Heat Simulation using MPI

Group 6

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Heat Simulation using MPI

Utilized Functions

Creating a 2d cartesion topology:

```
int MPI_Cart_create(MPI_Comm comm_old, int ndims, int *dims, int *periods,
                    int reorder, MPI_Comm *comm_cart)
```

Converting between coordinates and rank:

```
int MPI_Cart_rank(MPI_Comm comm, int *coords, int *rank)
int MPI_Cart_coords(MPI_Comm comm, int rank, int maxdims, int *coords)
```

Nonblocking send and receive commands:

```
int MPI_Isend(void *buf, int count, MPI_Datatype datatype, int dest, int tag,
              MPI_Comm comm, MPI_Request *request)
int MPI_Irecv(void *buf, int count, MPI_Datatype datatype, int source,
              int tag, MPI_Comm comm, MPI_Request *request)
int MPI_Wait(MPI_Request *request, MPI_Status *status)
```

Send and resceive buffers to transfer columns of the matrix

```
// Example: Receiving the left border
for (i = 1; i < size_y -1 ; i++)
    u[i*size_x] = recvbuf_left[i-1];
```

Heat Simulation using MPI

Code Jacobi

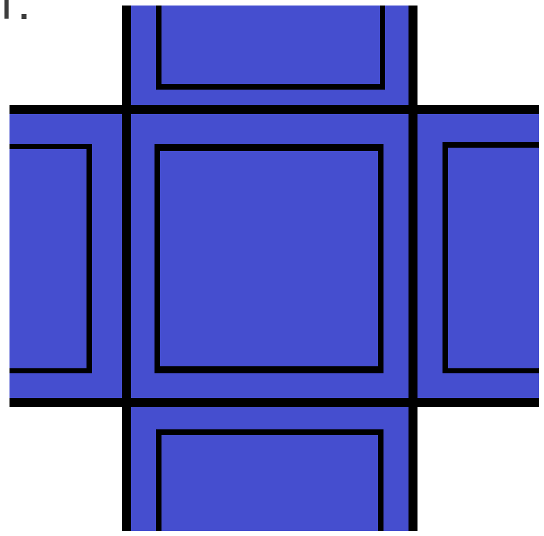
For each iteration do:

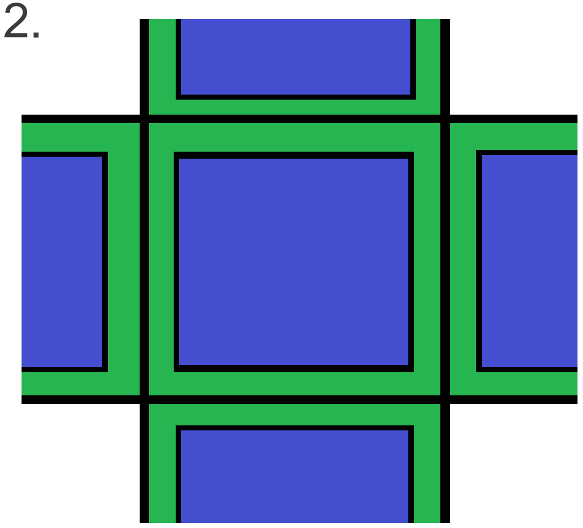
    Calculate the borders

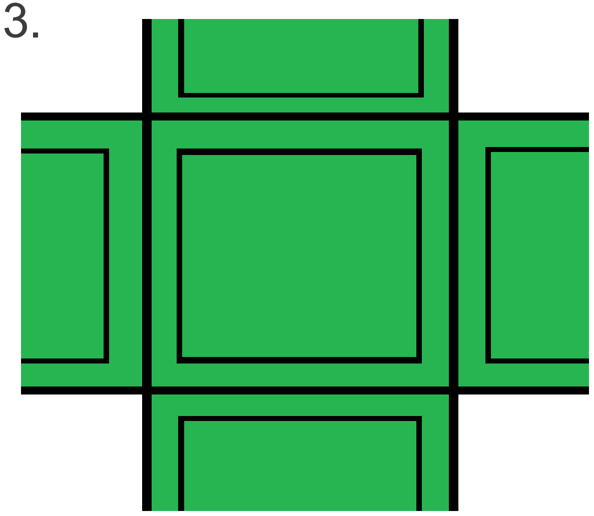
    Send border values to neighbors

    Calculate the inner part

    Receive border values from neighbors

1.


