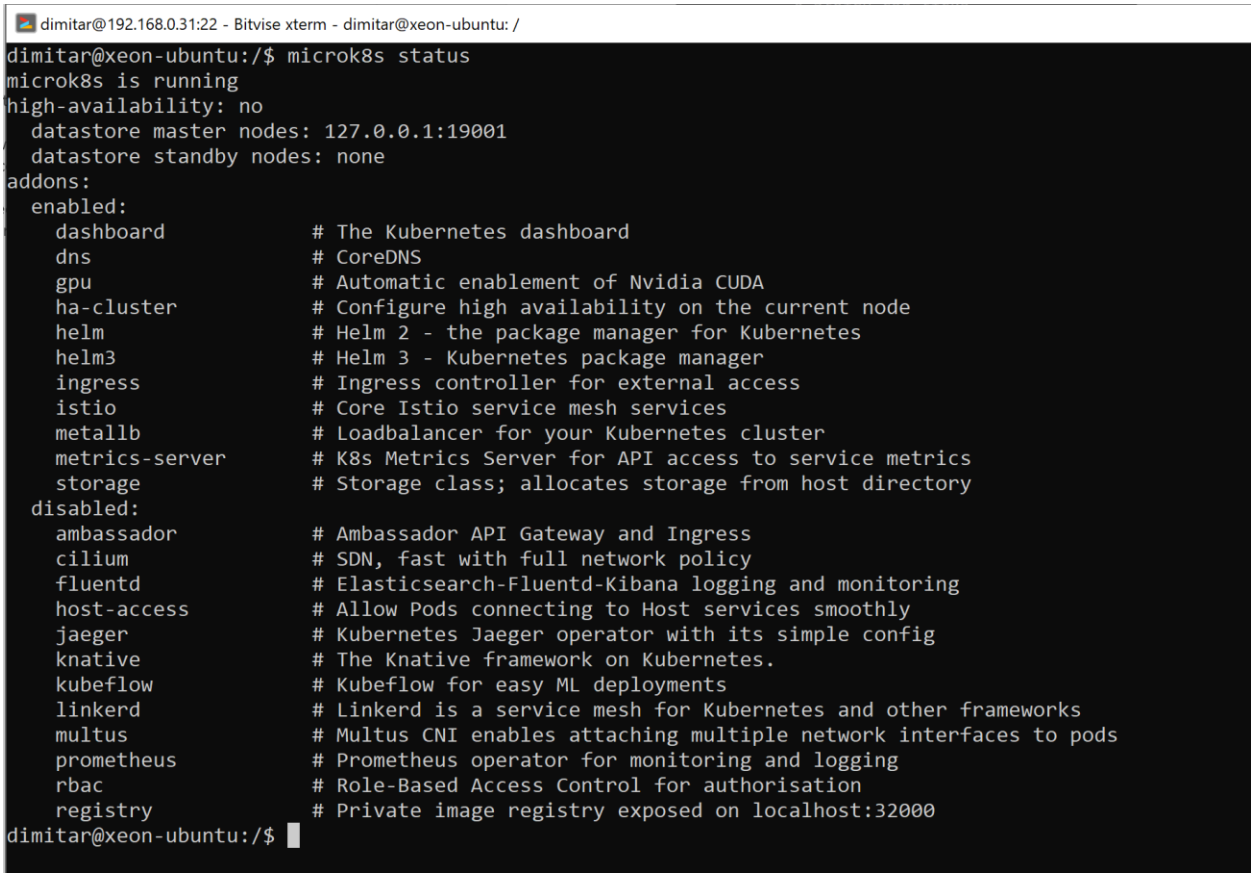
Additional Notes:

