Sec3_jacobi

Verardo Thomas

24/12/2021

#Jacobi solver

In the section 3, we have to compile and run the Jacobi program and test the performance in the theoretical and practical way. To test the first one and so to predict the Jacobi model performance, it's used this model:

$$P(L,N) = \frac{L^3 * N}{T_s + T_c}[MLUP/s]$$

With L as total time on a single process, N as the number of process, Ts as a time that is constant and it's estimated, Tc as the communication time per second, that is:

$$Tc(L,N) = \frac{c(L,N)}{B} + 4kT_l[seconds]$$

B is the bandwidth, T_l is the latency (λ) and c(L,N) is the message size:

$$c(L,N) = L^2 * k * 2 * 2 * 8[byte]$$

Lˆ2 * k must be multiplied for 8 because the message is a double, for 2 because we are in a bidirectional case and another time for 2 for the positive and negative direction.

Model prediction

There are several domain decomposition that can be done, but, for the purposes of the exercise and the performance, it's for little use to calculate all the decomposition performance, therefore only those that are studied best have been calculated.

All models are calculated with L = 700.

Table 1: Model thin, mapping by node

N_process	Nx	Ny	Nz	k	C	Tc	Model_perf	Real_perf	Elapsed_time	Perf_ratio
1	1	1	1	2	0.000	0.000	114.716	112.194	54.26	1.00000
12	12	1	1	2	7.477	0.001	1376.300	1334.310	54.80	1.00021
12	4	3	1	4	14.954	0.001	1376.011	1334.824	54.75	1.00042
12	3	2	2	6	22.430	0.002	1375.722	1342.339	54.57	1.00063
12	6	2	1	4	14.954	0.001	1376.011	1341.984	54.58	1.00042
24	24	1	1	2	7.477	0.001	2752.599	2680.570	54.80	1.00021
24	12	2	1	4	14.954	0.001	2752.021	2683.972	54.75	1.00042
24	8	3	1	4	14.954	0.001	2752.021	2678.966	54.78	1.00042
24	6	4	1	4	14.954	0.001	2752.021	2676.793	54.79	1.00042
24	6	2	2	6	22.430	0.002	2751.444	2681.906	54.82	1.00063
24	4	3	2	6	22.430	0.002	2751.444	2674.086	54.85	1.00063
48	48	1	1	2	7.477	0.001	5505.198	5260.938	56.39	1.00021
48	24	2	1	4	14.954	0.001	5504.043	5247.754	56.51	1.00042

N_process	Nx	Ny	Nz	k	C	Tc	Model_perf	Real_perf	Elapsed_time	Perf_ratio
48	12	4	1	4	14.954	0.001	5504.043	5249.959	56.58	1.00042
48	12	2	2	6	22.430	0.002	5502.887	5215.275	56.73	1.00063
48	8	6	1	4	14.954	0.001	5504.043	5222.120	56.67	1.00042
48	6	4	2	6	22.430	0.002	5502.887	5244.173	56.52	1.00063

Table 2: Model thin, mapping by socket

N_process	Nx	Ny	Nz	k	C	Tc	Model_perf	Real_perf	Elapsed_time	Perf_ratio
1	1	1	1	2	0.000	0.000	114.716	112.316	54.24	1.000000
4	4	1	1	2	7.477	0.001	458.655	448.578	54.35	1.000452
4	2	2	1	4	14.954	0.003	458.448	448.307	54.36	1.000905
8	8	1	1	2	7.477	0.001	917.311	888.956	54.74	1.000452
8	4	2	1	4	14.954	0.003	916.896	895.186	54.49	1.000905
8	2	2	2	6	22.430	0.004	916.482	895.898	54.47	1.001357
12	12	1	1	2	7.477	0.001	1375.966	1332.876	54.83	1.000452
12	4	3	1	4	14.954	0.003	1375.344	1336.472	54.84	1.000905
12	3	2	2	6	22.430	0.004	1374.723	1342.513	54.63	1.001357
12	6	2	1	4	14.954	0.003	1375.344	1342.499	54.62	1.000905

Table 3: Model thin, mapping by core

N_process	Nx	Ny	Nz	k	C	Tc	Model_perf	Real_perf	Elapsed_time	Perf_ratio
1	1	1	1	2	0.000	0.000	114.716	112.262	54.26	1.00000
4	4	1	1	2	7.477	0.001	458.683	448.071	54.44	1.00039
4	2	2	1	4	14.954	0.002	458.503	448.982	54.37	1.00079
8	8	1	1	2	7.477	0.001	917.366	894.611	54.59	1.00039
8	4	2	1	4	14.954	0.002	917.006	896.996	54.61	1.00079
8	2	2	2	6	22.430	0.004	916.646	894.367	54.61	1.00118
12	12	1	1	2	7.477	0.001	1376.048	1329.530	55.27	1.00039
12	4	3	1	4	14.954	0.002	1375.509	1315.655	55.70	1.00079
12	3	2	2	6	22.430	0.004	1374.970	1324.698	55.42	1.00118
12	6	2	1	4	14.954	0.002	1375.509	1323.848	55.46	1.00079

