Added technical aspects of p4est: Alternative quadrant representation and MPI-3 shared memory

Mikhail Kirilin, Carsten Burstedde
University of Bonn, Germany

Introduction

Many numerical simulations require a mesh of computational cells covering the domain of interest. The solution is approximated by functions associated with a set of cells.

- Implementation: the p4est software library
- Dynamic management of adaptive octrees
- Discretization of a computational domain
- Efficiently manages large-scale parallel tasks

The p4est library is actively used worldwide: linked e.g. by solver libraries deal.ii, PETSc, ForestClaw. Some possible applications: continuum mechanics and particle simulation.

Alternative quadrant representations

Cells as quadrants

p4est represents cells with 2D squares (3D cubes) which we call quadrants (octants). Their characterization:

- Defined by the coordinates of a corner and a level.
- It is allowed for them to be of various sizes.
- Store user’s information depending on application.

Per-quadrant operations are listed in the original paper on p4est.

Partition

Implemented Parent algorithm, constructing parent r of the 128-bit quadrant q. Written with use AVX/SSE.

Since an octant is defined by x, y, z and f, we consider four-way SIMD (Single Instruction Multiple Data) for accelerated processing. We base new quadrant representation on the Advanced Vector Extensions/Streaming SIMD Extensions (AVX/SSE).

### Reference