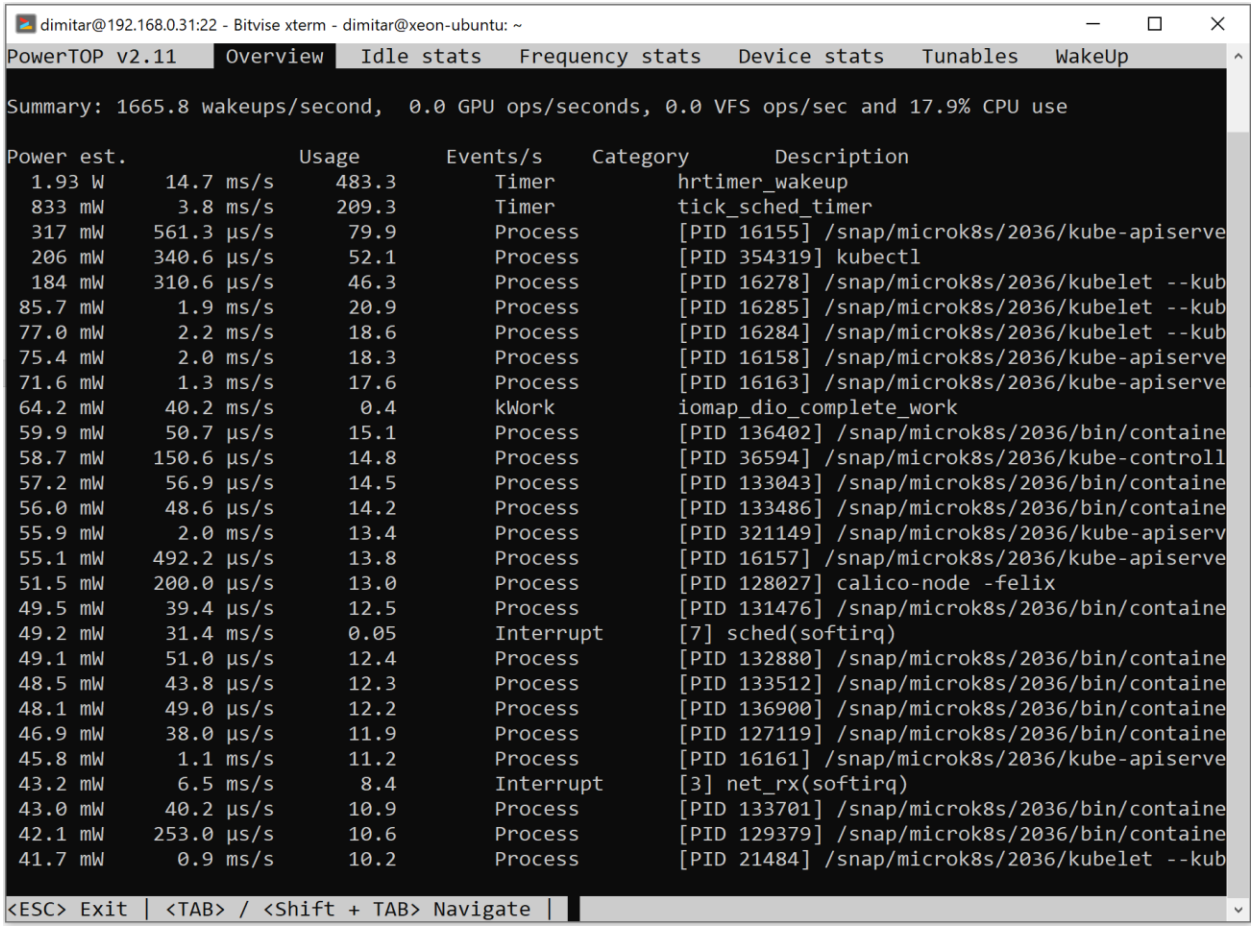
The 500W power supply coming with the mid tower chassis seems adequate for the graphics card provided you do not plan to reach frequently the max 250W which the card may need in peak memory and GPU utilization. The CPU drains no more than 73W, and the motherboard with the chipset and 64GB of RAM. Note that the chassis has an extension space allowing mounting larger power supply in case the one with 500W is not sufficient.

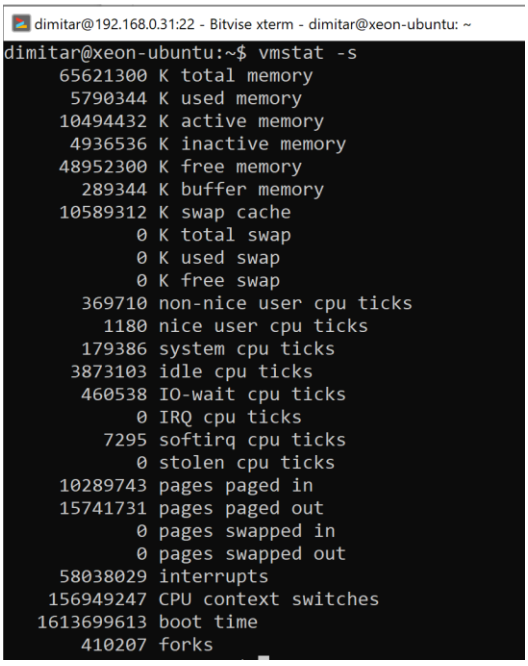
Use Ubuntu 20.04 and upgrade to 20.10.

