GPU Cluster Usage Tutorial

--How to make caffe and enjoy tensorflow on Torque

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PBS and Torque

- PBS: **P**ortable **B**atch **S**ystem, computer software that performs job scheduling
- versions of PBS
    i. OpenPBS: original open source version
    ii. Torque: A fork of OpenPBS
    iii. PBS Pro: the commercial version of PBS
- Torque: **T**erascale **O**pen-source **R**esource and **QUE**ue Manager, a distributed resource manager providing control over batch jobs and distributed compute nodes
- All commands of Torque are compatible with PBS

Basic info about cluster

- Head node: 192.168.17.240, 8 cores
- GPU cluster: 192.168.6.[101-107], aliased as Gpu101-Gpu107, 32 cores on each node. We can only access Gpu107
- Shared data disks and home dir

```
[yunfeng@torqueServer ~]$ lsb_release -a # Check distro info
LSB Version:    :core-4.0-amd64:core-4.0-noarch:graphics-4.0-am
Distributor ID: CentOS
Description:    CentOS release 6.3 (Final)
Release:        6.3
Codename:       Final
[yunfeng@torqueServer ~]$ cat /proc/cpuinfo #Get num of CPU
```

Cluster types

```
GPU used detail:
          0  1   |  2  3  4  5  6  7
GPU101: [x][x] | [x][x]
GPU102: [x][x] | [x][x]
GPU103: [x][x] | [x][x][x][x][x][x]
GPU104: [x][x] | [x][x][x][x][x][x]
GPU105: [x][x] | [x][x][x][x][x][x]
GPU106: [x][x] | [x][x][x][x][x][x]
GPU107: [x][x] | [x][x][x][x][x][x]

Type S:{Gpu101,Gpu102};D:{Gpu103,Gpu104};M:{Gpu105,Gpu106,Gpu10
```

Workflow of run job in Torque

- First login to head node, then debug on Gpu107
- Since everything is OK, write the script and send your task to queue
- Wait
- Check your results and errors

Login to cluster

Register an account

You need a ssh client, which has been included in XShell, cgywin and Linux.

```
$MY-PC ssh yunfeng@192.168.17.240
Last login: Fri Nov 11 10:38:16 2016 from 192.168.102.198
[yunfeng@torqueServer ~]$ df -h
Filesystem            Size  Used Avail Use% Mounted on
/dev/sdb1             985G  393G  543G  42% /home
/dev/sdc1             1.8T  865G  868G  50% /data
/dev/sdd1             8.1T  7.3T  415G  95% /data0
192.168.6.103:/data3  1.4T  679G  718G  49% /data3
192.168.6.104:/data4  1.4T  1.1T  314G  78% /data4
192.168.6.105:/data5  1.4T  552G  845G  40% /data5
192.168.6.106:/data6  1.4T  1.3T  102G  93% /data6
192.168.6.107:/data7  1.4T  1.4T   13G 100% /data7
192.168.6.101:/data1  1.3T  770G  561G  58% /data1
192.168.6.102:/data2  1.3T  447G  883G  34% /data2
```

tips: SSH without password

```
$ ssh-keygen #Simply type enter all the way down
$ ssh-copy-id -i yunfeng@192.168.17.240 # Enter password
$ ssh yunfeng@192.168.17.240 #No password needed since now!
```

