The OSU College of Engineering DGX System for Advanced GPU Computing

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OSU's College of Engineering bought six Nvidia DGX-2 systems

Each DGX server:

- Has 16 NVidia Tesla V100 GPUs
- Has 28TB of disk, all SSD
- Has two 24-core Intel Xeon 8168 Platinum 2.7GHz CPUs
- Has 1.5TB of DDR4-2666 System Memory
- Runs the CentOS 7 Linux operating system

Overall compute power:

- Each V100 NVidia Tesla card has 5,120 CUDA Cores and 640 Tensor Cores
- This gives each16-V100 DGX server a total of 81,920 CUDA cores and 10,240 Tensor cores
- This gives the entire 6-DGX package a total of 491,520 CUDA Cores and 61,440 Tensor Cores

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Performance Comparison with one of our previous Systems

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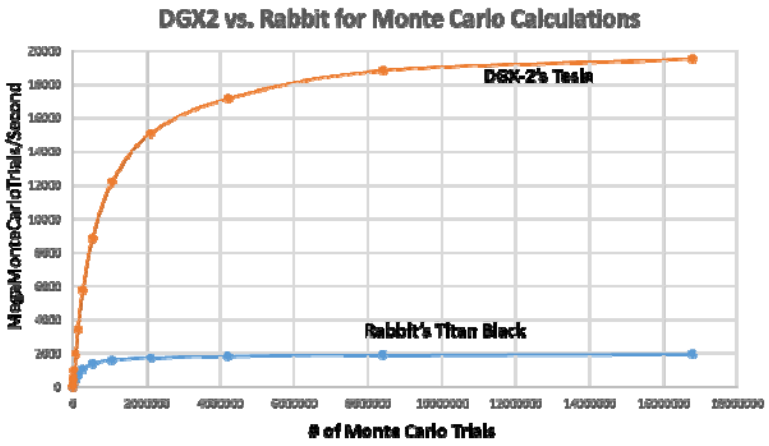

BTW, you can also use the *rabbit* machine:
ssh rabbit.engr.oregonstate.edu
It is a good place to write your code and get it to compile.
It is not a good place to run your code.

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How to SSH to the DGX Systems

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ssh over to a DGX submission machine -- **submit-a** and **submit-b** will also work

flip3 151% ssh submit-c.hpc.engr.oregonstate.edu

submit-c 142% module load slurm

Type this right away to set your path correctly

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How to Check on the DGX Systems

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Check on the queues

```
submit-c 143% squeue
JOBID PARTITION     NAME     USER ST       TIME      NODES NODELIST(REASON)
3923     mime4   c_only jayasurw  R 1-10:32:19          1 compute-e-1
3963     mime4     2Dex jayasurw  R   16:21:03          1 compute-e-2
3876     share CH3COOH_  chukwuk  R 1-23:36:45          1 compute-2-6
3971     nerhp     tcsh  dionnec  R    8:59:45          1 compute-h-8
3881      dgx2     bash     heli  R 1-22:50:44          1 compute-dgx2-1
3965      dgx2     bash  chenju3  R   13:47:36          1 compute-dgx2-4
3645      dgx2     bash mishrash  R 5-16:48:09          1 compute-dgx2-5
3585      dgx2     bash  azieren  R 6-17:34:00          1 compute-dgx2-3
3583      dgx2     bash  azieren  R 6-18:26:44          1 compute-dgx2-3
```

System Information

```
submit-c 144% sinfo
PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST
share*       up 7-00:00:00      2  drain compute-4-[3-4]
share*       up 7-00:00:00      1    mix compute-2-6
sharegpu     up 7-00:00:00      1    mix compute-dgxs-1
sharegpu     up 7-00:00:00      3   idle compute-dgxs-[2-3],compute-gpu
dgx2         up 7-00:00:00      1  drain compute-dgx2-2
dgx2         up 7-00:00:00      5    mix compute-dgx2-[1,3-6]
gpu          up 7-00:00:00      2    mix compute-gpu[3-4]
gpu          up 7-00:00:00      1   idle compute-gpu2
gpu          up 7-00:00:00      1   down compute-gpu1
dgx          up 7-00:00:00      3    mix compute-dgx2-[4-6]
dgxs         up 7-00:00:00      1    mix compute-dgxs-1
dgxs         up 7-00:00:00      2   idle compute-dgxs-[2-3]
class        up    1:00:00      1    mix compute-dgxs-1
class        up    1:00:00      2   idle compute-dgxs-[2-3]
eecs         up 7-00:00:00      1    mix compute-2-6
```

Your partitions

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Submitting a CUDA job to the DGX Systems using Slurm

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Create a shell file

submit.bash:

