UL HPC School 2017

PS5: HPC workflow with MPI Parallel/Distributed jobs (OSU Microbenchmarks, HPL)

UL High Performance Computing (HPC) Team

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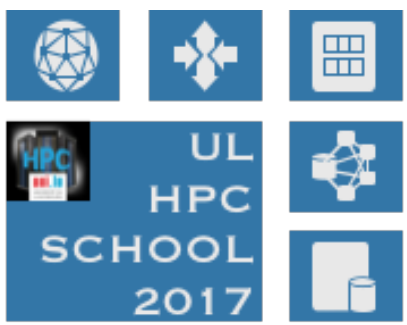
Latest versions available on Github:

UL HPC tutorials: https://github.com/ULHPC/tutorials

UL HPC School: http://hpc.uni.lu/hpc-school/

PS5 tutorial sources:

https://github.com/ULHPC/tutorials/tree/devel/advanced/OSU_MicroBenchmarks



Summary

Main Objectives of this Session

- See how to use the MPI suit available on the UL HPC platform:
  - ↪ Intel MPI and the Intel MKL
  - ↪ OpenMPI
  - ↪ MVAPICH2
    - ✓ MPI-3 over OpenFabrics-IB, Omni-Path, OpenFabrics-iWARP, PSM, and TCP/IP
- Build and run MPI code (through the provided launcher scripts)
- Test case on reference parallel MPI benchmarks:
  - ↪ OSU micro-benchmarks:
    - ✓ measure the performances of various MPI operations
  - ↪ High-Performance Linpack (HPL)

Summary

HPC Interconnect Benchmarking

OSU Micro-Benchmarks Instructions

http://ulhpc-tutorials.readthedocs.io/en/latest/advanced/OSU_MicroBenchmarks/

- **Pre-requisites**: get an interactive job for compilation
  - ↪ **Question**: what is the interest of requesting multiple cores?

```
### Iris cluster
(access)$> si -n 14
# iris (long version)
(access)$> srun -p interactive --qos qos-iteractive -n 14 --pty bash
# iris (long version, best-effort mode)
(access)$> srun -p interactive --qos qos-besteffort -n 14 --pty bash

### On gaia, chaos
(access)$> oarsub -I -l enclosure=1/nodes=1,walltime=4
```

OSU micro-benchmarks

- We will build **version 5.3.2 of the OSU micro-benchmarks**
- Focusing on (only) two one-sided benchmarks:
  - ↪ `osu_get_latency` - Latency Test
  - ↪ `osu_get_bw` - Bandwidth Test
- **Pre-requisites**:
  - ↪ clone ULHPC/tutorials and ULHPC/launcher-scripts repositories
  - ↪ Preparing your working directory

```
$> mkdir -p ~/git/ULHPC && cd  ~/git/ULHPC
$> git clone https://github.com/ULHPC/launcher-scripts.git
$> git clone https://github.com/ULHPC/tutorials.git
# Preparing  your working directory
$> mkdir -p ~/tutorials/OSU-MicroBenchmarks
$> cd ~/tutorials/OSU-MicroBenchmarks
 # Keep a symlink to the reference tutorial
$> ln -s ~/git/ULHPC/tutorials/advanced/OSU_MicroBenchmarks ref.ulhpc.d
```

Building the Benchmarks

Your Turn!

- Get the sources
- Uncompress them
- Compilation based on the **Intel MPI** suit
- Compilation based on the **Open MPI** suit
- Compilation based on the **Open MPI** suit over Ethernet interface
  - ↪ highlight performance drops compared to Infiniband