Connect all disks (NVMe, SSD1, SSD2, and HDD) in a single file system using LVM2

Do not configure swap partition in case you are going to run Kubernetes locally using microk8s or minikube.


dimitar@192.168.0.31:22 - Bitvise xterm - dimitar@xeon-ubuntu: /
dimitar@xeon-ubuntu:/$ microk8s status
microk8s is running
high-availability: no
datastore master nodes: 127.0.0.1:19001
datastore standby nodes: none
addons:
enabled:
dashboard # The Kubernetes dashboard
dns # CoreDNS
gpu # Automatic enablement of Nvidia CUDA
ha-cluster # Configure high availability on the current node
helm # Helm 2 - the package manager for Kubernetes
helm3 # Helm 3 - Kubernetes package manager
ingress # Ingress controller for external access
istio # Core Istio service mesh services
metallb # Loadbalancer for your Kubernetes cluster
metrics-server # K8s Metrics Server for API access to service metrics
storage # Storage class; allocates storage from host directory
disabled:
ambassador # Ambassador API Gateway and Ingress
cilium # SDN, fast with full network policy
fluentd # Elasticsearch-Fluentd-Kibana logging and monitoring
host-access # Allow Pods connecting to Host services smoothly
jaeger # Kubernetes Jaeger operator with its simple config
knative # The Knative framework on Kubernetes.
kubeflow # Kubeflow for easy ML deployments
linkerd # Linkerd is a service mesh for Kubernetes and other frameworks
multus # Multus CNI enables attaching multiple network interfaces to pods
prometheus # Prometheus operator for monitoring and logging
rbac # Role-Based Access Control for authorisation
registry # Private image registry exposed on localhost:32000
dimitar@xeon-ubuntu:/$


dimitar@192.168.0.31:22 - Bitvise xterm - dimitar@xeon-ubuntu: ~
PowerTOP v2.11 Overview Idle stats Frequency stats Device stats Tunables WakeUp
Summary: 1665.8 wakeups/second, 0.0 GPU ops/seconds, 0.0 VFS ops/sec and 17.9% CPU use
Power est. Usage Events/s Category Description
1.93 W 14.7 ms/s 483.3 Timer hrtimer_wakeup
833 mW 3.8 ms/s 209.3 Timer tick_sched_timer
317 mW 561.3 µs/s 79.9 Process [PID 16155] /snap/microk8s/2036/kube-apiserve
206 mW 340.6 µs/s 52.1 Process [PID 354319] kubectl
184 mW 310.6 µs/s 46.3 Process [PID 16278] /snap/microk8s/2036/kubelet --kub
85.7 mW 1.9 ms/s 20.9 Process [PID 16285] /snap/microk8s/2036/kubelet --kub
77.0 mW 2.2 ms/s 18.6 Process [PID 16284] /snap/microk8s/2036/kubelet --kub
75.4 mW 2.0 ms/s 18.3 Process [PID 16158] /snap/microk8s/2036/kube-apiserve
71.6 mW 1.3 ms/s 17.6 Process [PID 16163] /snap/microk8s/2036/kube-apiserve
64.2 mW 40.2 ms/s 0.4 kWork iomap_dio_complete_work
59.9 mW 50.7 µs/s 15.1 Process [PID 136402] /snap/microk8s/2036/bin/containe
58.7 mW 150.6 µs/s 14.8 Process [PID 36594] /snap/microk8s/2036/kube-controll
57.2 mW 56.9 µs/s 14.5 Process [PID 133043] /snap/microk8s/2036/bin/containe
56.0 mW 48.6 µs/s 14.2 Process [PID 133486] /snap/microk8s/2036/bin/containe
55.9 mW 2.0 ms/s 13.4 Process [PID 321149] /snap/microk8s/2036/kube-apiserv
55.1 mW 492.2 µs/s 13.8 Process [PID 16157] /snap/microk8s/2036/kube-apiserve
51.5 mW 200.0 µs/s 13.0 Process [PID 128027] calico-node -felix
49.5 mW 39.4 µs/s 12.5 Process [PID 131476] /snap/microk8s/2036/bin/containe
49.2 mW 31.4 ms/s 0.05 Interrupt [7] sched(softirq)
49.1 mW 51.0 µs/s 12.4 Process [PID 132880] /snap/microk8s/2036/bin/containe
48.5 mW 43.8 µs/s 12.3 Process [PID 133512] /snap/microk8s/2036/bin/containe
48.1 mW 49.0 µs/s 12.2 Process [PID 136900] /snap/microk8s/2036/bin/containe
46.9 mW 38.0 µs/s 11.9 Process [PID 127119] /snap/microk8s/2036/bin/containe
45.8 mW 1.1 ms/s 11.2 Process [PID 16161] /snap/microk8s/2036/kube-apiserve
43.2 mW 6.5 ms/s 8.4 Interrupt [3] net_rx(softirq)
43.0 mW 40.2 µs/s 10.9 Process [PID 133701] /snap/microk8s/2036/bin/containe
42.1 mW 253.0 µs/s 10.6 Process [PID 129379] /snap/microk8s/2036/bin/containe
41.7 mW 0.9 ms/s 10.2 Process [PID 21484] /snap/microk8s/2036/kubelet --kub
<ESC> Exit | <TAB> / <Shift + TAB> Navigate |