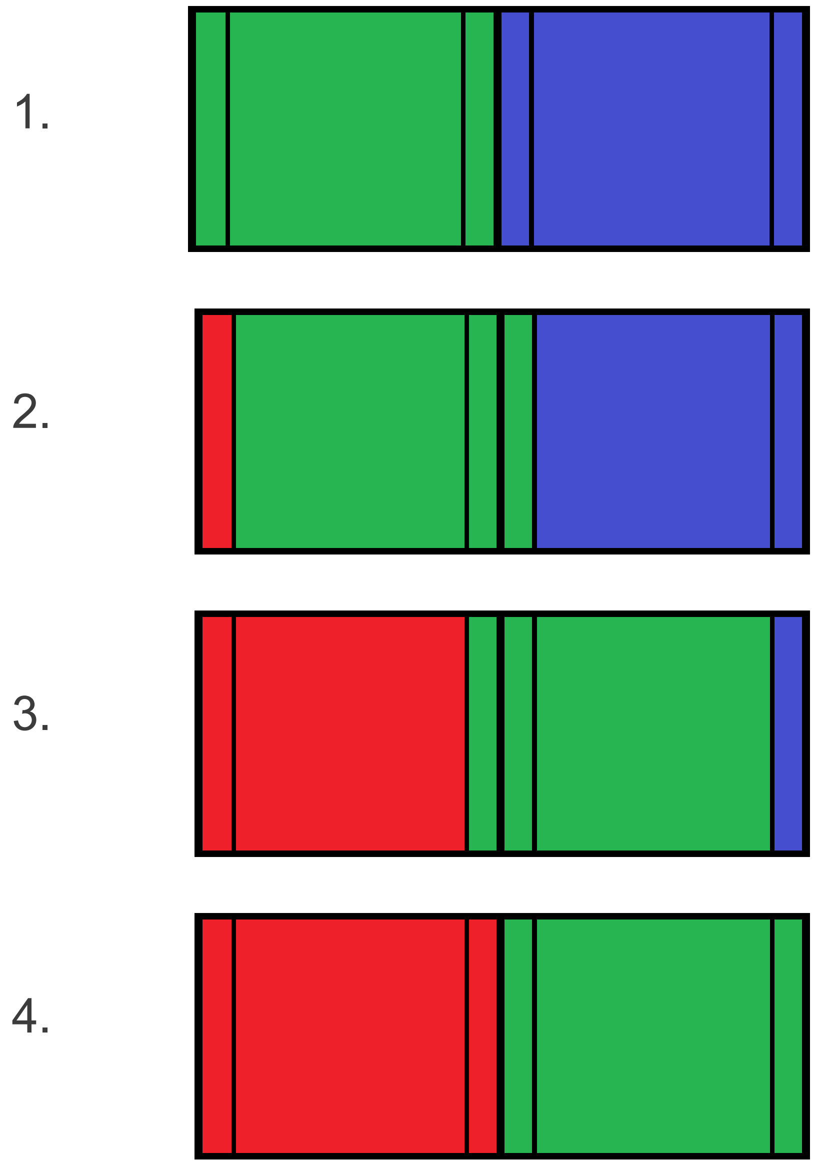
2.


3.


