Parralelisation of a Staggered Grid solver

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Outline

Why parallelize your code?

Pro

- more compute power
- more memory
- parallel computing is the future

Con

- added code complexity
- communication overhead
- Increased power consumption

Don't parallelize without profiling and performance modelling!

MPI in a nutshell

The Message Passing Interface

- call your program with `mpirun -np <N> <NAME> <ARGS>`
- spawns `<N>` identical processes
- only `MPI_MPI_Comm_rank(...)` gives different results

Typical usage:

- split domain between all processes
- perform local updates
- exchange the borders
- repeat

Implementation

The following steps must be parallelized

- SOR::solve()
- SOR::residual()
- SOR::normalize()
- determineNextDT()
- refreshBoundaries()
- computeFG()
- composeRHS()
- updateVelocities()

Most of the time is spent in the SORSolver, so this is the focus.

Domain partitioning

- Usually domain is split in roughly quadratic tiles
- We chose the simpler approach: Split in horizontal stripes

Pro

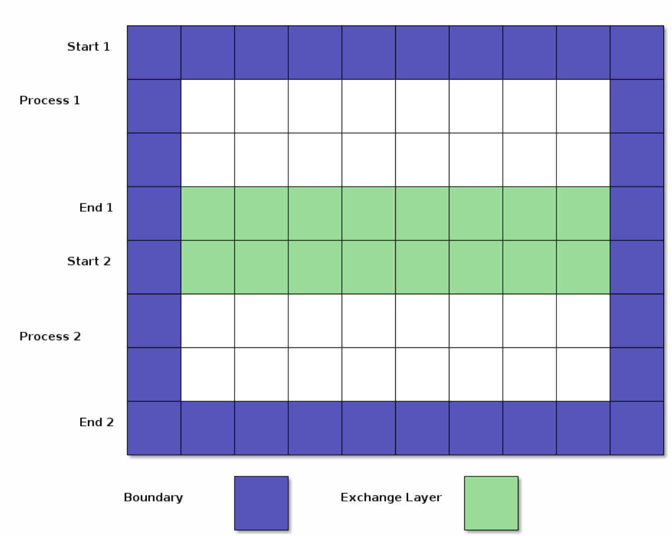
- easier to implement
- fast access patterns along the cachelines

Con

- bad surface / size ratio for large number of processes
- more communication overhead

Domain partitioning (cont.)

Example of a 8 x 9 domain with 2 processes



Continuous migration

How do we migrate our serial codebase to a parallel one without the agonizing pain™ ?

Migration phase:

- Every process still has all the data
- Parallelize only one operation at a time
- Methods can be tested individually

When all methods are converted, switch the Array implementation to store only local elements.

Results

Was it worth the effort?
Explanation:

- SOR or Jacobi solver does not scale well

Use a better algorithm before writing parallel code!

Possible improvements for numerical codes

Use LISP