Structure of the Cluster -- Hardware

Head Node – Magic.cse.buffalo.edu

Hardware Profile

- Model – Dell PowerEdge 1950
- CPU - two Dual Core Xeon Processors (5148LV) operating at 2.33GHz
- Memory - 16 GB Memory

Special Notes:

- This is the gateway in to the magic cluster
- This machine does not have a Tesla Co-Processor attached to it. This machine will run CUDA code in emulation mode only.

OS

- Red Hat Enterprise Linux 5.3
Structure of the Cluster -- Hardware

Worker Nodes (ci-xeon-1 – ci-xeon-8)

- Hardware Profile
  - Model - Dell PowerEdge 1950
  - CPU - Dual Core Xeon (X5260) Processor operating at 3.33GHz
  - Memory - 4 GB Memory

- OS
  - Red Hat Enterprise Linux 5.3

- Co-Processor
  - Nvidia Tesla 1070S
Structure of the Cluster -- Hardware

Worker Nodes (ci-xeon-9 – ci-xeon-13)

- **Hardware Profile**
  - Model - Dell PowerEdge 1950
  - CPU - two Quad Core Xeon (E5430) Processors operating at 2.66GHz
  - Memory - 8 GB Memory

- **OS**
  - Red Hat Enterprise Linux 5.3

- **Co-Processor**
  - Nvidia Tesla 1070S
Structure of the Cluster – Tesla GPUs

Tesla 1070S Coprocessor
# Structure of the Cluster – Tesla GPUs

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong># of Tesla GPUs</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong># of Streaming Processor Cores</strong></td>
<td>960 (240 per processor)</td>
</tr>
<tr>
<td><strong>Frequency of processor cores</strong></td>
<td>1.296 to 1.44 GHz</td>
</tr>
<tr>
<td><strong>Single Precision floating point performance (peak)</strong></td>
<td>3.73 to 4.14 TFlops</td>
</tr>
<tr>
<td><strong>Double Precision floating point performance (peak)</strong></td>
<td>311 to 345 GFlops</td>
</tr>
<tr>
<td><strong>Floating Point Precision</strong></td>
<td>IEEE 754 single &amp; double</td>
</tr>
<tr>
<td><strong>Total Dedicated Memory</strong></td>
<td>16 GB</td>
</tr>
<tr>
<td><strong>Memory Interface</strong></td>
<td>512-bit</td>
</tr>
<tr>
<td><strong>Memory Bandwidth</strong></td>
<td>408 GB/sec</td>
</tr>
<tr>
<td><strong>Max Power Consumption</strong></td>
<td>800 W</td>
</tr>
<tr>
<td><strong>System Interface</strong></td>
<td>PCIe x16 or x8</td>
</tr>
</tbody>
</table>
Structure of the Cluster – Tesla GPUs

Each Tesla Coprocessor is connected to a compute node via 2 PCI-X cards.
Structure of the Cluster – Tesla GPUs

Tesla 1070S Coprocessor

References:

http://www.nvidia.com/object/product_Tesla_s1070_us.html

http://www.transtec.co.uk/GB/E/products/personal_computer/supercomputing_pc.html#
Structure of the Cluster – Network

NAT

Magic is the head node with a publicly accessible IP address.

All worker nodes are hidden from the world behind the firewall (magic).

Magic “masquerades” as a worker node when a worker node needs to talk to the internet.

Internet access from the worker nodes should not occur that often.
Structure of the Cluster – Network

- Internet
- CSE Firewall
- Building Switch
- Lab Switch
- Magic (NAT)
- Cluster Switch
- Worker Nodes
- Colosseum (Storage)
Structure of the Cluster – Network

Network

- All network connections are Gigabit Ethernet
- There are two network switches, one is public facing, the other is private facing.
- The only way to hop from the public to the private switch is through the NAT firewall on magic. Magic is duo-homed with a NIC on the public switch and a NIC on the private switch.
- Colosseum also is duo-homed with a NIC on the public switch and a NIC on the private switch but does not have any NAT functionality.
- There is a host-based firewall between the cluster and the outside world. This firewall will drop inbound connections to any machine (internal) from off campus.
- If you wish to access the machine from off campus you can use the UBVPN. This will then allow you to access the machine.
Network

- All Edge switches connect to the UB Backbone through fiber channel 1Gb/s connections. This is in the process of being upgraded to 10 Gb/s connections.
- The firewall between the Building Edge switch is currently 100Mb/s. This is due to be upgraded during the winter break.
- UB’s backbone connects to the internet through the NYSERNet ISP Across 2 router links.
- Speed to the internet has been clock at 6.50 Mb/S
The Storage Server is colosseum.cse.buffalo.edu.