tips: Use aliases to speed up workflow

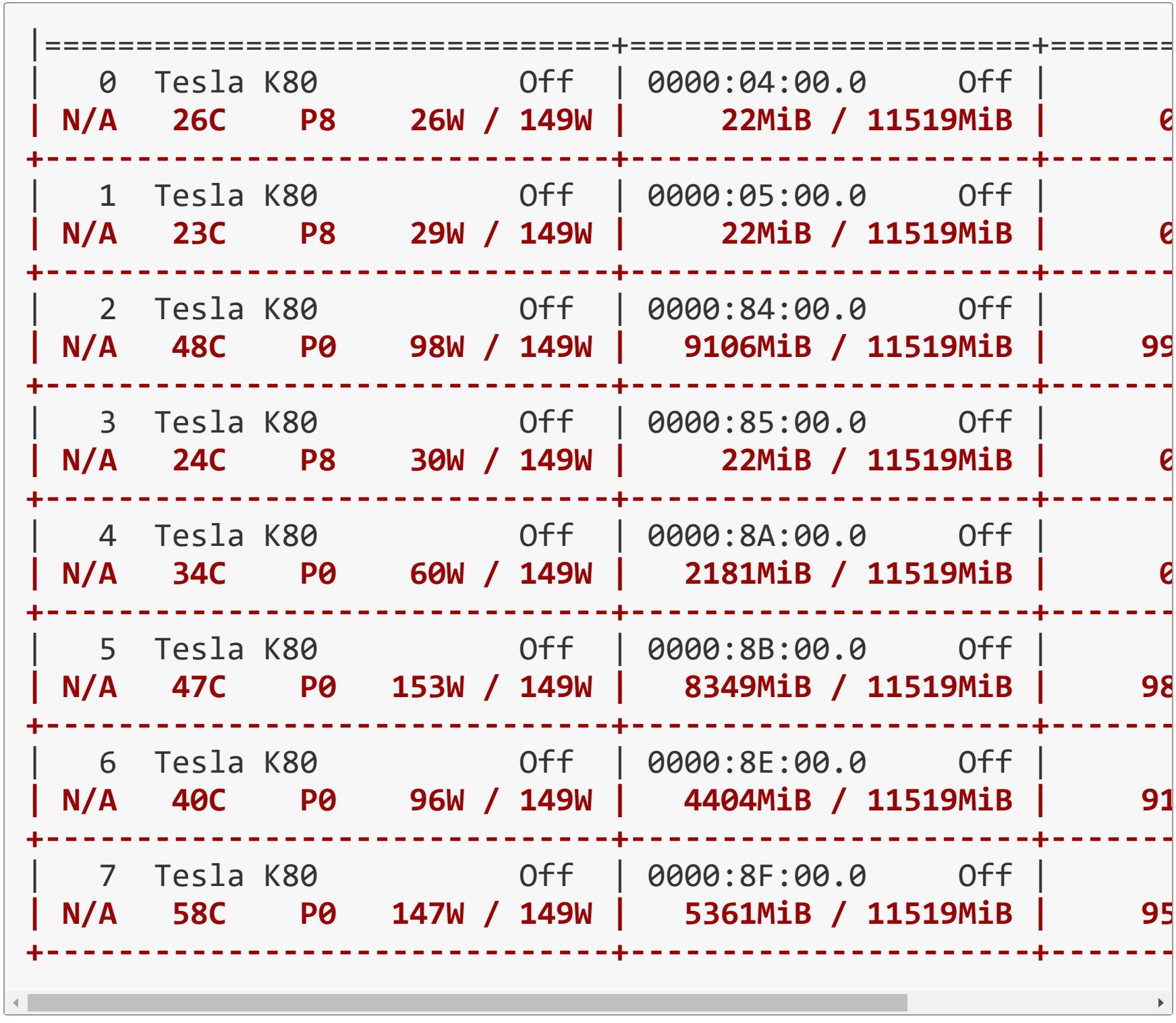
```
$ echo "alias ssh240='ssh yunfeng@192.168.17.240'" >> ~/.bashrc
$ source ~/.bashrc
$ ssh240 # Same as 'ssh yunfeng@192.168.17.240'
```

tips: Some utilities to improve your shell experience

1. oh-my-zsh
2. tmux
3. ipython

Login to Gpu107 to debug your Caffe

```
[yunfeng@torqueServer ~]$ ssh Gpu107
Last login: Fri Nov 11 11:02:43 2016 from torqueserver
[yunfeng@Gpu107 ~]$ nvidia-smi
```


|===============================+======================+=======
| 0 Tesla K80   Off | 0000:04:00.0   Off |
| N/A   26C   P8   26W / 149W | 22MiB / 11519MiB | 0
+-------------------------------+----------------------+-------
| 1 Tesla K80   Off | 0000:05:00.0   Off |
| N/A   23C   P8   29W / 149W | 22MiB / 11519MiB | 0
+-------------------------------+----------------------+-------
| 2 Tesla K80   Off | 0000:84:00.0   Off |
| N/A   48C   P0   98W / 149W | 9106MiB / 11519MiB | 99
+-------------------------------+----------------------+-------
| 3 Tesla K80   Off | 0000:85:00.0   Off |
| N/A   24C   P8   30W / 149W | 22MiB / 11519MiB | 0
+-------------------------------+----------------------+-------
| 4 Tesla K80   Off | 0000:8A:00.0   Off |
| N/A   34C   P0   60W / 149W | 2181MiB / 11519MiB | 0
+-------------------------------+----------------------+-------
| 5 Tesla K80   Off | 0000:8B:00.0   Off |
| N/A   47C   P0   153W / 149W | 8349MiB / 11519MiB | 98
+-------------------------------+----------------------+-------
| 6 Tesla K80   Off | 0000:8E:00.0   Off |
| N/A   40C   P0   96W / 149W | 4404MiB / 11519MiB | 91
+-------------------------------+----------------------+-------
| 7 Tesla K80   Off | 0000:8F:00.0   Off |
| N/A   58C   P0   147W / 149W | 5361MiB / 11519MiB | 95
+-------------------------------+----------------------+-------

