Project Proposal: Efficient Message Passing

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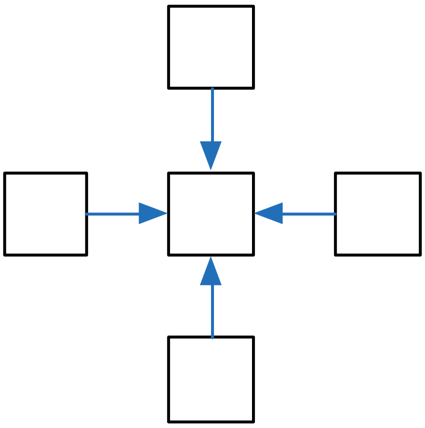

Fig. 1. 4 point 2D von Neumann style stencil

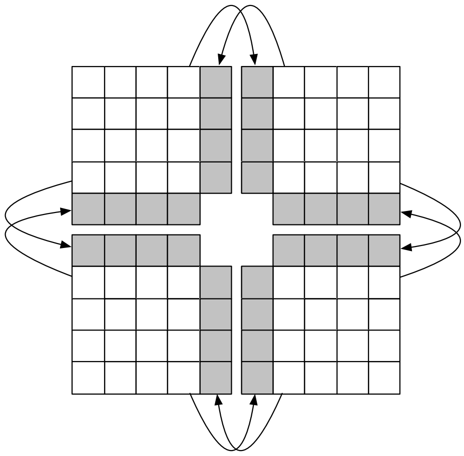

Fig. 2. Communications patterns in 2D decomposition over 4 nodes.

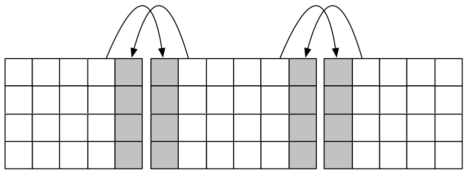

Fig. 3. Communications patterns in 1D decomposition.

I. Background

Stencil codes are commonly found in applications where computer simulation is used to model physical processes. These applications employ iterative kernels which traverse elements of the simulation and update them based on the values of their neighbours. The pattern of neighbourhood cells which provide input to each update, such as the one seen in Fig. 1, is referred to as a stencil.

Scientific computing workloads are typically spread over multiple nodes within a cluster to reduce time to solution and allow larger simulation domains. For stencil codes, the simplest approach is to statically assign each node with a fixed-size continuous subsection of the simulation domain. Nodes then only have to communicate with their neighbours to exchange boundary data at the end of each simulation step.

Fig. 2 shows how ghost cells can be used in two dimensions to support boundary communications. The ghost cells mirror the current values in the boundary cells of their corresponding neighbour processor. Once boundary cells are swapped each node can perform its time step calculations independently.

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