Programming of Supercomputers

Assignment 1:
Single Node Performance

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Assignment 1 Tasks

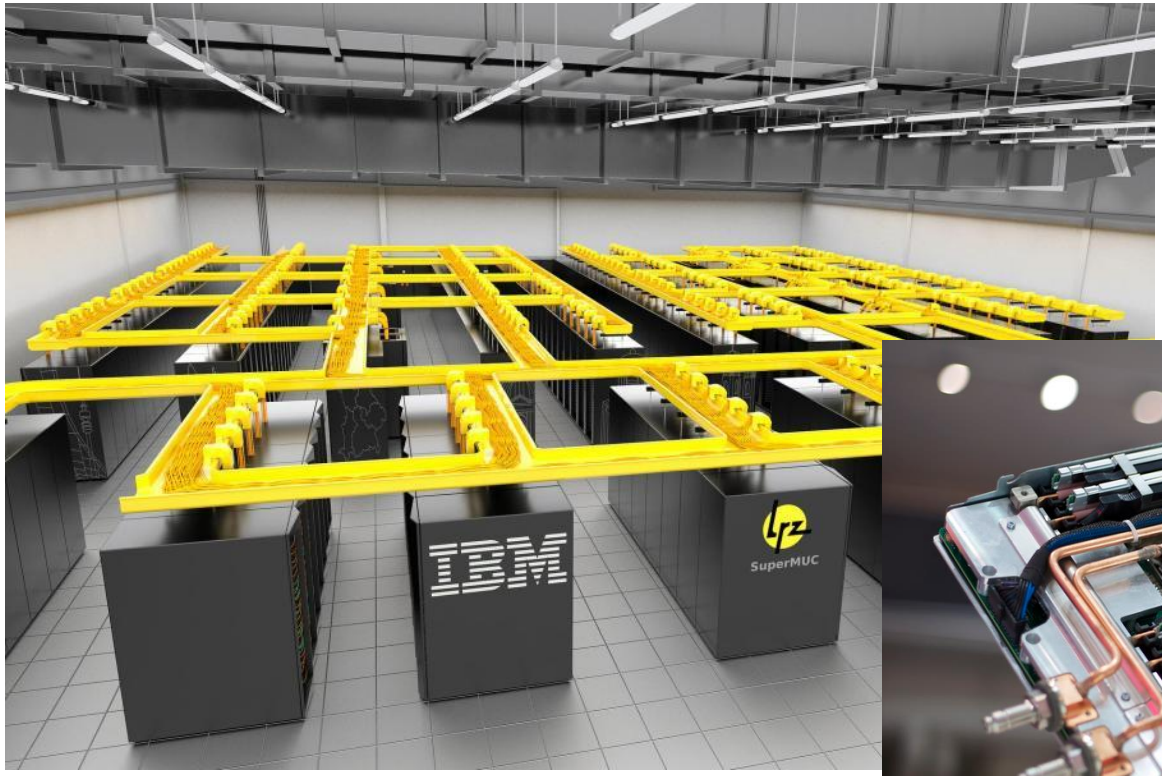
Single-thread Performance

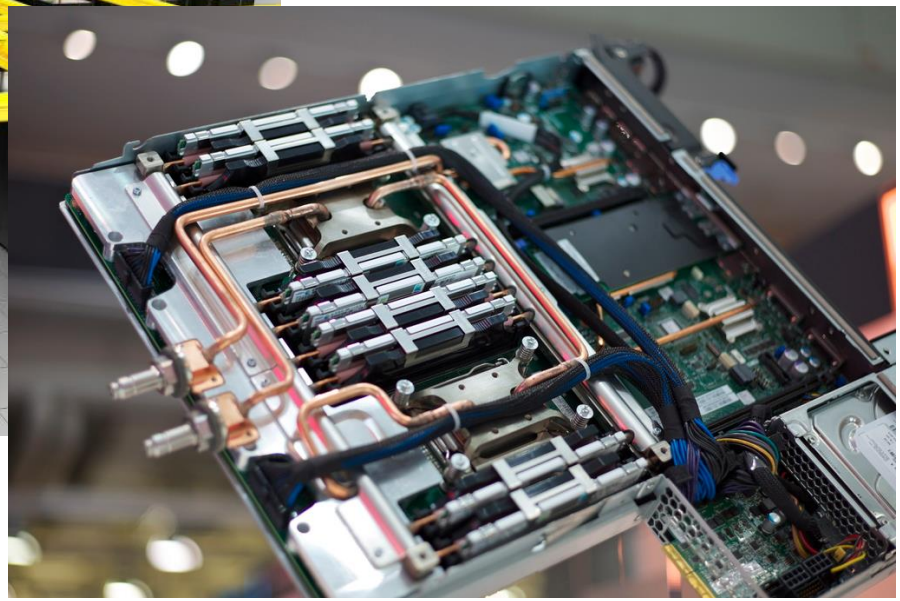
- GPROF
  - Flat profile
  - Call graph
- Compiler Flags
  - GCC
  - ICC
- Optimization Pragmas
  - GCC pragmas
  - ICC pragmas

Multi-thread Performance

- OpenMP
  - Single process
  - Scaling with threads
    - Shared address space
    - Direct load and stores
    - Coherency, locks, etc.
- MPI
  - Multiple processes
  - Only certain process counts valid
  - Scaling with processes
    - Separate address spaces
    - Messages
- MPI+OpenMP

SuperMUC





Login to SuperMUC, Documentation

- First change the standard password
  - https://idportal.lrz.de/r/entry.pl
- Login via
  - lxhalle due to restriction on connecting machines
  - ssh <userid>@supermuc.lrz.de
  - No outgoing connections allowed
- Documentation
  - http://www.lrz.de/services/compute/supermuc/
  - http://www.lrz.de/services/compute/supermuc/loadleveler/
  - Intel compiler: http://software.intel.com/sites/products/documentation/hpc/composerxe/en-us/2011Update/cpp/lin/index.htm