1. Copy compiled caffe to your dir

```
[yunfeng@Gpu107 ~]$ mkdir /data2/yunfeng
[yunfeng@Gpu107 ~]$ cd /data2/yunfeng
[yunfeng@Gpu107 ~]$ cp -r /opt/caffe-master .
[yunfeng@Gpu107 ~]$ mv caffe-master caffe
```

2. Write shell script to run your job

```
# /home/yunfeng/run_mnist.sh Example script of running mnist
cd /data2/yunfeng/caffe
./data/mnist/get_mnist.sh
./examples/mnist/create_mnist.sh
./examples/mnist/train_lenet.sh
```

3. Debug and check everything is OK

```
[yunfeng@Gpu107 ~]$ cd ~
[yunfeng@Gpu107 ~]$ chmod +x run_mnist.sh
[yunfeng@Gpu107 ~]$ ./run_mnist.sh
```

Submit your job to queue

1. go to head node, write pbs script

```
# /home/yunfeng/run_mnist.pbs configuration file of your job
#PBS -N run_mnist  #Name of your job
#PBS -o /home/yunfeng/run_mnist.out #the file stdout will writ
#PBS -e /home/yunfeng/run_mnist.err #the file stderr will writ
#PBS -l nodes=1:gpus=1:S #cluster type to use
#PBS -r y #run the job immediately or not

## Put out debug info,don't modify this part
cd $PBS_O_WORKDIR
echo Time is `date`
echo Directory is $PWD
echo This job runs on following nodes:
cat $PBS_NODEFILE

## The name of script to run main job
./run_mnist.sh
```

2. Submit job and check status

```
[yunfeng@torqueServer ~]$ qsub run_mnist.pbs # Send job to queu
[yunfeng@torqueServer ~]$ chk_gpu # Check the status of your jo
```

```
yunfeng@torqueServer:~
[yunfeng@torqueServer ~]$ vi run_mnist.pbs
[yunfeng@torqueServer ~]$ chk_gpu

Jobid   User       JobName              Req_parm        Start_time          S Run_time   Alloc_GPUS

4126    liuyj      conv1_0.004_96       1:gpus=2:D      20161028 22:43:28   R 283:21:39  Gpu103-gpu/3/2
4179    liuyj      myjob1               1:gpus=2:D      20161101 22:36:09   R 236:00:29  Gpu103-gpu/5/4
4240    liuyj      conv1_hard           1:gpus=2:M      20161105 11:23:04   R 151:25:14  Gpu107-gpu/7/6
4299    zhangyh    T_Step_B             1:gpus=2:M      20161107 22:03:25   R 80:11:25   Gpu107-gpu/3/2
4314    huangjl    lstm_train           1:gpus=2:M      20161108 10:31:20   R 80:16:31   Gpu105-gpu/1/0
4316    yann       IFCNN_Q22            1:gpus=1:S      20161108 10:38:51   R 76:51:11   Gpu102-gpu/1
4324    fw092      caffe_train_dog_rand 1:gpus=2:D      20161108 20:34:40   R 70:13:49   Gpu103-gpu/1/0
4340    yann       IFCNN_end2end_Q32    1:gpus=2:D      20161109 10:33:47   R 31:41:36   Gpu104-gpu/5/4
4345    liuyj      conv1_hard           1:gpus=1:S      20161109 17:21:15   R 49:27:14   Gpu102-gpu/2
4346    liuyj      conv1_hard           1:gpus=1:S      20161109 17:23:27   R 49:25:01   Gpu102-gpu/0
4348    fanhz      net2_13              1:gpus=2:D      20161109 23:15:39   R 28:44:13   Gpu104-gpu/1/0
4351    huangjl    lstm_train01         1:gpus=2:M      20161110 10:18:12   R 32:30:06   Gpu107-gpu/5/4
4357    zenglh     zenglhjob2           1:gpus=1:S      20161110 18:05:59   R 24:42:26   Gpu101-gpu/0
4358    zenglh     zenglhjob3           1:gpus=1:S      20161110 18:19:23   R 24:29:03   Gpu101-gpu/1
4361    fengxy     test_lr              1:gpus=6:M      20161110 21:25:25   R 21:22:26   Gpu105-gpu/7/6/5/4/3/2
4362    yangjw     lrelu_alexnet_01     1:gpus=2:D      20161110 21:27:43   R 21:20:34   Gpu104-gpu/3/2
4363    fanhz      net2_14              1:gpus=2:D      20161110 21:43:07   R 14:19:37   Gpu104-gpu/7/6
4367    fanhz      net2_15              1:gpus=2:D      20161110 21:54:01   R 05:20:56   Gpu103-gpu/7/6
4397    liyao      Barc-29              1:gpus=1:S      20161111 15:05:08   R 03:43:17   Gpu101-gpu/3
4398    liyao      Barc-33              1:gpus=1:S      20161111 15:05:12   R 03:43:16   Gpu102-gpu/3
4399    housh      jointvegfru_vggcp    1:gpus=2:M      20161111 15:08:10   R 03:40:05   Gpu106-gpu/1/0
4401    yangjw     elu_alexnet          1:gpus=4:M      20161111 15:11:29   R 03:36:46   Gpu106-gpu/5/4/3/2
4406    housh      jointvegfru_vggcpv2  1:gpus=2:M      20161111 15:24:03   R 03:24:12   Gpu106-gpu/7/6
4408    housh      jointaircrafts_vggcp 1:gpus=2:M      20161111 15:29:34   R 03:18:44   Gpu107-gpu/1/0
4411    sunshy     train_idx            1:gpus=1:S      20161111 15:48:50   R 02:59:36   Gpu101-gpu/2
4412    yann       IFCNN_ph22_Q32       1:gpus=1:S      20161111 16:30:11   Q
4413    yann       IFCNN_ph22_Q37       1:gpus=1:S      20161111 16:30:20   Q
4415    liux       train_ucf            1:gpus=1:S      20161111 17:51:36   Q

GPU used detail:
         0  1  |  2  3  4  5  6  7
GPU101: [x][x] | [x][x]
GPU102: [x][x] | [x][x]
GPU103: [x][x] | [x][x][x][x][x][x]
GPU104: [x][x] | [x][x][x][x][x][x]
GPU105: [x][x] | [x][x][x][x][x][x]
GPU106: [x][x] | [x][x][x][x][x][x]
GPU107: [x][x] | [x][x][x][x][x][x]

Type S:{Gpu101,Gpu102}; D:{Gpu103,Gpu104}; M:{Gpu105,Gpu106,Gpu107}

Total 28 jobs.
```

