TSUBAME2.5 Supercomputer Short Guidance

This is a simplified version of material by GSIC

History of TSUBAME

2006
TSUBAME 1.0
85TFlops/1.1PB

No.1 system in asia

2007
TSUBAME 1.1
100TFlops/1.6PB

Storage/accelerators are added

2008
TSUBAME 1.2
160TFlops/1.6PB

GPU accelerators are added

Nov 2010
TSUBAME 2.0
2.4PFlops/7.1PB
30x Performance over TSUBAME1.0

GPUs are upgraded

Sep 2013
TSUBAME 2.5
5.7PFlops/7.1PB

Aug 2017
TSUBAME 3.0
12PFlops / 15.9PB

.....

Information on TSUBAME

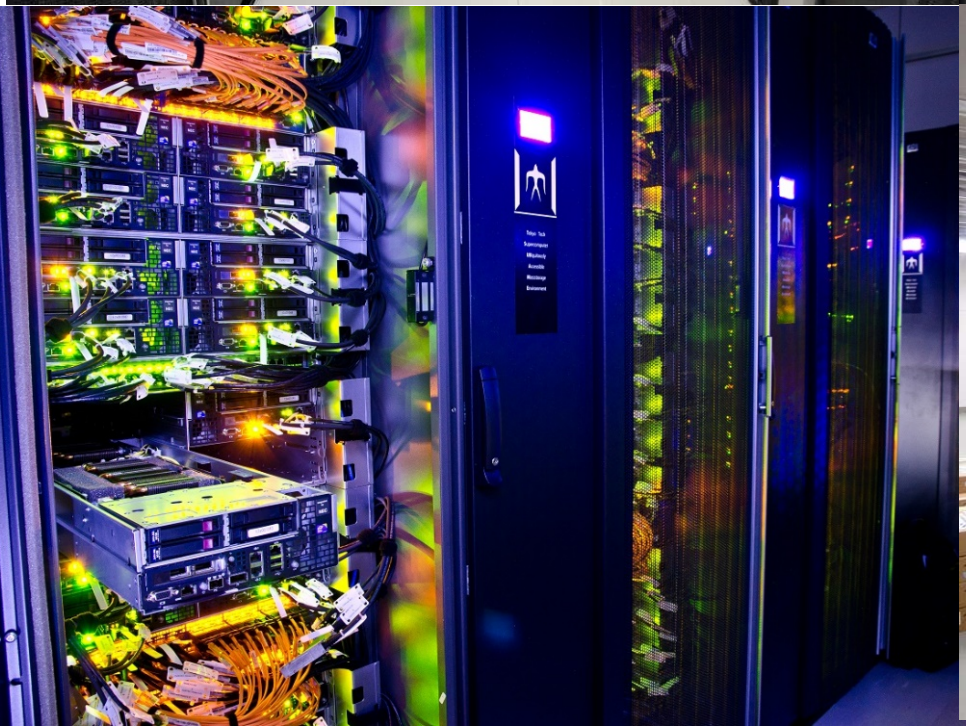
- http://tsubame.gsic.titech.ac.jp
  - Manual
  - FAQ
  - Statistics (node usage etc.)
  - Maintenance schedule
- TSUBAME query ML:
  - soudan@cc.titech.ac.jp

Features of TSUBAME2.5 (1)

- High computation performance of 5.7PFlops
  - Total CPUs: 0.2PFlops
  - Total GPUs: 5.5PFlops
- Large storage capacity of 7.1PByte
- High speed network
  - 80Gbps per node
  - 200Tbps bisection bandwidth

Features of TSUBAME2.5 (2)

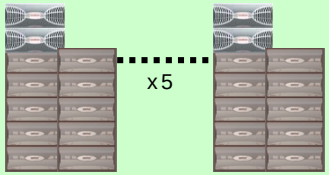
- Easy to use with commodity technologies
  - Intel CPUs + Linux OS
  - Commodity software work on TSUBAME
  - Lots of parallel programming environments
    - MPI, OpenMP, CUDA, OpenACC…