Running the Benchmarks

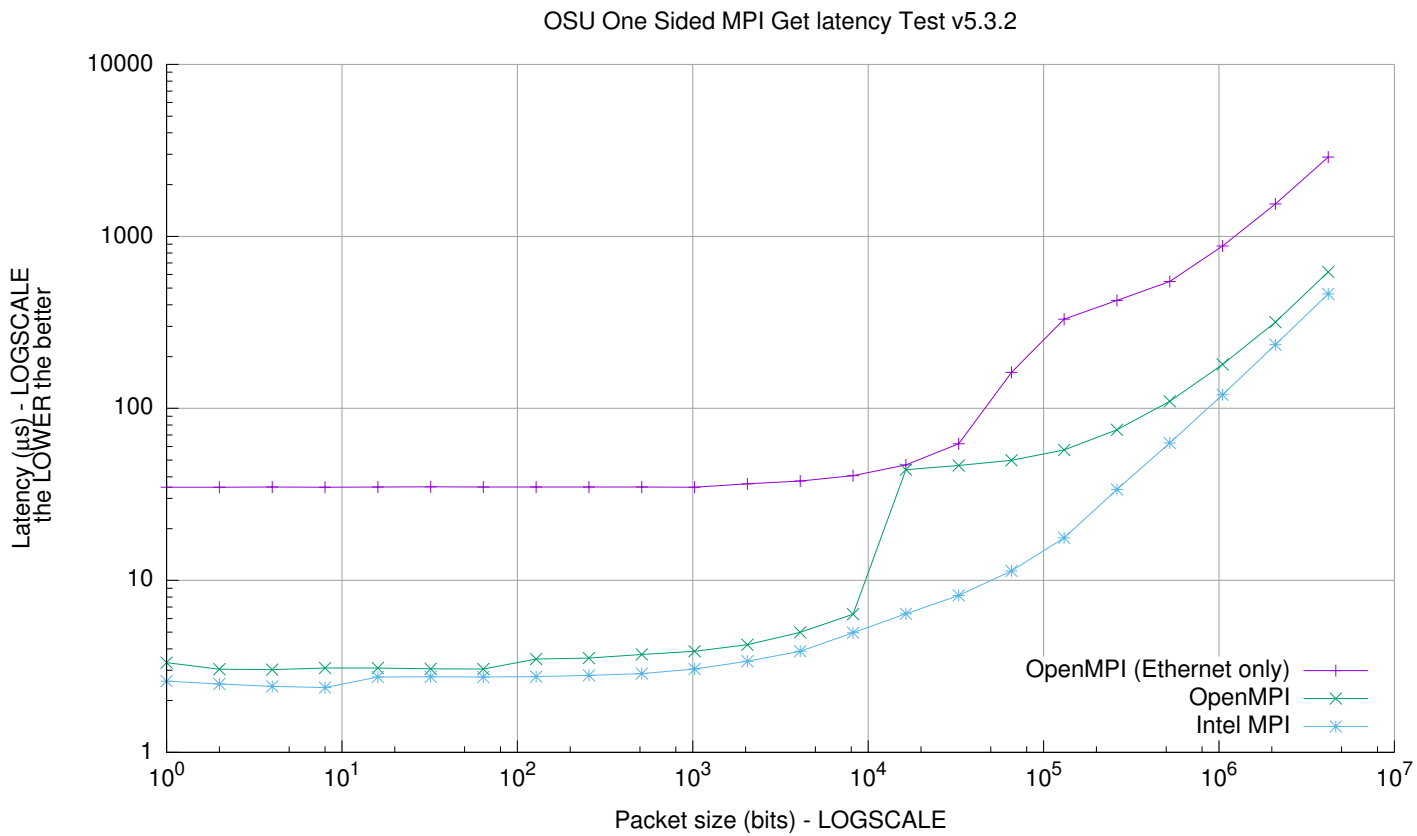
Your Turn!