You should only log in to this machine to transfer large data sets via SCP, SFTP, or Windows File Sharing (available on campus only).

- Programs such as filezilla or winSCP should be used to move large data sets.

All storage space on this machine is exported to every machine in the cluster via NFS.

File Systems

- /shared-space is an area for software installation shared across all worker nodes.
- /scratch is a read/write area for temporary files shared across all worker nodes. Files will be purged after 1 week.
- /home is where user home directories reside. Quota space is 15 Gb per user.
- /projects is an area for all Cyber Infrastructure specific storage.
## Structure of the Cluster – Storage

<table>
<thead>
<tr>
<th>Filesystem</th>
<th>Size</th>
<th>Used</th>
<th>Avail</th>
<th>Use%</th>
<th>Mounted on</th>
</tr>
</thead>
<tbody>
<tr>
<td>colosseum:/projects</td>
<td>7.9T</td>
<td>175M</td>
<td>7.5T</td>
<td>1%</td>
<td>/projects</td>
</tr>
<tr>
<td>colosseum:/scratch</td>
<td>2.9T</td>
<td>405M</td>
<td>2.8T</td>
<td>1%</td>
<td>/scratch</td>
</tr>
<tr>
<td>magic:/home</td>
<td>262G</td>
<td>16G</td>
<td>233G</td>
<td>7%</td>
<td>/home</td>
</tr>
<tr>
<td>magic:/shared-space</td>
<td>262G</td>
<td>16G</td>
<td>233G</td>
<td>7%</td>
<td>/shared-space</td>
</tr>
</tbody>
</table>
All 13 nodes, head node, storage node, and disk shelves are on uninterruptable power supplies. These 3 power supplies will tolerate around 10 minutes of power failure before nodes shut down.

The Tesla units are on wall power. If the power fails in Furnas hall the Tesla units will shut down!
Tools -- CUDA

NVIDIA’s CUDA development tools consist of three key components to help you get started:

- The latest CUDA driver – installed on all machines
- A complete CUDA toolkit
  - NVCC C compiler
    - Found at /usr/local/cuda/bin on each machine.
  - CUDA FFT and BLAS libraries for the GPU
  - Profiler
  - gdb debugger for the GPU
  - CUDA runtime driver (also available in the standard NVIDIA GPU driver)
- CUDA programming manual

http://www.nvidia.com/object/Tesla_software.html
http://www.nvidia.com/object/cuda_learn.html
NVIDIA’s CUDA development tools consist of three key components to help you get started:

- **Developer SDK**
  - examples with source code
  - Built-in to /shared-space/CUDA-SDK on all machines
Tools – Languages and Compiles

- Fortran
- C++
- Java
**Accessing the Cluster**

**SSH to magic.cse.buffalo.edu**

- Windows -- use the Putty program available on the UBIT website.
  - [http://ubit.buffalo.edu/software/win/putty.php](http://ubit.buffalo.edu/software/win/putty.php)
- Mac/Linux – use your built-in SSH client
  - `ssh Username@magic.cse.buffalo.edu`
- If you are off campus be sure to be using the UBVPN client
  - [http://ubit.buffalo.edu/software/](http://ubit.buffalo.edu/software/)
If you need a graphical connection

- **Windows** -- use the xwin32 program available on the UBIT website.
  - [http://ubit.buffalo.edu/software/win/XWin32/](http://ubit.buffalo.edu/software/win/XWin32/)

- **Mac/Linux** – use your built-in SSH client
  - `ssh -X Username@magic.cse.buffalo.edu`

**Note:** Be careful what you do graphically! Encrypting a graphics tunnel is expensive to the network bandwidth. Consider if you really need to run something graphically.
The Queuing System

Nodes should be access using the batch system, torque.

The advantage of the queuing system is that you will be placed on a node with the greatest amount of available resources. At any given time users from the grid, or other researchers could be running jobs.

An interactive session can be started by entering “qsub –I”.

Use the following reference for instructions on interacting with the queuing system.

Accessing the Cluster

You MUST properly configure your ssh keys before using Torque. To do so execute:

- `ssh-keygen -t rsa` (select all defaults, including blank password)
- `cp ~/.ssh/id_rsa.pub ~/.ssh/authorized_keys`
- Copy the `/local/torque/dot-rhosts` to `~/.rhosts`
Accounts

Accounts will be created based on your UBIT name and your CSE password.

Accounts on this cluster are managed separately from UBIT and CSE machines. Onetime password synchronization will occur between your CSE account and your account on magic. From then on, password changes from UBIT or CSE will propagate to magic.

You username and password are the same on every node of the cluster.
Contact Information

kpcleary@cse.buffalo.edu
  For quick questions

OR

Cse-consult@cse.buffalo.edu