ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

High-Performance Computing Lab for CSE   **2024**

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Solution for Project 1a   Due date: 11 March 2024, 23:59

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1. Euler warm-up [10 points]

1. The module system is a tool used to manage software environments on a Euler. It allows us to configure their environment by dynamically loading or unloading software modules. These modules adjust system variables to ensure that the necessary binaries and libraries are accessible. You use it by loading specific software versions with module load and unloading them with module unload when done.

2. Slurm is a tool used in big computer clusters to help manage who gets to use the computers and when. It schedules tasks and makes sure everything runs smoothly by allocating resources like processors and memory. It's like the traffic controller for a cluster of computers.

3. see hostname.cpp

4. see slurm_job_one.sh

5. see slurm_job_two.sh

2. Performance characteristics [50 points]

2.1. Peak performance

Source: `https://scicomp.ethz.ch/wiki/Euler#Euler_VII_.E2.80.94_phase_1`

Table 1: Euler VII Phase 1 and Phase 2 Specifications

Phase	Compute Nodes	CPUs per Node	CPU	Clock Speed (GHz)
Phase 1	292	2	AMD EPYC 7H12	2.6
Phase 2	248	2	AMD EPYC 7763	2.45

$$n_{\text{super}} = \frac{1}{TP} = 2$$
$$n_{\text{FMA}} = 2$$
$$n_{\text{SMID}} = 4$$

Values are the same for both Euler VII Phase 1 and 2.
Source for FMA, TP and : `https://uops.info/table.html`
Source for the SIMD values: "Software Optimization Guide for AMD EPYC™ 7002 Processors" and "Software Optimization Guide for AMD EPYC™ 7003 Processors"

$$P_{\text{core}} = n_{\text{super}} \cdot n_{\text{FMA}} \cdot n_{\text{SMID}} \cdot f$$
$$P_{\text{CPU}} = P_{\text{core}} \cdot \#\text{Cores}$$
$$P_{\text{node}} = P_{\text{core}} \cdot \#\text{CPUs}$$
$$P_{\text{EulerVII}} = P_{\text{node}} \cdot \#\text{Nodes}$$

Table 2: Peak Performance Comparison

Metric	Phase 1	Phase 2
P_{core}	41.6 GFLOP/s	39.2 GFLOP/s
P_{CPU}	2.66 TFLOP/s	2.51 TFLOP/s
P_{node}	5.32 TFLOP/s	5.02 TFLOP/s
P_{EulerVII}	1.55 PFLOP/s	1.24 PFLOP/s

2.2. Memory Hierarchies

2.2.1. Cache and main memory size

Table 3: Cache and Main Memory Sizes

Phase	L1 (KB)	L2 (KB)	L3 (MB)	Main Memory (GB)
Phase 1	32	512	16	256
Phase 2	32	512	32	256

The only difference between the cache sizes of Phase 1 and Phase 2 is the L3 cache size. Phase 2 has twice the L3 cache size of Phase 1.

2.3. Bandwidth: STREAM benchmark

As we can see the bandwidths are roughly the same for both processors and most operations. The Copy operation has the highest bandwidth just as in the example provided. Aside from that nothing else is particularly interesting about the results. The maximum bandwidth is approximately 25GB/s for both processors.

Table 4: Memory Bandwidth Comparison

Function	AMD EPYC 7H12	AMD EPYC 7763
Copy	33044.7 MB/s	34873.5 MB/s
Scale	25137.2 MB/s	24681.9 MB/s
Add	25676.8 MB/s	25473.4 MB/s
Triad	26346.1 MB/s	25710.9 MB/s

2.4. Performance model: A simple roofline model

The formula for the naive roofline model is:

$$P = \begin{cases} \pi & \pi < \beta \cdot I \\ \beta \cdot I & \text{else} \end{cases}$$

Where π is the peak performance and I is the operational intensity and β is the peak bandwidth. Here we are looking at the performance of a single core so we can use the peak performance we calculated in task 2.1. The peak bandwidth was calculated in task 2.3.