- Build directory:
  `libexec/osu-micro-benchmarks/mpi/one-sided/`
- Prepare a batch launcher
  - ↪ copy and adapt the default SLURM launcher
- Run it in batch mode

```
$> cd ~/tutorials/OSU-MicroBenchmarks/runs
### On iris
$> sbatch ./launcher-OSU.intel.sh osu_get_bw
$> sbatch ./launcher-OSU.intel.sh osu_get_latency
### On gaia, chaos
$> oarsub -S ./launcher-OSU.intel.sh
```

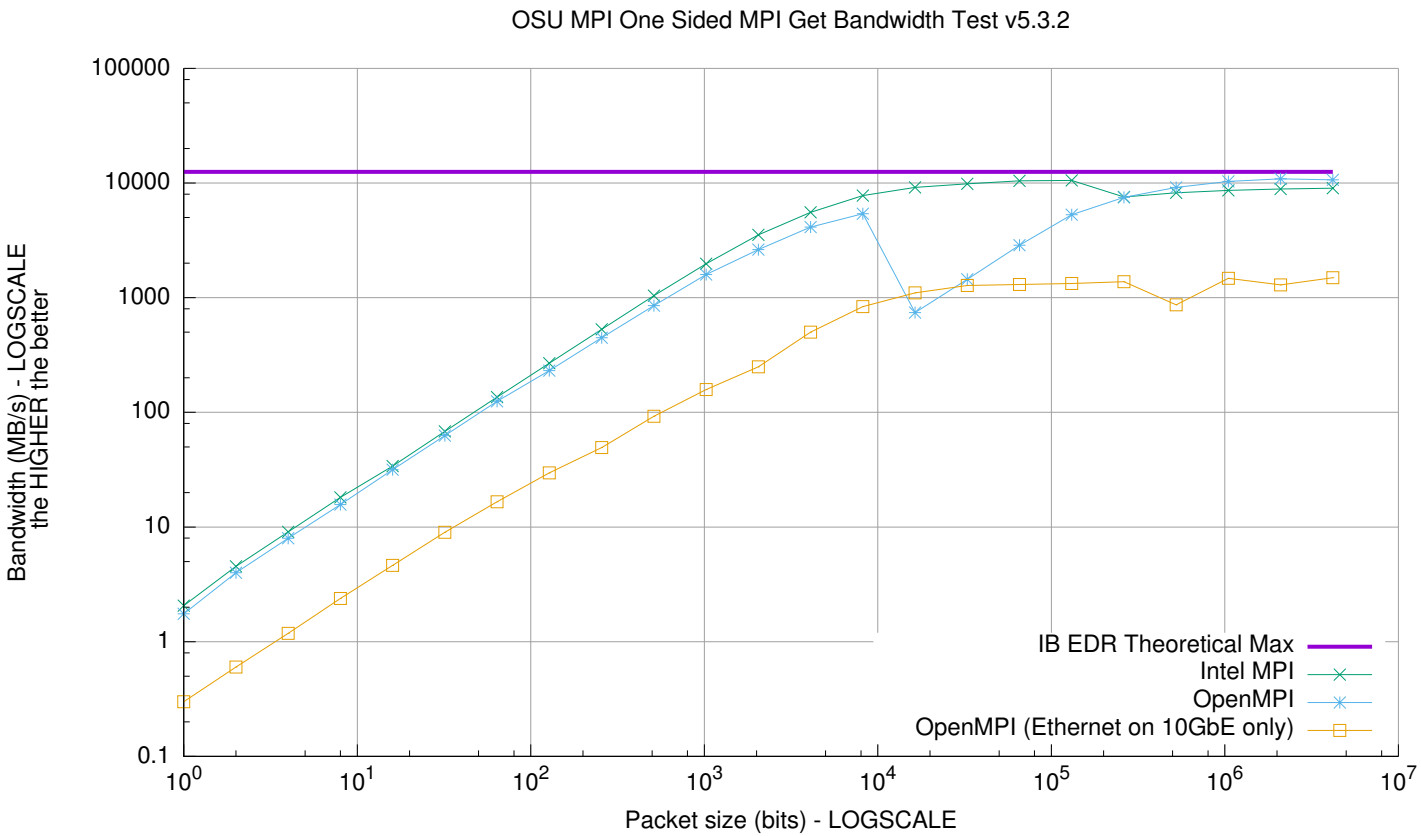
Interconnect Performances

- Based on OSU Micro-benchmarks



Interconnect Performances

- Based on OSU Micro-benchmarks



Summary

High-Performance Linpack (HPL)