Building the Benchmark

- Load the required modules:

```
module unload mpi.ibm
module load mpi.intel
```

- Update your Makefile (refer to the provided instructions)
  - Baseline
  - OpenMP
  - MPI
  - MPI + OpenMP
- Build and verify that the binaries were created
- Run the benchmark in the login node
- Identify your **performance metric** from the output!
  - More is better or less is better?
  - Check the benchmark's documentation online

Batch Scripts

- Advantages
  - ***Reproducible performance***
  - Run larger and longer running jobs

- Several job classes available
  - ***Test (recommended for this assignment‘s tasks)***
    - Phase 1:
      - Max 1 island, 32 nodes, 30 minutes, 1 job in queue
    - Phase 2:
      - Max 1 island, 20 nodes, 30 minutes, 1 job in queue
  - Micro
    - Phase 1:
      - Max 1 island, 32 nodes, 48 hours, 8 jobs in queue
    - Phase 2:
      - Max 1 island, 20 nodes, 48 hours, 8 jobs in queue

Submitting a Batch Job

- llsubmit ll.sh
  - Submission to batch system
- llq –u $USER
  - Check status of own jobs
- llcancel <jobid>
  - Kill job if no longer needed
  - Obtain the <jobid> from the llq output

```
#!/bin/bash
#@ wall_clock_limit = 00:20:00
#@ job_name = pos-lulesh-openmp
#@ job_type = MPICH
#@ class = micro
#@ output =
pos_lulesh_openmp_$(jobid).out
#@ error =
pos_lulesh_openmp_$(jobid).out
#@ node = 1
#@ total_tasks = 16
#@ node_usage = not_shared
#@ energy_policy_tag = lulesh
#@ minimize_time_to_solution = yes
#@ island_count = 1
#@ queue

. /etc/profile
. /etc/profile.d/modules.sh

export OMP_NUM_THREADS=16
./lulesh2.
```

Use CPU hours responsibly

- Specify job execution as tight as possible
  - In this assignment, 10 minutes is sufficient
- Only request the number of nodes required.
  - 1 node is sufficient for all tasks in assignment 1.
- Small tests can be done in the login node
  - Create a batch only after you are ready to collect results
  - Running in a batch eliminates interference from other users.
- All types of runs can be tested in the login node
  - Baseline
  - MPI,
  - OpenMP and
  - Hybrid

Video capture with Kazam

- Install with your package manager

```
apt-get install kazam
```

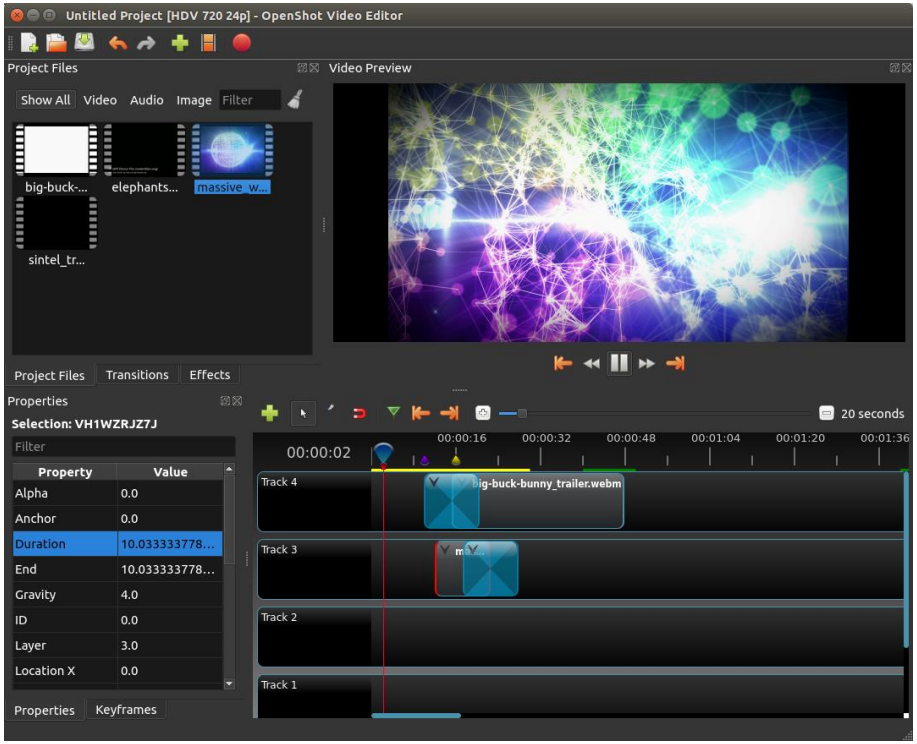
- Run by calling ‘kazam’ from the terminal
- Use the GUI to configure your
  - capture area,
  - audio and
  - output file

Video and Audio Mixing with OpenShot

- Install with your package manager

```
apt-get install openshot
```

- Run by calling ‘openshot’ from the terminal
- GUI allows for mixing
  - Captured video from the desktop with Kazam
  - Any other video file
  - Recorded audio
    - Embedded audio in the video
    - Other sources
  - Set the output file name
  - Output format and compression levels



Playback with VLC

- Install with your package manager

  ```
  apt-get install vlc
  ```

- Run by calling ‘vlc’ from the terminal
- Use the GUI to
  - Load your video
    - Captured desktop parts from Kazam
    - Audio tracks from Kazam or other sources
    - Final mix from OpenShot
- Moodle limit at 300MB
- No specific format requirements
  - ***Just make sure your video can be played with VLC!***