dimitar@192.168.0.31:22 - Bitvise xterm - dimitar@xeon-ubuntu: ~
dimitar@xeon-ubuntu:~$ vmstat -s
65621300 K total memory
5790344 K used memory
10494432 K active memory
4936536 K inactive memory
48952300 K free memory
289344 K buffer memory
10589312 K swap cache
0 K total swap
0 K used swap
0 K free swap
369710 non-nice user cpu ticks
1180 nice user cpu ticks
179386 system cpu ticks
3873103 idle cpu ticks
460538 IO-wait cpu ticks
0 IRQ cpu ticks
7295 softirq cpu ticks
0 stolen cpu ticks
10289743 pages paged in
15741731 pages paged out
0 pages swapped in
0 pages swapped out
58038029 interrupts
156949247 CPU context switches
1613699613 boot time
410207 forks

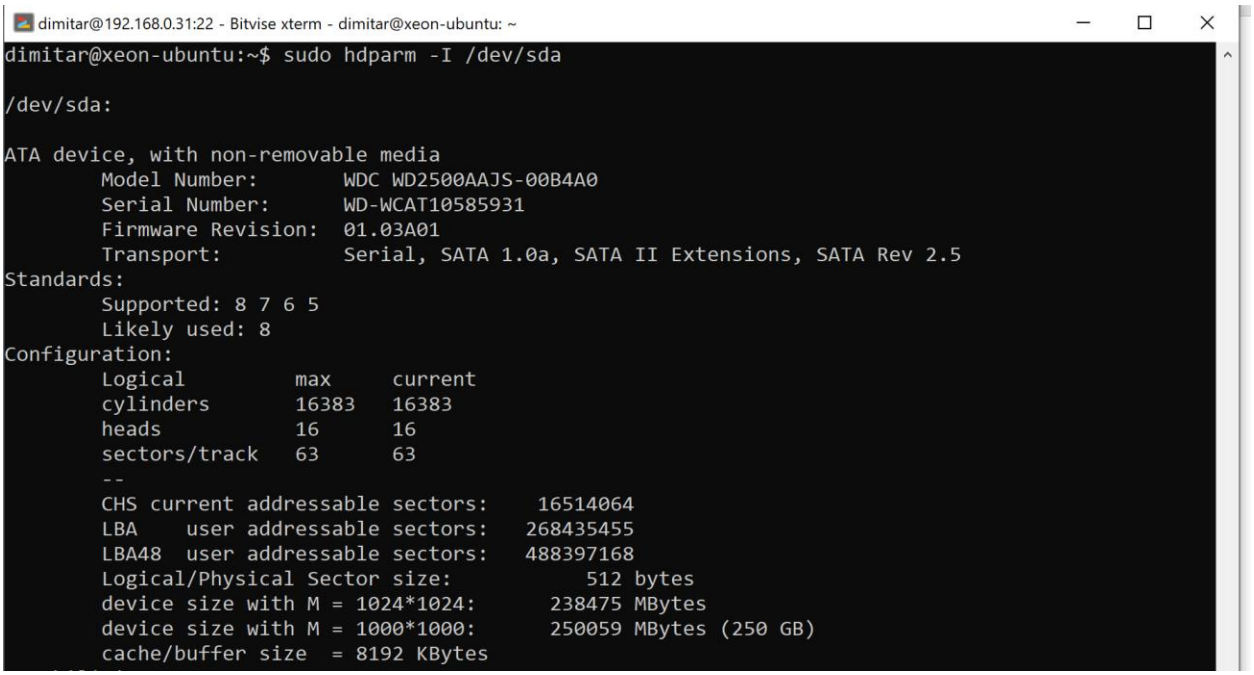
dimitar@192.168.0.31:22 - Bitvise xterm - dimitar@xeon-ubuntu: /usr/local/cuda-11.2/samples/1_Utilities/deviceQuery