HPL Instructions

http://ulhpc-tutorials.readthedocs.io/en/latest/advanced/HPL/

- **Pre-requisites**: get an interactive job for compilation
  - ↪ **Question**: what is the interest of requesting multiple cores?

```
### Iris cluster
(access)$> si -n 14
# iris (long version)
(access)$> srun -p interactive --qos qos-iteractive -n 14 --pty bash
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```

High-Performance Linpack (HPL)

http://www.netlib.org/benchmark/hpl/

- Portable implem. of High-Performance Linpack (HPL) Benchmark
  - ↪ for Distributed-Memory Computers, ref. benchmark for Top500
- We will build **version 2.2 of the HPL**
  - ↪ Focusing (only) on Intel MPI+MKL build
- **Pre-requisites**:
  - ↪ clone ULHPC/tutorials and ULHPC/launcher-scripts repositories
  - ↪ Preparing your working directory

```
$> mkdir -p ~/git/ULHPC && cd  ~/git/ULHPC
$> git clone https://github.com/ULHPC/launcher-scripts.git
$> git clone https://github.com/ULHPC/tutorials.git
# Preparing  your working directory
$> mkdir -p ~/tutorials/HPL
$> cd ~/tutorials/HPL
# Keep a symlink to the reference tutorial
$> ln -s ~/git/ULHPC/tutorials/advanced/HPL ref.ulhpc.d
```

Building HPL

Your Turn!

- Get the sources
- Uncompress them
- Compilation based on the **Intel MPI** suit
  - ↪ Prepare and adapt `src/hpl-2.2/Make.intel64`
- Compile it !

```
$> cd ~/tutorials/HPL/src/hpl-2.2
$> cp setup/Make.Linux_Intel64 Make.intel64
$> vim Make.intel64
# [...] change TOPdir and MP{dir,inc,lib} (at least)
$> make arch=intel64 clean_arch_all
$> make arch=intel64
```

Preparing the HPL Benchmark Run

Your Turn!

- Build directory: `bin/intel64`
- Prepare a batch launcher
  - ↪ copy and adapt the default SLURM launcher
- Prepare an input `HPL.dat` file
  - ↪ use Tuning HPC Online for some default settings

- **Main HPL parameters constraints**
  - ↪ `PxQ = <nodes>*<cores> = $SLURM_NTASKS`
  - ↪ Problem size: `N` (to be as large as possible)
    - ✓ $\texttt{N} = \alpha\sqrt{\#nodes * RAM * 1024}$ where RAM is expressed in GiB
  - ↪ `NB`: depends on processor architecture (Ex: Intel MKL notes)
    - ✓ `NB = 192` on `iris` cluster

Example HPL.dat