Heat Simulation using MPI

Code 1D-Gauss

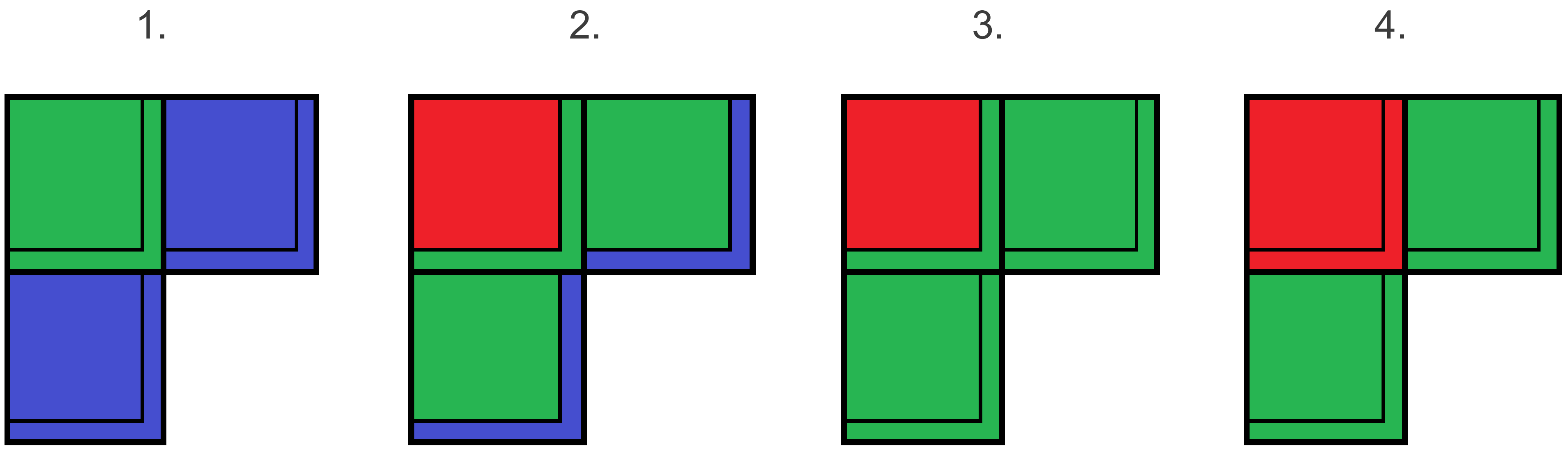
```
For each iteration do:
    Receive border values from left neighbor
    Calculate left border
    Send border values to left neighbor
    Calculate inner part
    Receive border values from right neighbor
    Calculate right border
    Send border values to right neighbor
```