System Overview of The TSUBAME2.5 Supercomputer

Petascale HDD Storage: Total 7.2PB (Lustre+ home)

Parallel FS Partition 6.0PB



Storage
DDN SFA10000 x5
(10 enclosure x5)
Storage Server
HP DL360 G6/G8 x26nodes
HP DL380 G6 x4nodes
File Sytem
Lustre 3.6PB, GPFS 2.4PB

Storage Servers x30

Home Partition 1.2PB

Storage
DDN SFA10000 x1
10 enclosure x1)
Storage Server
HP DL380 G6 x4nodes
BlueArc Mercury 100 x2
File System
NFS, CIFS, iSCSI

NFS,CIFS servers x4 NFS,CIFS,iSCSI x2

HPCI storage 0.6PB

Storage
DDN SFA12000
(5 enclosure)
File Sytem
GFarm

StorageTek
SL8500
Tape System
~8PB

Node Interconnect: Optical, Full Bisection, Non-Blocking, Dual-Rail QDR InfiniBand

Core Switch

Voltaire Grid Director 4700 12switches
IB QDR: 324port

Edge Switch

Voltaire
Grid Director 4036 179switches
IB QDR : 36 port

Edge Switch (with 10GbE port)

Voltaire
Grid Director 4036E 6 switches
IB QDR:34port
10GbE: 2port

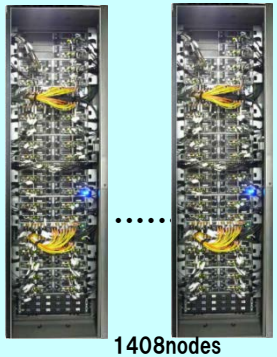
Titenet3

Mgmt Servers

SINET5

Compute Nodes: 5.76PFLOPS (CPU+GPU), 225TFLOPS (CPU), ~120TB memory, >200TB SSD

Thin Nodes



1408nodes

30node x 42MCS racks, others 148nodes

HP Proliant SL390s G7 1408nodes
CPU Intel Westmere-EP X5670 2.93GHz
(Turbo boost 3.2GHz) 12Core/node
Mem: 58GB (54GiB) x1367nodes
103GB (96GiB) x41nodes
GPU NVIDIA Tesla K20X 1.31TFlops,3GPU/node
SSD 60GB x 2 120GB ※54GiB node
120GB x 2 240GB ※96GiB node
OS: SUSE Linux Enterprise / Windows HPC Server

CPU Total Speed: 216TFLOPS (w/Turbo boost)

Total Speed: 5750TFLOPS

Memory Total:83.5TB (CPU) + 27.2TB (GPU)

SSD Total:173.9TB

Medium Nodes

HP DL580 G7 24nodes
CPU Intel Nehalem-EX 2.0GHz
32Core/node
Mem:137GB (128GiB)
SSD 120GB x 4 480GB
OS: Suse Linux Enterprise Server

CPU Total Speed: 6.14TFLOPS

Fat Nodes

HP DL580 G7 10nodes
CPU Intel Nehalem-EX 2.0GHz
32Core/node
Mem:274GB (256GiB) x8nodes
548GB (512GiB) x2nodes
SSD 120GB x 4 480GB
OS: Suse Linux Enterprise Server