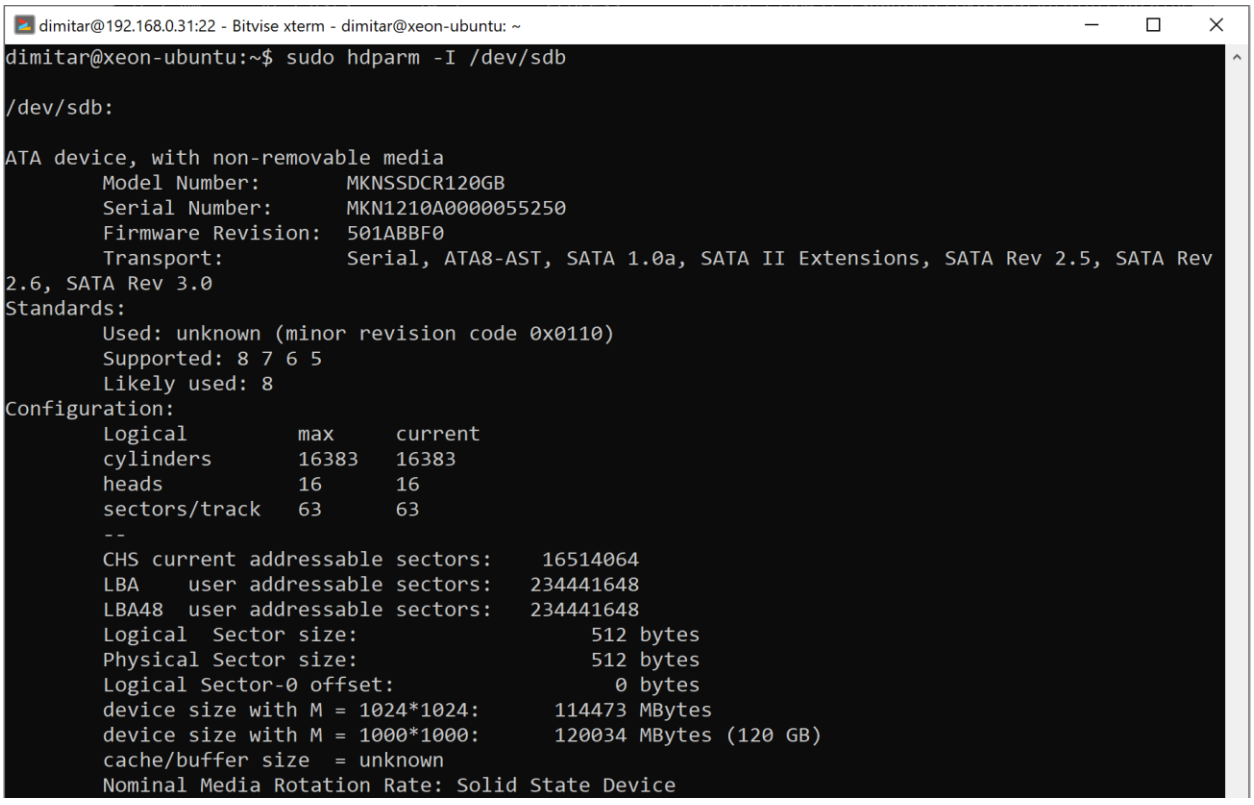
```
dimitar@xeon-ubuntu:/usr/local/cuda-11.2/samples/1_Utilities/deviceQuery$ ./deviceQuery
./deviceQuery Starting...

 CUDA Device Query (Runtime API) version (CUDART static linking)

Detected 1 CUDA Capable device(s)

Device 0: "Tesla M40"
  CUDA Driver Version / Runtime Version          11.2 / 11.2
  CUDA Capability Major/Minor version number:    5.2
  Total amount of global memory:                 11449 MBytes (12004753408 bytes)
  (24) Multiprocessors, (128) CUDA Cores/MP:     3072 CUDA Cores
  GPU Max Clock rate:                            1112 MHz (1.11 GHz)
  Memory Clock rate:                             3004 Mhz
  Memory Bus Width:                              384-bit
  L2 Cache Size:                                 3145728 bytes
  Maximum Texture Dimension Size (x,y,z)         1D=(65536), 2D=(65536, 65536), 3D=(4096, 4096, 4096)
  Maximum Layered 1D Texture Size, (num) layers  1D=(16384), 2048 layers
  Maximum Layered 2D Texture Size, (num) layers  2D=(16384, 16384), 2048 layers
  Total amount of constant memory:               65536 bytes
  Total amount of shared memory per block:       49152 bytes
  Total shared memory per multiprocessor:        98304 bytes
  Total number of registers available per block: 65536
  Warp size:                                     32
  Maximum number of threads per multiprocessor:  2048
  Maximum number of threads per block:           1024
  Max dimension size of a thread block (x,y,z): (1024, 1024, 64)
  Max dimension size of a grid size    (x,y,z): (2147483647, 65535, 65535)
  Maximum memory pitch:                          2147483647 bytes
  Texture alignment:                             512 bytes
  Concurrent copy and kernel execution:          Yes with 2 copy engine(s)
  Run time limit on kernels:                     Yes
  Integrated GPU sharing Host Memory:            No
  Support host page-locked memory mapping:       Yes
  Alignment requirement for Surfaces:            Yes
```