Note: A single dash (-) is used for a single character flag
A double dash (--) is used for a word (more than a single character) flag

```
#!/bin/bash
#SBATCH  -J  MatrixMult
#SBATCH  -A  cs475-575
#SBATCH  -p  class
#SBATCH  –gres=gpu:1
#SBATCH  -o  matrixmul.out
#SBATCH  -e  matrixmul.err
#SBATCH  --mail-type=BEGIN,END,FAIL
#SBATCH  --mail-user=joeparallel@oregonstate.edu
/usr/local/apps/cuda/cuda-10.1/bin/nvcc -o matrixMul  matrixMul.cu
./matrixMul
```

The Job Name

Your class account

This is the partition name that we use for classes

Double dash

bash code

submit-c 143% sbatch submit.bash
Submitted batch job 474

Submit the job described in your shell file

submit-c 144% cat matrixmul.err

Check the output
(I like sending my output to standard error, not standard output)

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What Showed up in my Email

From	Subject
Slurm workload manager	Slurm Job_id=3980 Name=MatrixMul Ended, Run time 00:00:12, COMPLETED, ExitCode 0
Slurm workload manager	Slurm Job_id=3980 Name=MatrixMul Began, Queued time 00:00:01

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Submitting a Loop

submitloop.bash:

```
#!/bin/bash
#SBATCH  -J  MatrixMul
#SBATCH  -A  cs475-575
#SBATCH  -p  class
#SBATCH  --gres=gpu:1
#SBATCH  -o  matrixmul.out
#SBATCH  -e  matrixmul.err
#SBATCH  --mail-type=BEGIN,END,FAIL
#SBATCH  --mail-user=joeparallel@oregonstate.edu
for t in 1 2 4 8 16 32
do
        /usr/local/apps/cuda/cuda-10.1/bin/nvcc  -DNUMT=$t  -o matrixMul  matrixMul.cu
        ./matrixMul
done
```

bash code

submit-c 153% sbatch submitloop.bash
Submitted batch job 475

submit-c 154% tail –f matrixmul.err

Displays the latest output added to matrixmul.err.
Keeps doing it forever.

Control-c to get out of it.

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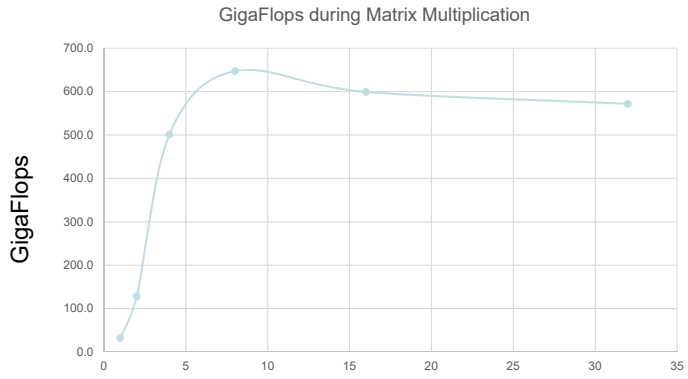
Results for Multiplying two 1024x1024 Matrices



(A CUDA block was actually *NUMTxNUMT* threads)

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Use slurm's *scancel* if your Job Needs to Be Killed

submit-c 163% sbatch submitloop.bash
Submitted batch job 476

submit-c 164% scancel 476

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Submitting an OpenCL job to the DGX Systems using Slurm

submit.bash:

```
#!/bin/bash
#SBATCH  -J  MatrixMult
#SBATCH  -A  cs475-575
#SBATCH  -p  class
#SBATCH  –gres=gpu:1
#SBATCH  -o  printinfo.out
#SBATCH  -e  printinfo.err
#SBATCH  --mail-type=BEGIN,END,FAIL
#SBATCH  --mail-user=joeparallel@oregonstate.edu
g++ -o printinfo printinfo.cpp /usr/local/apps/cuda/cuda-10.1/lib64/libOpenCL.so.1.1 -lm -fopenmp
./printinfo
```

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Here's What *printinfo* Got on the DGX System


```
Number of Platforms = 1
Platform #0:
    Name    = 'NVIDIA CUDA'
    Vendor  = 'NVIDIA Corporation'
    Version = 'OpenCL 1.2 CUDA 10.1.351'
    Profile = 'FULL_PROFILE'
    Number of Devices = 1
    Device #0:
      Type = 0x0004 = CL_DEVICE_TYPE_GPU
      Device Vendor ID = 0x10de (NVIDIA)
      Device Maximum Compute Units = 80
      Device Maximum Work Item Dimensions = 3
      Device Maximum Work Item Sizes = 1024 x 1024 x 64
      Device Maximum Work Group Size = 1024
      Device Maximum Clock Frequency = 1530 MHz

Device Extensions:
cl_khr_global_int32_base_atomics
cl_khr_global_int32_extended_atomics
cl_khr_local_int32_base_atomics
cl_khr_local_int32_extended_atomics
cl_khr_fp64
cl_khr_byte_addressable_store
cl_khr_icd
cl_khr_gl_sharing
cl_nv_compiler_options
cl_nv_device_attribute_query
cl_nv_pragma_unroll
cl_nv_copy_opts
cl_nv_create_buffer
```

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