Other useful pbs commands

```
[yunfeng@torqueServer ~]$ qstat # Show status of pbs jobs
[yunfeng@torqueServer ~]$ qhold job_id # Hold pbs jobs
[yunfeng@torqueServer ~]$ qrls job_id #Release hold of jobs
[yunfeng@torqueServer ~]$ qdel job_id # Delete job
[yunfeng@torqueServer ~]$ pbsnodes # Show staus of nodes
```

Compile caffe from scratch

```
$ ssh Gpu107
$ cd /data2/yunfeng/Lab
$ git clone https://github.com/BVLC/caffe.git
$ cd caffe
$ cp Makefile.config.example Makefile.config
```

Edit `Makefile.config`, change these lines:

```
5  USE_CUDNN := 1
21 OPENCV_VERSION := 3
51 BLAS_LIB := /usr/lib64/atlas
79 PYTHON_LIB := /usr/lib64
```

Then save `Makefile.config`, run commands:

```
$ make all -j32
$ make test -j32
$ make runtest -j32
```

How to run Tensorflow on Cluster?

1. Use system tensorflow (version:0.10.0)

```
[yunfeng@Gpu107 ~]$ ipython
Python 2.7.5 (default, Nov 20 2015, 02:00:19)
Type "copyright", "credits" or "license" for more information

In [1]: import tensorflow as tf

In [2]: tf.__version__
Out[2]: '0.10.0'
```

2. Or install lastest version of tensorflow for yourself

```
$ export TF_BINARY_URL=https://storage.googleapis.com/tensorflo
$ pip install --user --upgrade $TF_BINARY_URL
```

3. Write your command in shell script and then submit it, just like the example above

How to prepare data for my experiment?

1. Use `scp` to copy your data to cluster

```
$ scp -r my_data/ yunfeng@192.168.17.240:/data2/yunfeng/
```

2. Since data disks are shared, you can then use your data in code

```
# example.py
data_dir = '/data2/yunfeng/my_data'
result = my_func(data_dir)
```

How to check logs of my job

Normally, we can only see log when job finished. However,we can

1. Use `>>` or `tee` to

```
# run_mnist.sh
...
./examples/mnist/train_lenet.sh >> my_mnist_log
```

```
# run_mnist.sh
...
#Please check the manual of tee to fully use it.
./examples/mnist/train_lenet.sh | tee my_mnist_log
```

2. Use tensorflows' tensorboard to check the result

```
$ tensorboard --logdir=path/to/log-directory
```

Docs location

192.168.6.232:/data2/public/torque_tutorial

Q&A