Data are calculated with the following parameters:

- By node: $\lambda = 1.02$ [usec], B = 11946 [MB/s]
- By socket: $\lambda = 0.49$ [usec], B = 5530 [MB/s]
- By core: $\lambda = 0.22$ [usec], B = 6372 [MB/s]

The model performed seems accurate, but you can notice that the estimated performance is better with mapping by node and socket and worse with core. In the expected theoretical model this data should be different, that us the mapping by core better than node.

Table 4: Model gpu, mapping by socket

N_process	Nx	Ny	Nz	k	C	Tc	Model_perf	Real_perf	Elapsed_time	Perf_ratio
1	1	1	1	2	0.000	0.000	79.453	77.285	75.47	1.000000
12	12	1	1	2	7.477	0.001	953.138	900.188	83.73	1.000317
12	4	3	1	4	14.954	0.003	952.836	900.329	83.15	1.000634

N_process	Nx	Ny	Nz	k	C	Tc	Model_perf	Real_perf	Elapsed_time	Perf_ratio
12	3	2	2	6	22.430	0.004	952.535	893.078	83.52	1.000950
12	6	2	1	4	14.954	0.003	952.836	899.948	83.18	1.000634
24	24	1	1	2	7.477	0.001	1906.276	1698.968	88.97	1.000317
24	12	2	1	4	14.954	0.003	1905.672	1699.918	89.11	1.000634
24	8	3	1	4	14.954	0.003	1905.672	1699.285	88.88	1.000634
24	6	4	1	4	14.954	0.003	1905.672	1698.867	88.94	1.000634
24	6	2	2	6	22.430	0.004	1905.069	1699.699	88.86	1.000950
24	4	3	2	6	22.430	0.004	1905.069	1699.090	88.90	1.000950
48	48	1	1	2	7.477	0.001	3812.552	2528.730	115.50	1.000317
48	24	2	1	4	14.954	0.003	3811.345	2542.104	114.50	1.000634
48	12	4	1	4	14.954	0.003	3811.345	2531.668	115.00	1.000634
48	12	2	2	6	22.430	0.004	3810.138	2546.495	114.30	1.000950
48	8	6	1	4	14.954	0.003	3811.345	2531.779	114.60	1.000634
48	6	4	2	6	22.430	0.004	3810.138	2542.649	114.50	1.000950

Table 5: Model gpu, mapping by core

N_process	Nx	Ny	Nz	k	C	Tc	Model_perf	Real_perf	Elapsed_time	Perf_ratio
1	1	1	1	2	0.000	0.000	79.453	77.285	75.47	1.000000
12	12	1	1	2	7.477	0.001	953.178	850.527	88.24	1.000275
12	4	3	1	4	14.954	0.002	952.916	849.571	88.14	1.000550
12	3	2	2	6	22.430	0.004	952.654	849.634	88.03	1.000825
12	6	2	1	4	14.954	0.002	952.916	850.352	88.10	1.000550
24	24	1	1	2	7.477	0.001	1906.355	1690.635	89.12	1.000275
24	12	2	1	4	14.954	0.002	1905.831	1700.242	88.86	1.000550
24	8	3	1	4	14.954	0.002	1905.831	1699.032	88.91	1.000550
24	6	4	1	4	14.954	0.002	1905.831	1700.316	88.96	1.000550
24	6	2	2	6	22.430	0.004	1905.308	1698.990	88.89	1.000825
24	4	3	2	6	22.430	0.004	1905.308	1699.548	88.89	1.000825
48	48	1	1	2	7.477	0.001	3812.711	2538.199	114.90	1.000275
48	24	2	1	4	14.954	0.002	3811.663	2534.727	115.10	1.000550
48	12	4	1	4	14.954	0.002	3811.663	2523.002	115.40	1.000550
48	12	2	2	6	22.430	0.004	3810.615	2550.307	114.40	1.000825
48	8	6	1	4	14.954	0.002	3811.663	2549.906	114.50	1.000550
48	6	4	2	6	22.430	0.004	3810.615	2527.282	115.30	1.000825

Unlike the CPU, in the GPU performance we can see that the estimated model performance of the mapping by core is sligthy better than the mapping by socket.