Heat Simulation using MPI

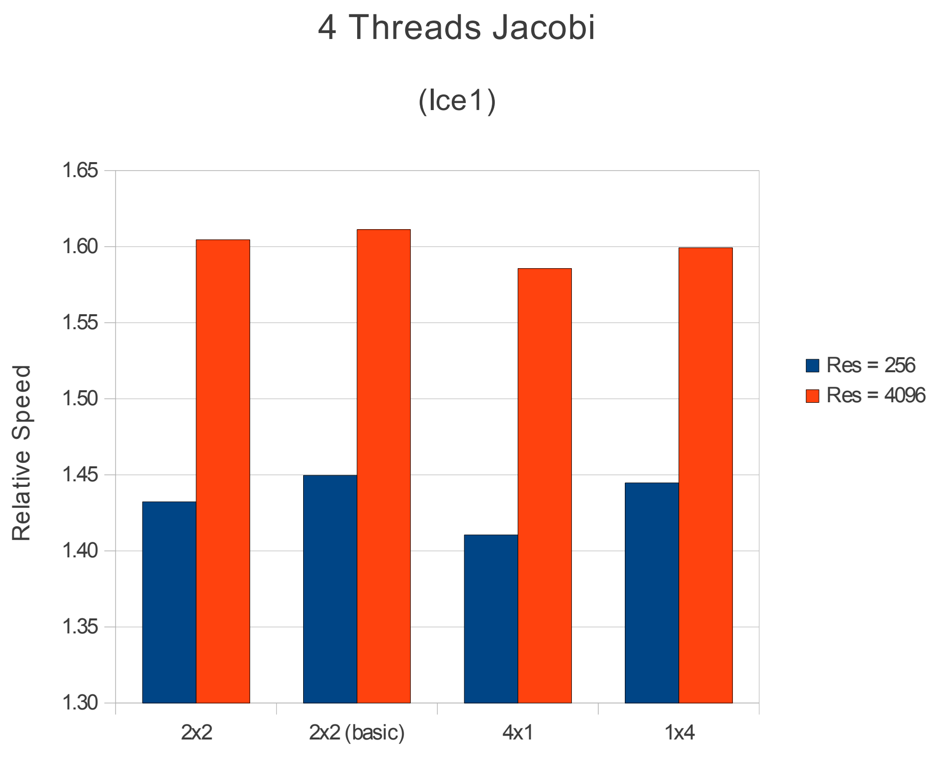
Code 2D-Gauss

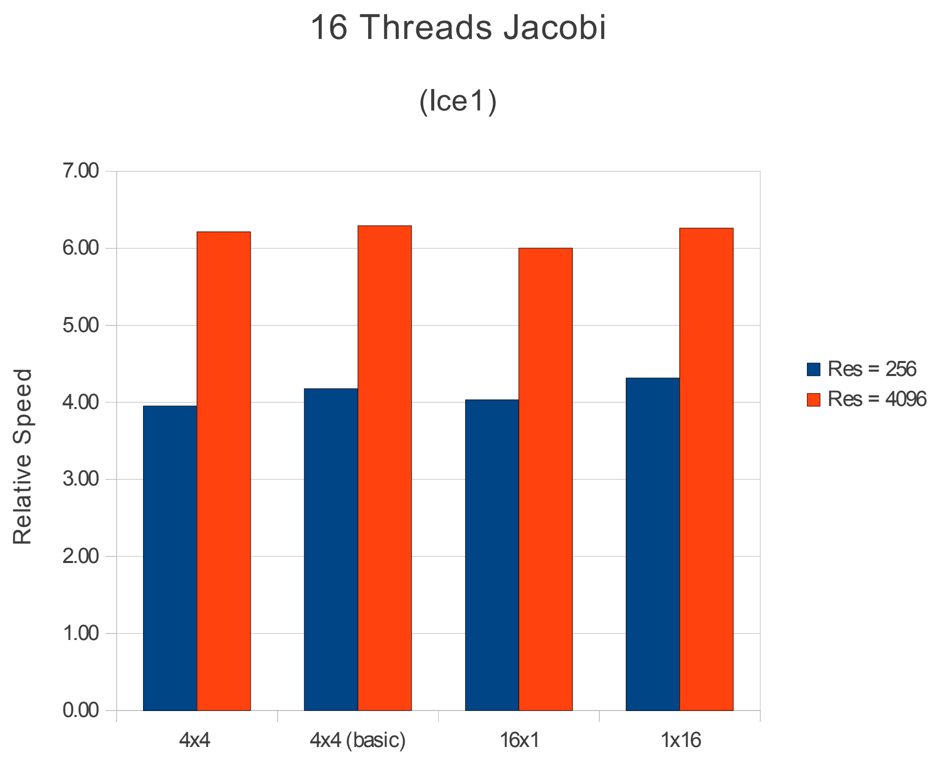
```
For each iteration do:
    Receive border values from top and left neighbor
    Calculate top and left border and inner part
    Receive border values from right and bottom neighbor
    Calculate bottom and right border
    Send border values to all neighbors
```



