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The OSU College of Engineering DGX System for Advanced GPU Computing

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OSU's College of Engineering has *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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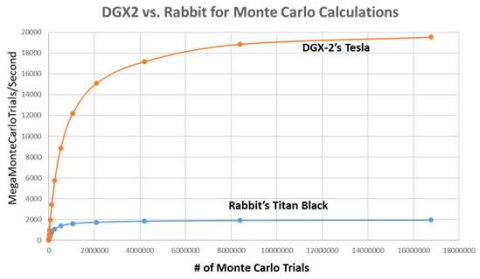
Performance Comparison with one of our other Systems



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 do the final run of your code.

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How to SSH to the DGX Systems

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

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
```

Class partitions

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Submitting a Non-batch Test-CUDA job to the DGX System

Create a bash shell file that looks like this

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

run.bash:

```
#!/bin/bash
/usr/local/apps/cuda/cuda-10.1/bin/nvcc -o montecarlo  montecarlo.cu
./montecarlo
```

These 2 lines are actual bash code

This is the partition name that we use for our class when running ***tests***.

Our class account

Double dash

The bash script

submit-c 166% srun -A cs475-575 -p classgputest --pty bash run.bash
srun: job 976138 queued and waiting for resources
srun: job 976138 has been allocated resources
Number of Trials = 2048, Blocksize = 8, MegaTrials/Second = 58.8235, Probability = 26.92%
submit-c 167%

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Submitting a Batch Final-CUDA job to the DGX System

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Create a bash shell file that looks like this

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

submit.bash:

```
#!/bin/bash
#SBATCH  -J  MonteCarlo
#SBATCH  -A  cs475-575
#SBATCH  -p  classgpufinal
#SBATCH  --constraint=v100
#SBATCH  --gres=gpu:1
#SBATCH  -o  montecarlo.out
#SBATCH  -e  montecarlo.err
#SBATCH  --mail-type=BEGIN,END,FAIL
#SBATCH  --mail-user=joeparallel@oregonstate.edu

/usr/local/apps/cuda/cuda-10.1/bin/nvcc -o montecarlo  montecarlo.cu
./montecarlo
```

Your Job Name

Our class account

This is the partition name that we use for our class when taking your ***final performance numbers***.

Double dash

These 2 lines are actual bash code

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

Submit the job described in your shell file

submit-c 144% cat montecarlo.err

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

What is the Difference Between the Partitions *classgputest* and *classgpufinal*?

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classgputest lets your program get into the system sooner, but it might be running alongside other jobs, so its performance might suffer. But, you don't care because you are just compiling and debugging, not taking performance numbers for your report.

classgpufinal makes your program wait in line until it can get dedicated resources so that you get performance results that are much more representative of what the machine can do, and thus are worthy to be listed in your report.

Auto-Notifications via Email

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```
#SBATCH  --mail-user=joeparallel@oregonstate.edu
```

You don't have to do this, but if you do,
please be sure you get your own email address right!

Our IT people are getting *real* tired of fielding the bounced emails when people spell their own email address wrong.

What Showed up in my Email (which I spelled correctly)

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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

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submitloop.bash:

```
#!/bin/bash
#SBATCH  -J  MonteCarlo
#SBATCH  -A  cs475-575
#SBATCH  -p  classgpufinal
#SBATCH  --constraint=v100
#SBATCH  --gres=gpu:1
#SBATCH  -o  montecarlo.out
#SBATCH  -e  montecarlo.err
#SBATCH  --mail-type=BEGIN,END,FAIL
#SBATCH  --mail-user=joeparallel@oregonstate.edu

for t in 2048 8192 131072 2097152
do
 for b in 8 16 32 64 128 256
 do
   /usr/local/apps/cuda/cuda-10.1/bin/nvcc -DNUMTRIALS=$t -DBLOCKSIZE=$b -o montecarlo  montecarlo.cu
   ./montecarlo
 done
done
```

These 8 lines are actual bash code

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

submit-c 154% tail -f montecarlo.err

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

Control-c to get out of it.

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

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

submit-c 164% scancel 476

Submitting an OpenCL job to the DGX System

submit.bash:

```
#!/bin/bash
#SBATCH  -J  PrintInfo
#SBATCH  -A  cs475-575
#SBATCH  -p  classgpufinal
#SBATCH  --constraint=v100
#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 one graphics card on the DGX System


```
Number of Platforms = 1
Platform #0:
    Name    = 'NVIDIA CUDA'
    Vendor  = 'NVIDIA Corporation'
    Version = OpenCL 1.2 CUDA 11.2.153'
    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
```

For comparison, *rabbit's* graphics card has **15** Compute Units

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