dimitar@192.168.0.31:22 - Bitvise xterm - dimitar@xeon-ubuntu: /usr/local/cuda-11.2/samples/1_Utilities/bandwidthTest

```
dimitar@xeon-ubuntu:/usr/local/cuda-11.2/samples/1_Utilities/bandwidthTest$ ./bandwidthTest
[CUDA Bandwidth Test] - Starting...
Running on...

 Device 0: Tesla M40
 Quick Mode

 Host to Device Bandwidth, 1 Device(s)
 PINNED Memory Transfers
   Transfer Size (Bytes)        Bandwidth(GB/s)
   32000000                     12.2

 Device to Host Bandwidth, 1 Device(s)
 PINNED Memory Transfers
   Transfer Size (Bytes)        Bandwidth(GB/s)
   32000000                     12.9

 Device to Device Bandwidth, 1 Device(s)
 PINNED Memory Transfers
   Transfer Size (Bytes)        Bandwidth(GB/s)
   32000000                     216.8

Result = PASS

NOTE: The CUDA Samples are not meant for performance measurements. Results may vary when GPU Boost is enabled.
dimitar@xeon-ubuntu:/usr/local/cuda-11.2/samples/1_Utilities/bandwidthTest$
```

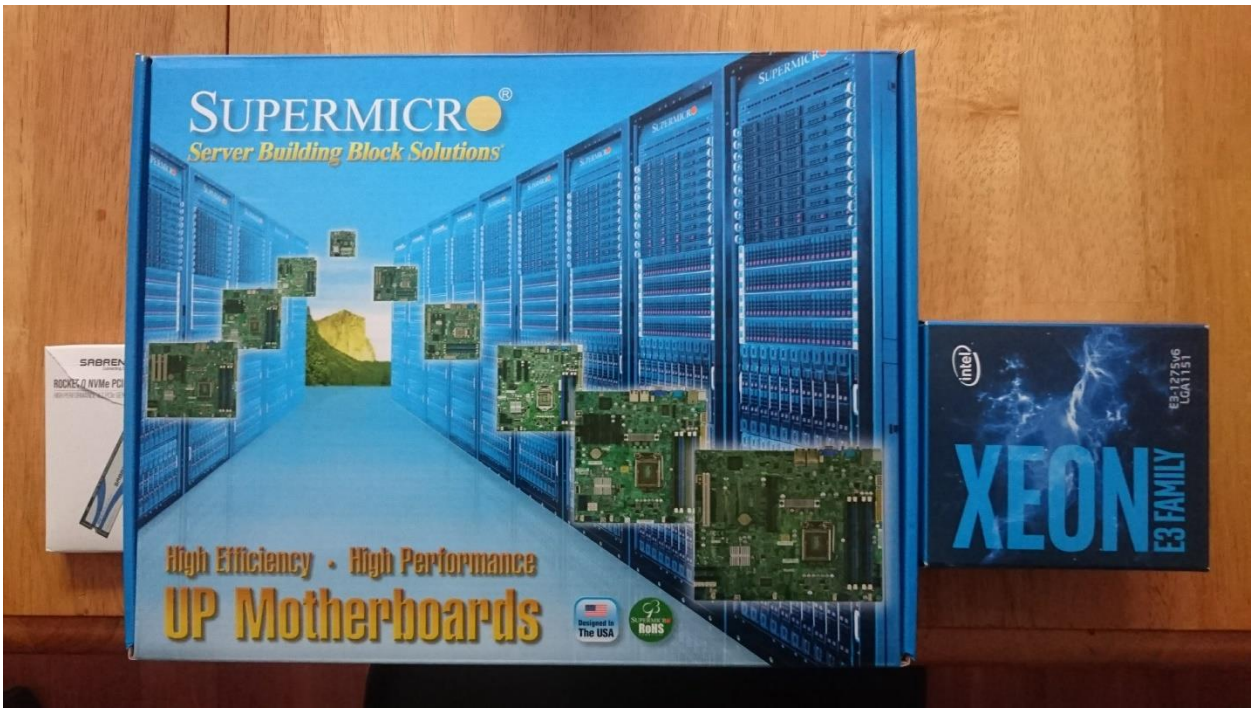
```
dimitar@xeon-ubuntu:~$ sudo nvme list
Node             SN                   Model                                    Namespace Usage                      Format           FW Rev
---------------- -------------------- ---------------------------------------- --------- -------------------------- ---------------- --------
/dev/nvme0n1     0546070A1EF388282021 Sabrent Rocket Q                         1           1.00  TB /   1.00  TB    512   B +  0 B   RKT30Q.2
dimitar@xeon-ubuntu:~$
```

