Programming of Supercomputers

Assignment 3:
MPI Point-to-Point and One-Sided Communication

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Schedule Updates

- **Assignment 1 and 2:**
  - Discussion today

- **Assignment 3 and 4:**
  - Core programming and optimization assignments
  - Deadlines: 12 of January, and 2 of February
    - Need to discuss our sessions
  - A3 introduced today; a few comments about A4

- **Video and Oral Exam**
  - Summary of A1, A2 and A3 in the video
  - Oral exam covers all topics from A1 to A4
  - Deadline TBD: passible to determine it today

- **Course evaluation email sent**

Assignment 1 Discussions

- After submissions we encourage you to interact, but not before
  - Compare your results among each other
  - Learn from each other's experience

- Key issue with many was the performance metric
  - Grind time
  - FEM
  - **Incorrect**: wall clock time
    - Weak-scaling applications cannot be evaluated with this metric
    - Problem size varies with the number of processes in this case

Suggestions:

- Enumerate questions in the same order as they were stated
  - No points were taken based on this

Assignment 2 Discussions

- Bugs in parallel programming
  - Were you familiar with them?
  - What did you learn about floating point arithmetic?
  - Are all of them parallel programming specific?
- What do you think about TotalView?
  - Is it worth learning?
  - Good OpenMP support?
  - Good MPI support?
  - Did you explore more than what was in the assignment?
- Alternative: Allinea DDT
  - Also in SuperMUC if you want to try it

MPI Point-to-Point Communication

- Covered in the Parallel Programming lecture
- Large set of operations in the standard
  - Send, receive and combined operations
    - Receives matching sends
  - Blocking and non-blocking
    - Wait and probe
  - Buffered, ready, synchronous

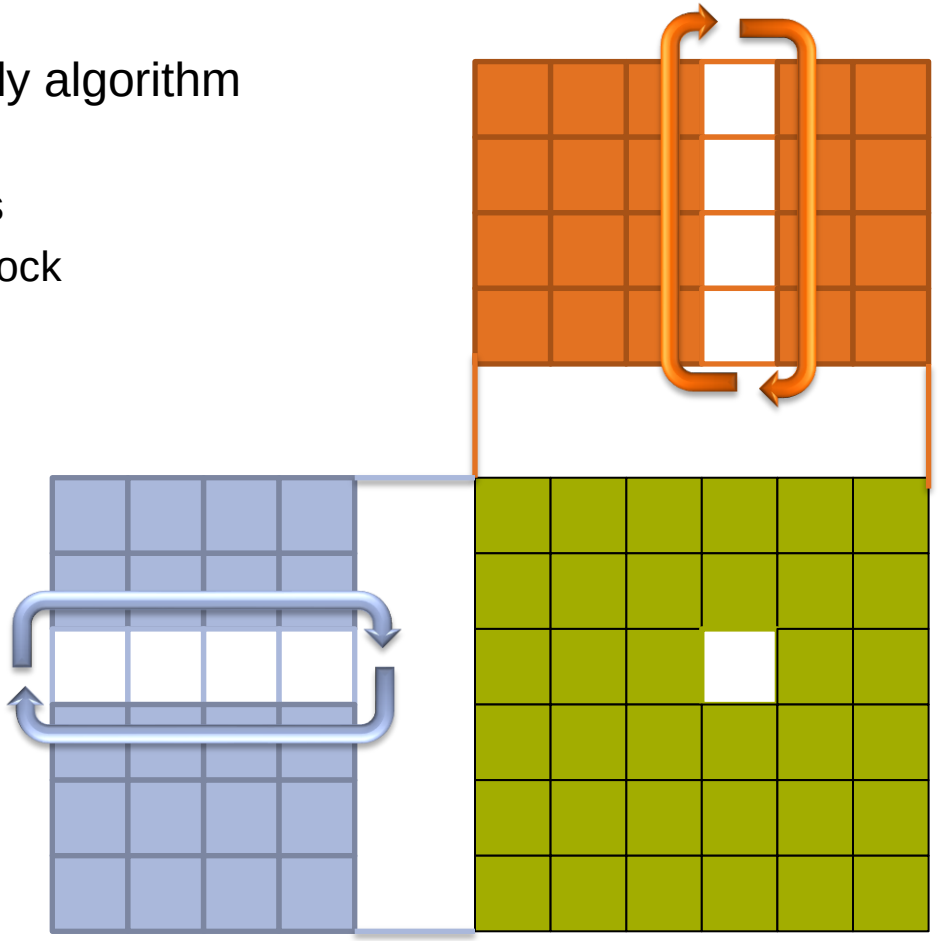
- Part 1 of the assignment
  - Focus on blocking and non-blocking communication
  - Convert blocking to non-blocking communication
  - Try to achieve overlap
    - Perfect overlap is the target
    - Theoretical double performance

MPI One-Sided Communication

- Also covered in the Parallel Programming lecture
- Remote Memory Access (RMA)
- Operations are non-blocking
  - Remote process not blocked during transfer
  - Possible overlap with theoretical double performance
- No need for matching operations at the receiver
- Also a large set of operations in the standard
  - Put and get operations
  - Direct access to memory of other processes through windows
- Multiple benefits vs. point to point communication
  - Aim to reduce synchronization with bulk transfers and no direct matching
  - Aim to reduce data movement by eliminating intermediate buffering
  - Can simplify programming since only one side of the communication is specified
  - Can better benefic for RMA hardware features in some NICs

Cannon's Matrix-Matrix Multiplication

- Distributed Matrix-Matrix multiply algorithm
  - Works well in 2D meshes
  - Constant storage requirements
  - Each process stores its own block
  - Cycle operand blocks
- Implementation given
  - MPI blocking point-to-point
  - Cartesian topology
- Tasks:
  - Convert to non-blocking
  - Convert to one-sided
- Scale of the programming task
  - 4 nodes
  - 64 processes
  - Large generated matrices



Recommended: Vampir Trace or Intel Trace Analyzer