```
HPLinpack benchmark input file
Innovative Computing Laboratory, University of Tennessee
HPL.out      output file name (if any)
6            device out (6=stdout,7=stderr,file)
1            # of problems sizes (N)
24650        Ns
1            # of NBs
192          NBs
0            PMAP process mapping (0=Row-,1=Column-major)
2            # of process grids (P x Q)
2 4          Ps
14 7         Qs
[...]
```

- Targeting 1 node in this case on 2 sets of parameters (PxQ = 28)

	N	NB	P	Q
Run 1	24650	192	2	14
Run 2	24650	192	4	7

HPL Benchmark [batch] Runs

- Adapt the default SLURM launcher
- Run it

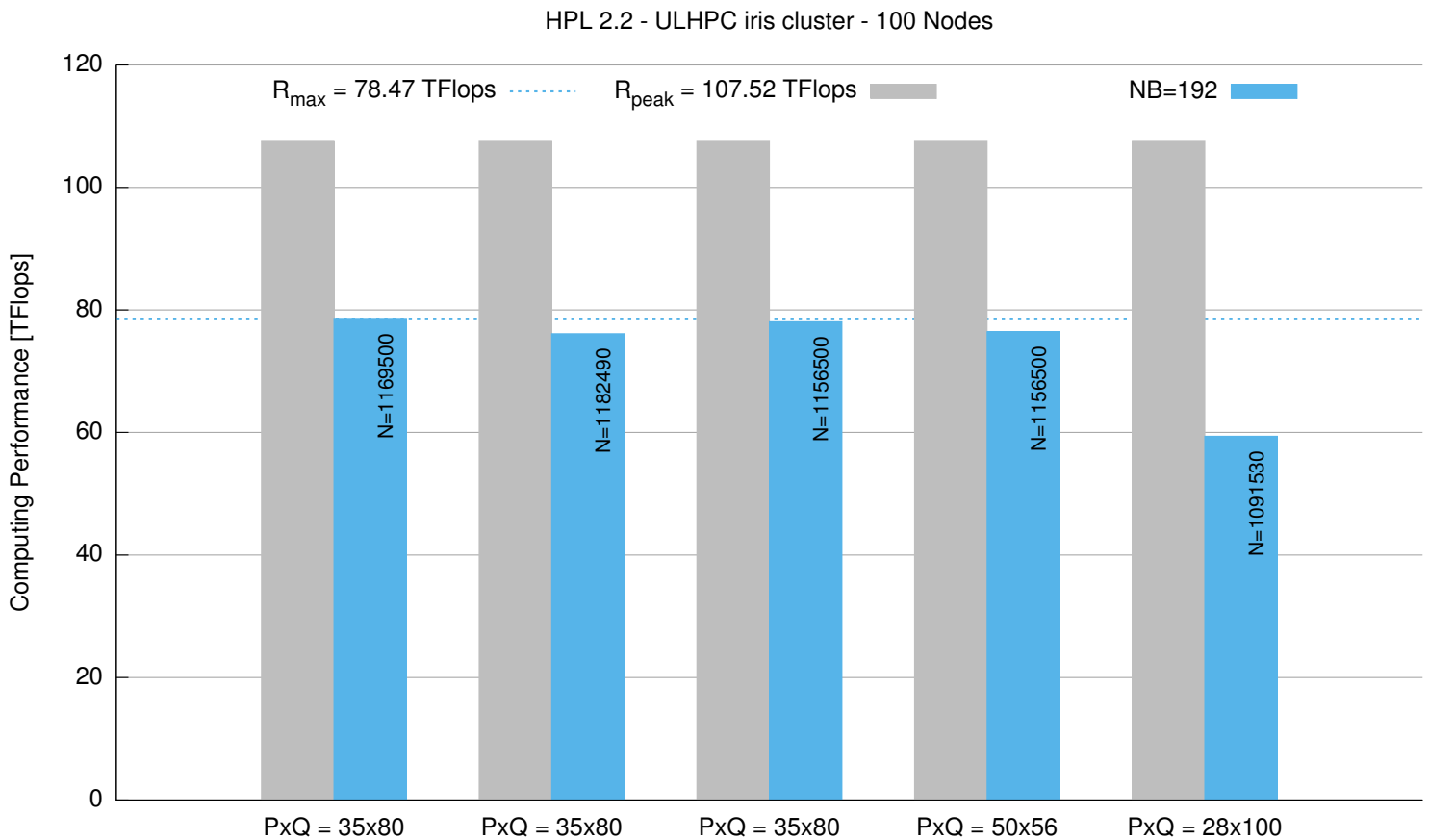
```
$> cd ~/tutorials/HPL/runs
$> cp ../ref.ulhpc.d/HPL.dat .
### On iris
$> sbatch ./launcher-HPL.intel.sh
### On gaia, chaos
$> oarsub -S ./launcher-HPL.intel.sh
```

- Grab the HPL results from the output logs

```
# T/V     N       NB      P     Q    Time       Gflops
$> grep WR slurm-2758.out
WR11C2R4  24650   192     2     14   13.51      7.392e+02
WR11C2R4  24650   192     4     7    12.69      7.869e+02
```

Computing Performances / HPL

- Based on High-Performance Linpack (HPL)
  - ↪ reference benchmark for Top 500



Questions?

http://hpc.uni.lu

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