

**Introduction to High Performance Computing**  
**Term 2014/2015 (Winter)**

## **Exercise 11**

- **Return electronically until Tuesday, 26.01.2014 23:55 Uhr**
- **Include name on the top sheet. Stich several sheets together.**
- **A maximum of two students is allowed to work jointly on the exercises.**

### **Notes:**

- Our High-Octane cluster is available for you to run your programs on EXTOLL (R2)!
- Please use slurm to launch any experiments! Don't disturb any running jobs!
- You can select between EXTOLL or Gigabit Ethernet.

To get on the cluster you have to login to the headnode *htx02* (from door). And than on the headnode of High-Octane *octane* (from *htx02*).

For using Gigabit Ethernet write a script to use Slurm (for more info on slurm reed the SLURM HOW-TO from 4. November).

It should look like the following:

```
#!/usr/bin/env bash

#Redirect all output to this file
#SBATCH -o output.out
#Number of nodes requested
#SBATCH -N 4
#Number of tasks per node
#SBATCH --ntasks-per-node=1

mpirun YOURPROGRAMM
```

To start the script use:

```
sbatch <script>
```

Other usefull commands:

```
sinfo #shows status of the nodes
squeue #shows job queue
```

Insert following lines into your *.bashrc* file (located in your home directory) to use EXTOLL:

```
if [ -d /extoll2 ]; then
    export EXTOLL_R2_HOME=/extoll2
    source /extoll2/extoll_env.bash
    ulimit -l 4194304
    ulimit -s unlimited
fi
```

Now your script should look like:

```
#!/usr/bin/env bash

#Redirect all output to this file
#SBATCH -o output.out
#Number of nodes requested
#SBATCH -N 4
#Number of tasks per node
#SBATCH --ntasks-per-node=1

extoll2/mpi/openmpi-1.6.4/bin/mpirun YOURPROGRAMM
```

The current configuration of EXTOLL is a 3D torus, as can be seen when logging in to *octane*.

This is an experimental system! Please only work according to this documentation and be aware of sudden outages.

### 11.1 Readings

Read the following two papers and provide reviews as explained in the first lecture (see slides):

- Holger Fröning, Mondrian Nüssle, Heiner Litz, Christian Leber and Ulrich Brüning. 2013. On Achieving High Message Rates. In *Proceedings of 13th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (CCGrid)*, May 13-16, 2013, Delft, The Netherlands.
- Lena Oden and Holger Fröning. 2013. GGAS: Global GPU Address Spaces for Efficient Communication in Heterogeneous Clusters. In *Proceedings of IEEE International Conference on Cluster Computing (CLUSTER2013)*, September 23-27, 2013, Indianapolis, US.

(25 points)

### 11.2 Latency and bandwidth of EXTOLL

Use your test programs you developed and run it on EXTOLL to measure bandwidth and latency. Compare your results to Gigabit Ethernet on the same machines. Provide a graphic to show your results and interpret them.

(15 points)

### 11.3 Heat relaxation (1D partitioning) on EXTOLL

Do the same experiments for the new system as you did before for the heat exercise. Provide a graphic and interpret the results. What do you expect and what does really happen? Compare with EXTOLL and Ethernet.

(20 points)

### 11.4 Nbody on EXTOLL

Now use also your nbody program to run it on EXTOLL. Do the same analysis again (Ethernet and EXTOLL) and interpret results. How big is the improvement if you use a “faster” interconnection network?

(20 points)

**Total: 80 points**