The OSU College of Engineering DGX System for Advanced GPU Computing

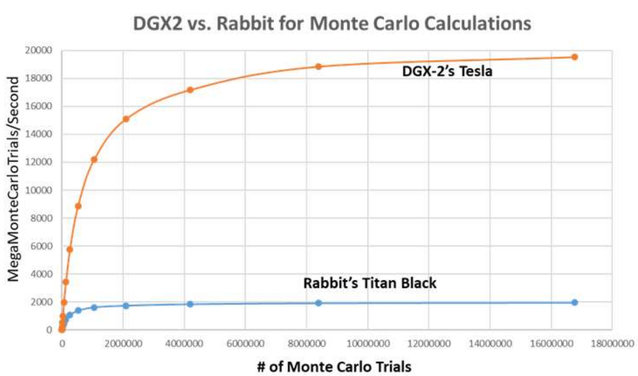
Oregon State University
Mike Bailey
mjb@cs.oregonstate.edu

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

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.

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

How to Check on the DGX Systems

5

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
```

Oregon State University
Computer Graphics

mjb – April 15, 2024

5

Submitting a Batch CUDA job to the DGX System

6

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  classgputest
#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/11.7/bin/nvcc -o montecarlo  montecarlo.cu
./montecarlo
```

Your Job Name (makes it easier to find in the squeue)

Our class account

This is the partition name that we use for our class when ***debugging and testing***.

Double dash

These 2 lines are bash code

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

Submit the job described in your bash file

submit-c 144% cat montecarlo.err

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

Oregon State University
Computer Graphics

mjb – April 15, 2024

6

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

7

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 debugging and testing, 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.

Oregon State University
Computer Graphics

mjb – April 15, 2024

7

Auto-Notifications via Email

8

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

You don't have to ask the system to email information to you, but if you do, *please be sure you get your own email address right*!

Our IT people are getting *really* tired of fielding the bounced emails when people misspell their own email address.

Oregon State University
Computer Graphics

mjb – April 15, 2024

8

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

From	Subject	
Slurm workload manager	Slurm Job_id=3980 Name=MatrixMul Ended, Run time 00:00:12, COMPLETED, ExitCode 0	2
Slurm workload manager	Slurm Job_id=3980 Name=MatrixMul Began, Queued time 00:00:01	1

Oregon State
University
Computer Graphics

Submitting a Loop

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/11.7/bin/nvcc -DNUMTRIALS=$t -DBLOCKSIZE=$b -o montecarlo  montecarlo.cu
   ./montecarlo
 done
done
```

These lines are 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.

Oregon State
University
Computer Graphics

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

Oregon State
University
Computer Graphics

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

module load cuda/10.1
g++ -o printinfo printinfo.cpp /usr/local/apps/cuda/11.7/lib64/libOpenCL.so.1.1 -lm -fopenmp
./printinfo
```

Oregon State
University
Computer Graphics

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

Oregon State University
Computer Graphics