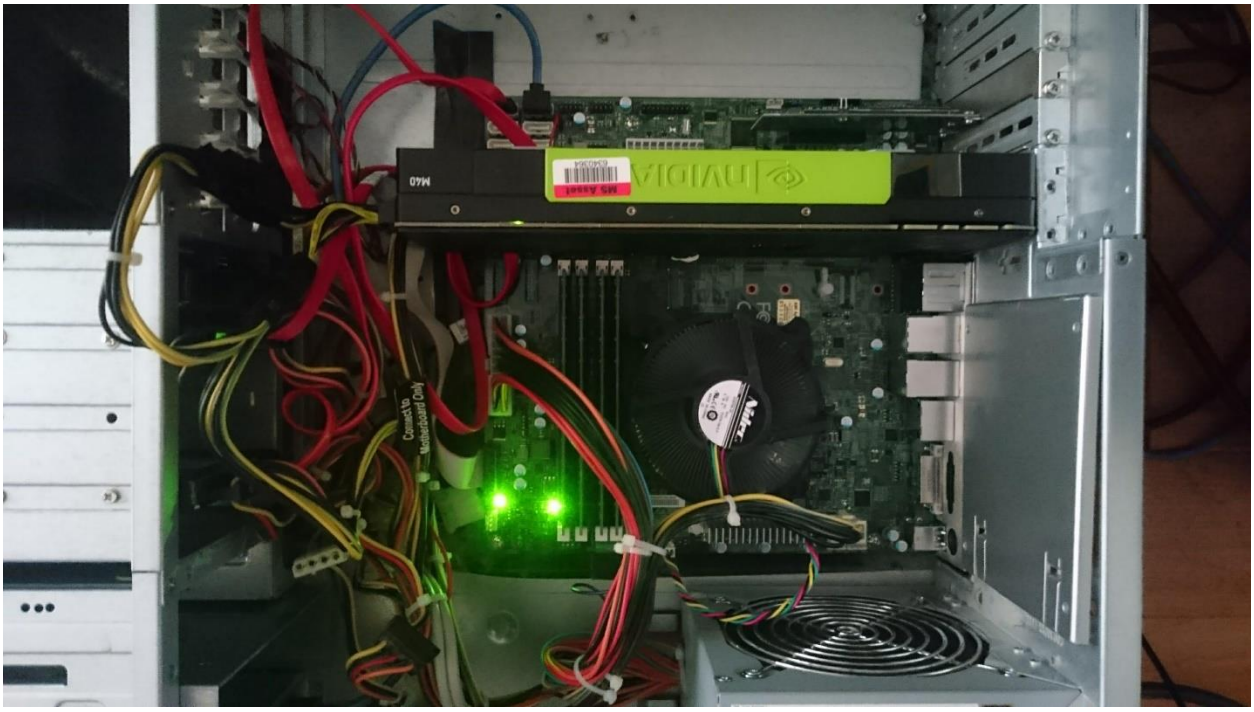

dimitar@192.168.0.31:22 - Bitvise xterm - dimitar@xeon-ubuntu: ~
dimitar@xeon-ubuntu:~$ sudo hdparm -I /dev/sda
/dev/sda:
ATA device, with non-removable media
Model Number: WDC WD2500AAJS-00B4A0
Serial Number: WD-WCAT10585931
Firmware Revision: 01.03A01
Transport: Serial, SATA 1.0a, SATA II Extensions, SATA Rev 2.5
Standards:
Supported: 8 7 6 5
Likely used: 8
Configuration:
Logical max current
cylinders 16383 16383
heads 16 16
sectors/track 63 63
--
CHS current addressable sectors: 16514064
LBA user addressable sectors: 268435455
LBA48 user addressable sectors: 488397168
Logical/Physical Sector size: 512 bytes
device size with M = 1024*1024: 238475 MBytes
device size with M = 1000*1000: 250059 MBytes (250 GB)
cache/buffer size = 8192 KBytes


dimitar@192.168.0.31:22 - Bitvise xterm - dimitar@xeon-ubuntu: ~
dimitar@xeon-ubuntu:~$ sudo hdparm -I /dev/sdb
/dev/sdb:
ATA device, with non-removable media
Model Number: MKNSSDCR120GB
Serial Number: MKN1210A0000055250
Firmware Revision: 501ABBF0
Transport: Serial, ATA8-AST, SATA 1.0a, SATA II Extensions, SATA Rev 2.5, SATA Rev 2.6, SATA Rev 3.0
Standards:
Used: unknown (minor revision code 0x0110)
Supported: 8 7 6 5
Likely used: 8
Configuration:
Logical max current
cylinders 16383 16383
heads 16 16
sectors/track 63 63
--
CHS current addressable sectors: 16514064
LBA user addressable sectors: 234441648
LBA48 user addressable sectors: 234441648
Logical Sector size: 512 bytes
Physical Sector size: 512 bytes
