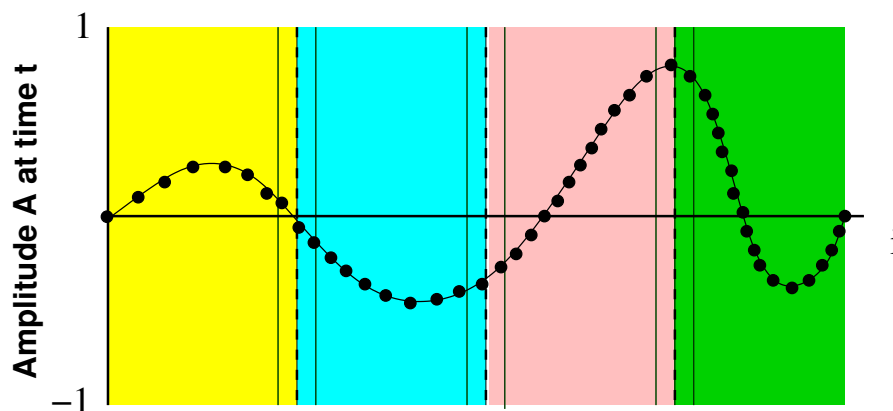# Assignment 2

Message Passing with MPI

Assignment 2.1: Distributed wave equation simulation

Reconsider the 1-dimensional wave equation studied in assignment 1.1. Write a distributed C+MPI program that uses multiple compute nodes to simulate the above wave equation following the domain decomposition approach as illustrated below.

Each MPI process shall only store the relevant parts of the three amplitude buffers in its local memory. Add halo cells as necessary and exchange their values between time steps as needed. Aim at an efficient implementation that overlaps communication with computation as demonstrated during the lecture.

Repeat your experiments of assignment 1.1 with three different system configurations: up to 8 MPI processes on a single node, up to 8 nodes with a single MPI process per node and up to 8 nodes with 8 MPI processes per node. Compare the results of the new experiments with those of assignment 1.1.

Assignment 2.2: Collective communication

Collective communication is a form of structured communication, where instead of a dedicated sender and a dedicated receiver all MPI processes of a given communicator participate. A simple example is *broadcast* communication where a given MPI process sends a message to all other MPI processes in the communicator. Write a C+MPI function

```
int MYMPI_Bcast( void *buffer,          /* INOUT : buffer address   */
                 int count,             /* IN    : buffer size */
                 MPI_Datatype datatype, /* IN    : datatype of entry   */
                 int root,              /* IN    : root process (sender)  */
                 MPI_Comm communicator) /* IN    : communicator   */
```

that implements broadcast communication by means of point-to-point communication. Each MPI process of the given communicator is assumed to execute the broadcast function with the same message parameters and root process argument. The root process is supposed to send the content of its own buffer to all other processes of the communicator. Any non-root process uses the given buffer for receiving the corresponding data from the root process.

A particular advantage of collective communication operations is that their implementation can take advantage of the underlying physcial network topology without making an MPI-based application program specific to any such topology. For your implementation of broadcast assume a 1-dimensional ring topology, where each node only has communication links with its two direct neighbours with (circularly) increasing and decreasing MPI process ids. While any MPI process may, nonetheless, send messages to any other MPI process, messages may need to be routed through a number of intermediate nodes. Communication cost may be assumed to be linear in the number of nodes involved. Aim for an efficient implementation of your function on an (imaginary) ring network topology.

Assignment due date: November 15, 2012, 12:00