Heat Simulation using MPI

Results Jacobi

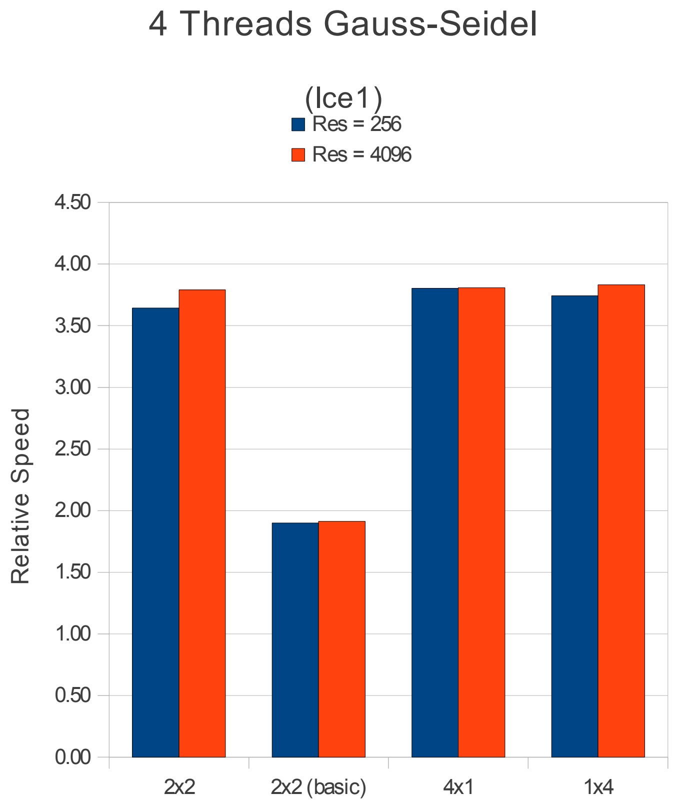


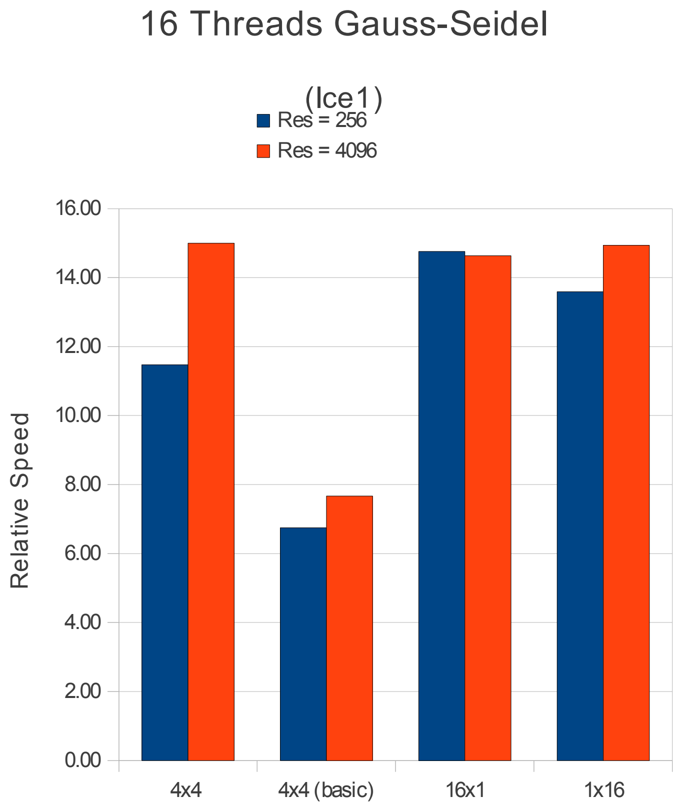


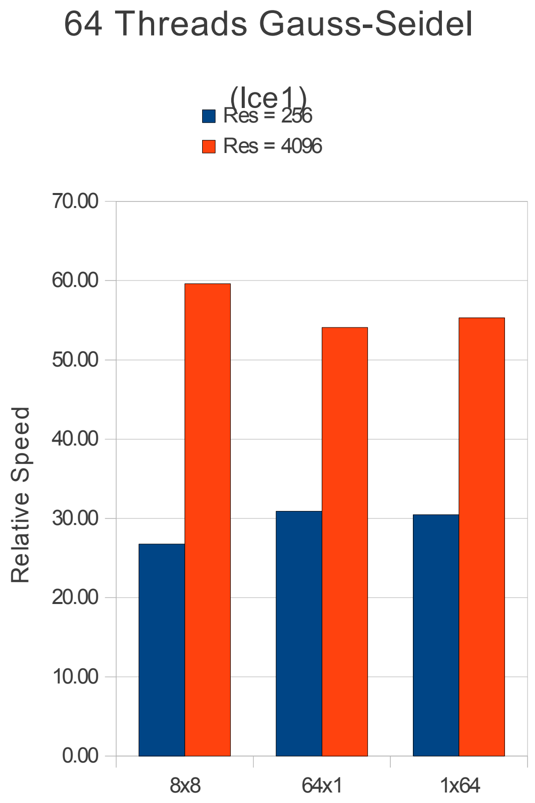
„Basic“ means that the blocks are not devided into inner part and border, but calculated at once.

Heat Simulation using MPI

Results Gauss







„Basic“ means that the blocks are not devided into upper left part and lower right border, but calculated at once.

Raw Results in MFlops (Gauss)

4 Threads

Resolution	Seial	2x2	4x1 (spec)	1x4 (spec)
256	842	3068	3202	3152
4096	819	3104	3118	3139

16 Threads

Resolution	Serial	4x4	16x1 (spec)	1x16 (spec)
256	842	9657	12425	11443
4096	819	12281	11987	12234

64 Threads

Resolution	Serial	8x8
256	842	22521
4096	819	48842

Raw Results in MFlops (Jacobi)

4 Threads

Resolution	1	2x2	4x1	1x4
256	2943	4215	4151	4252
4096	2587	4151	4102	4137

16 Threads

Resolution	1	4x4	16x1	1x16
256	2943	11632	11871	12706
4096	2587	16078	15532	16202