INSTITUTE OF MICROELECTRONICS

NSSC2 - Exercise 1

Group ?

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1 Task 1: Questions

(a) Describe the advantages/disadvantages of a two-dimensional decomposition (over a one-dimensional decomposition).

(b) Using a ghost layer based decomposition, how could multiple independent Jacobi iterations be achieved before communication has to happen?

(c) Describe the conceptual differences between an hybrid OpenMP/MPI-parallelization over a pure MPIparallelization.

(d) How big is the sum of all L2 caches for 2 nodes of the IUE-cluster1?

2 Task 2: 1D Decomposition

2.1 Description

Your task is to implement a one-dimensional decomposition using ghost layers and MPI-communication to update the ghost layers. Create a program which is callable by

```
mpirun —n NUMMPIPROC ./jacobiMPI resolution iterations
```

e.g.,

```
mpirun —n 4 ./jacobiMPI 250 30
```

, where NUMMPIPROC is the number of MPI-processes to launch, resolution defines the grid spacing as h = 1:0=(resolution-1), and iterations defines the number of Jacobi iterations to perform. Further and more specifically, your program should

- use $\bar{u}_h = 0$ as initial approximation to u, and (after finishing all iterations)
- print the Euclidean $|| \cdot ||_2$ and Maximum $|| \cdot ||_\infty$ norm of the residual $||A_h\bar{u}_h - b_h||$ and of the total error $||\bar{u}_h - u_p||$ to the console, and
- print the average runtime per iteration to the console, and
- produce the same results as a serial run.

Finally, benchmark the parallel performance of your program jacobiMPI using 2 nodes of the IUE-Cluster for 4 different $resolutions = \{250, 1000, 4000, 8000\}$ using between 1 and 80 MPI-processes (NUMMPIPROC). More specifically, you should

- create a plot of the parallel speed and a plot of the parallel efficiency for each resolution, and
- discuss the results in detail

3 Task 3: Single-Precision Data Representation

Adopt your program jacobiMPI from above by changing the underlying floating point data type of the direcrtization from double to float. Specifically,

- a correct implementation (by comparing results to a serial run), and
- compare the results to with the results from Task 2 in a suitable plot and dicuss your results.

4 Task 4: 1D Decomposition

Extend your program from Task 2 by implementing a two-dimensional decomposition using a ghost layer and MPI-communication to update the ghost layers. Create a program which is callable by mpirun -n NUMMPIPROC . / jacobiMPI2D resolution iterations where the command parameters have the same meaning as bove. Ensure a correct implementation by comparing your results to a serial run. Benmarking on the cluster is not required.