Logical Sector-0 offset: 0 bytes
device size with M = 1024*1024: 114473 MBytes
device size with M = 1000*1000: 120034 MBytes (120 GB)
cache/buffer size = unknown
Nominal Media Rotation Rate: Solid State Device

dimitar@192.168.0.31:22 - Bitvise xterm - dimitar@xeon-ubuntu: ~

```
dimitar@xeon-ubuntu:~$ sudo hdparm -I /dev/sdc

/dev/sdc:

ATA device, with non-removable media
        Model Number:       OCZ-VERTEX3
        Serial Number:      OCZ-QYVTL4SXQ484P9GT
        Firmware Revision:  2.15
        Transport:          Serial, ATA8-AST, SATA 1.0a, SATA II Extensions, SATA Rev 2.5, SATA Rev
2.6, SATA Rev 3.0
Standards:
        Used: unknown (minor revision code 0x0110)
        Supported: 8 7 6 5
        Likely used: 8
Configuration:
        Logical         max     current
        cylinders       16383   16383
        heads           16      16
        sectors/track   63      63
        --
        CHS current addressable sectors:    16514064
        LBA    user addressable sectors:   234441648
        LBA48  user addressable sectors:   234441648
        Logical  Sector size:                   512 bytes
        Physical Sector size:                   512 bytes
        Logical Sector-0 offset:                  0 bytes
        device size with M = 1024*1024:      114473 MBytes
        device size with M = 1000*1000:      120034 MBytes (120 GB)
        cache/buffer size  = unknown
        Nominal Media Rotation Rate: Solid State Device
```




NVIDIA
M40
Connect to Motherboard Only