CPU Total Speed: 2.56TFLOPS

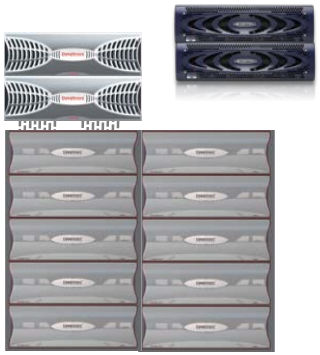
Compute Nodes

- There are (mainly) 1408 compute nodes

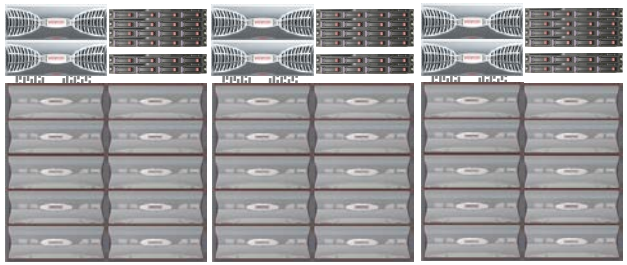
  HP Proliant SL390s G7

  – CPU: Intel Xeon 2.93GHz 6 cores × 2=12 cores
    - With Hyperthreading, 24 hyperthreads
  – GPU: NVIDIA Tesla K20X 3GPU
  – Memory: 54GB (some has 96GB)
  – SSD: 120GB (some has 240GB)
  – Network: QDR InfiniBand x 2 = 80Gbps

TSUBAME2.5 Shared Storage



- Home directory (/home)
  - Every user can use up to 25GB



- Parallel filesystem (/work0, /work1)
  - “TSUBAME group” need to buy use rights

First Access to TSUBAME2.5

- Application for new account
  - Login to Tokyo Tech Portal → “TSUBAME Portal” → Application

    Tokyo Tech Portal : http://portal.titech.ac.jp
  - Temporary password will be informed by e-mail, and then change it to real password in TSUBAME portal

- Login to TSUBAME
  - Connect to “login-t2.g.gsic.titech.ac.jp” by SSH protocol
  - From inside of campus, public key and password are OK
  - From outside of campus, public key is OK, password is NG

System Software

OS	SUSE Linux Enterprise Server 11 SP3
Job Scheduler	PBS Professional

Compiler	Intel Compiler, PGI CDK, gcc 4.3.4
MPI	OpenMPI, MVAPICH2
GPGPU	CUDA

- You can switch compilers by environment variables
  - See manuals in TSUBAME web
- Software versions may be upgraded in maintenance

Illustration of TSUBAME Usage

(1) SSH

login-t2.g.gsic.titech.ac.jp

(2) You are connected to one of “interactive” nodes. You can edit/compile your programs

(3) Throw jobs via the job scheduler

>1000 Compute nodes

Login to TSUBAME2

- From Linux, Mac
  - ssh login-t2.g.gsic.titech.ac.jp
- From terminals in Windows (putty, ttssh, etc.)
  - Host : login-t2.g.gsic.titech.ac.jp
  - Protocol : SSH
    - Port: 22
- Input your account name and password

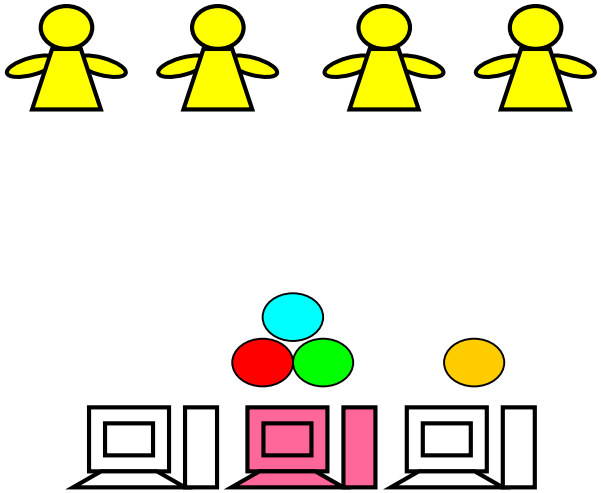
→ If you see a prompt like below, your login is successful

10B12345@t2a006163:>

What is Job Scheduler?

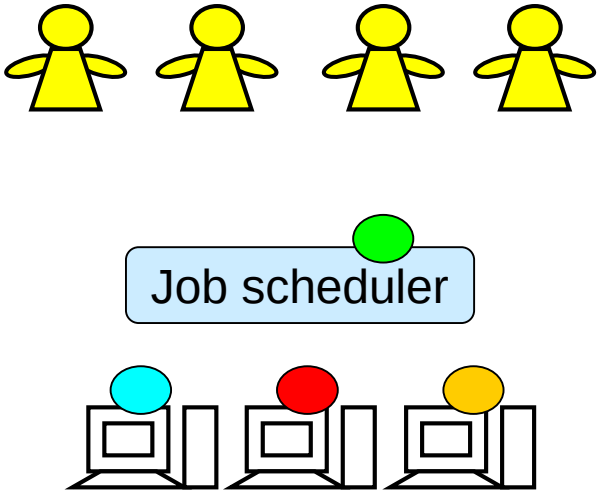
- You have to use the job scheduler (PBSPro on TSUBAME2), when you execute programs for a long time (such as >10minutes)
- The job scheduler does “traffic control” of many programs by many users

Without scheduler



If users execute programs without control, there will be congestions

With scheduler



Scheduler determines nodes for each job.
Some program executions may be “queued”

Using Job Scheduler
Basics of t2sub command

- You are going to execute your program named “myprog”

(1) Please make a script file on the same directory (In this example, the script name is “job.sh”)

Contents of job.sh file

```
#!/bin/sh
cd $PBS_O_WORKDIR
./myprog
```

(2) Make the script “executable” by `chmod u+x job.sh` once

(3) Throw a new job with t2sub command

```
t2sub –q S –W group_list=xxx ./job.sh
```

-q xxx: Specify queue name (refer to manuals)

-W group_list=xxx: TSUBAME group name (consult to your instructor)

Using Job Scheduler
Basics of t2sub command (cont'd)

(4) You will see the following messages (If not, something is wrong)

```
Checking accounting informations...
      :
Submitting a job to PBS...
12345.t2zpbs01
```

This is ID of your jobs

(5) Wait until job execution is finished

(6) You will see new files, whose names are look like

- OTHERS.o12345
- OTHERS.e12345

Depend on the job ID

The output by myprog has been stored in the files

Using Job Scheduler for Thread (OpenMP) Programs

(1) You are going to execute a program, myprog

job.sh file

```
#!/bin/sh
cd $PBS_O_WORKDIR
export OMP_NUM_THREADS=8
./myprog
```

(3) Throw a job with t2sub

```
t2sub –q S –W group_list=xxx –l ncpus=8 ./job.sh
```

- myprog will be executed with 8 threads on a single node

Using Job Scheduler for MPI Programs

(1)Here you are going to execute a MPI program, myprog

job.sh file

```
#!/bin/sh
cd $PBS_O_WORKDIR
mpirun –n [number-of-processes] –hostfile $PBS_NODEFILE ./myprog
```

(3) Throw a job with t2sub

```
t2sub –q S –W group_list=xxx –l select=10:mpiprocs=12 ¥
        -l place=scatter ./job.sh
```

- In this case, 10 nodes are allocated, and 12 processes per node are invoked. Number-of-process is 10x12 = 120

Other Options of t2sub

- -l walltime=10:00:00

Maximum execution time of the job. Default is 1hour

- -l select=～～:mem=40gb

Maximum memory size used by the job (per node). Default is 1GB

- -o /xxx/yyy.txt

Output file name for “stdout”

- -e /xxx/yyy.txt

Output file name for “stderr”

Fore more detail, “t2sub –h” and manuals on web will be helpful

Other Commands related to Job Scheduler

- t2stat

  See status of jobs. In default, your own jobs are listed

  cf) t2stat –all: See jobs by all users

- t2del

  Delete your job before it finishes

  cf) t2del 12345.t2zpbs01

Rules in TSUBAME Usage

- On interactive nodes, do not execute long running (and CPU centric) programs
  - You can execute editors (vi, emacs, etc.) or visualization tools longer than 10 minutes, since they do not consume CPUs much
  - With long CPU centric programs, you should use job scheduler
- Use the account of yourself. Do NOT lend/borrow accounts.