Optimization of a Finite-Volume Method Application

MPI: Implementation and Anlysis

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Convexion-Diffusion (Recap)

What? Calculates the heat diffusion of a fluid while it spreads through an area;

How? Uses Finite-Volume method;

Why? Represents surface as a mesh, making each cell only dependent of its neighbours;

Approach

- Mesh is shared by all processes;
- Work is divided among all processes;
- Master process gathers all data;

Problems

- High level of communication between processes;
- High level of barrier synchronization;
- Some balancing problems;
- Computed error spikes;
- Some of FVLib's templates are hard to serialize (locality);
- Sequential portion is slow;

Environment

Environmental Setup

- SeARCH Group 101
  - 64-bit Intel®Xeon™@ 3.2 GHz;
  - 4 hardware threads per node;
  - 16 KB L1 data cache, 2 MB L2 cache, 2 GB RAM;

Results

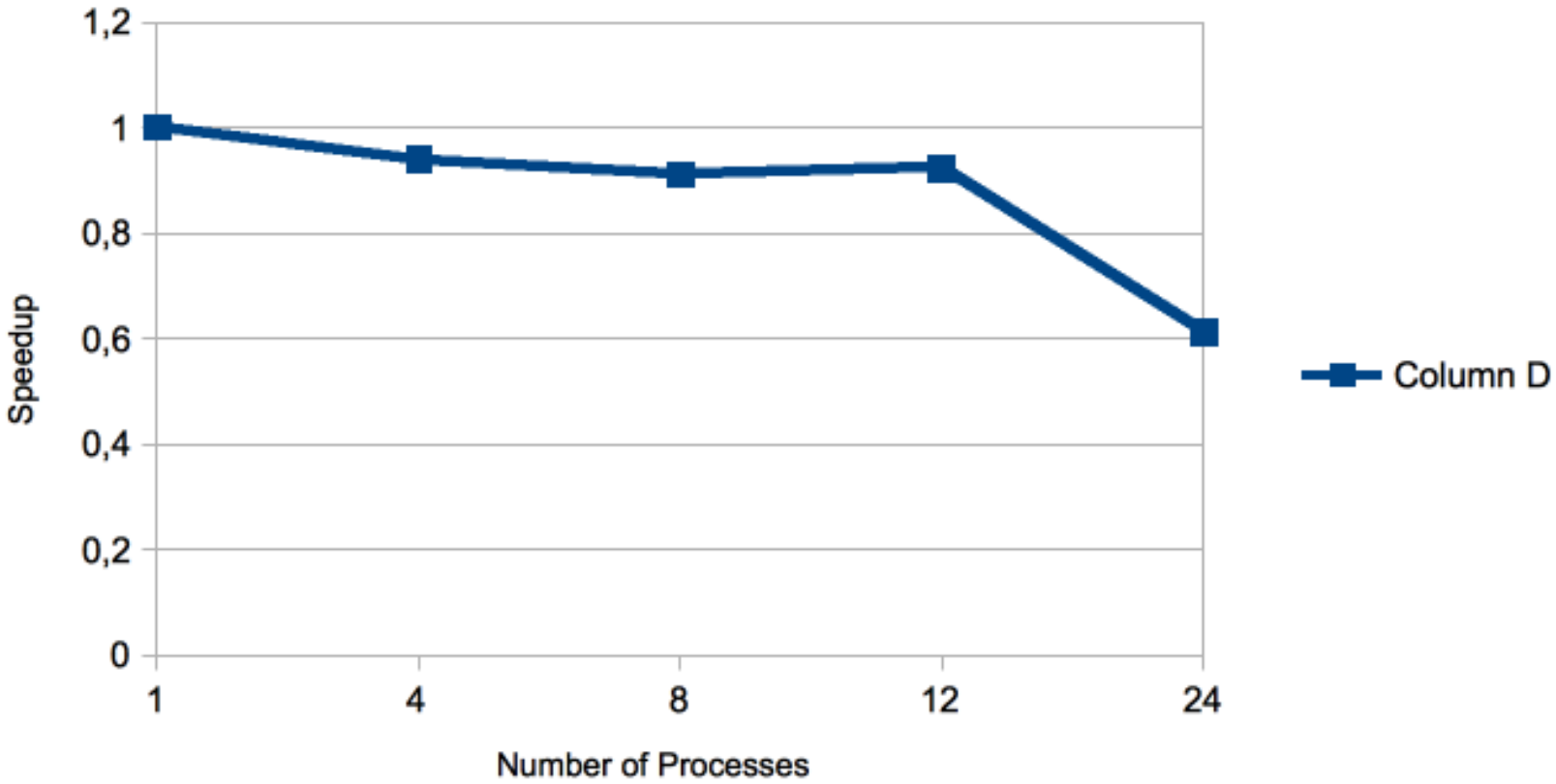

Figure : Achieved Speedups

Results

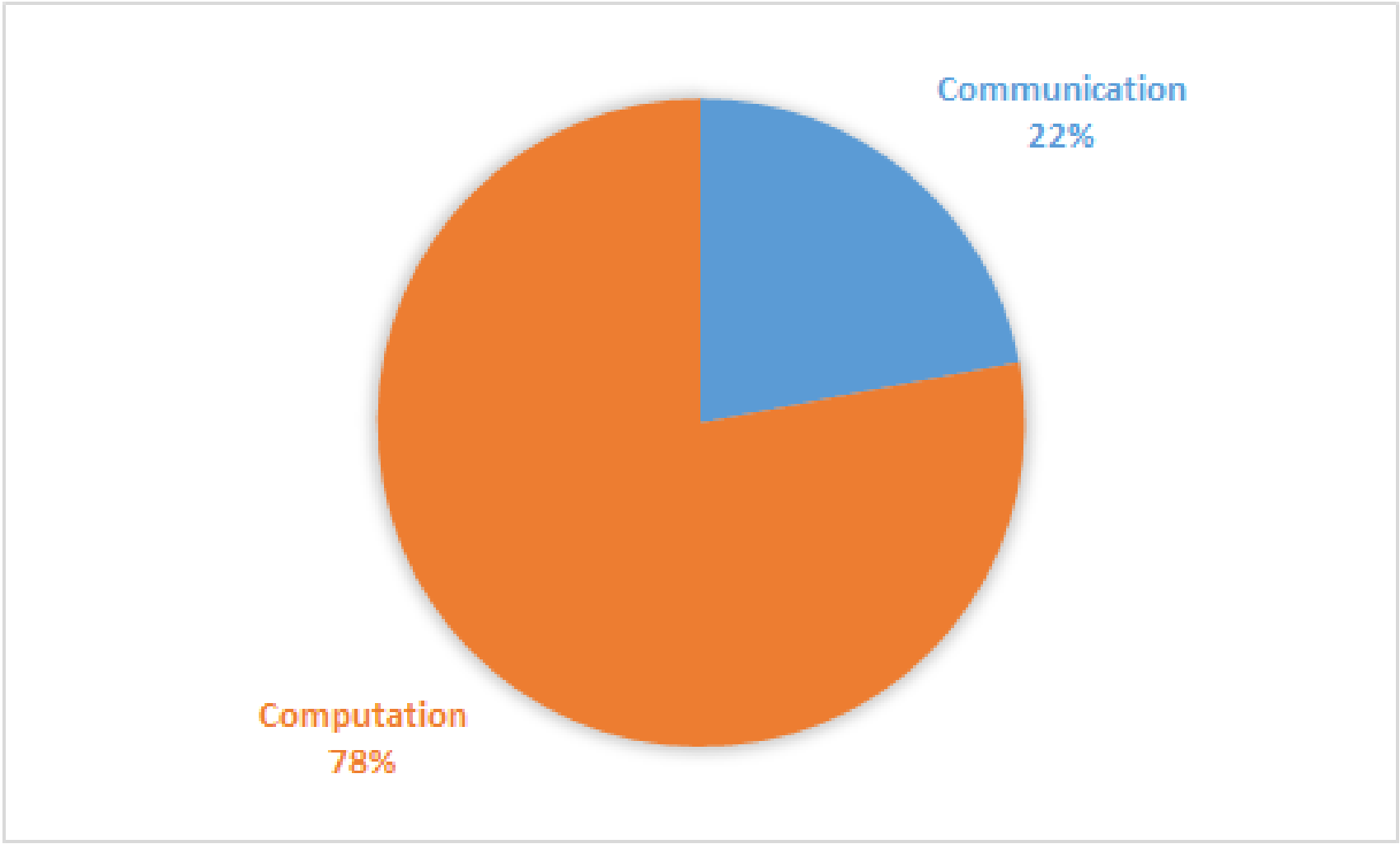

Figure : Communication/Computation Ratio

Conclusions

- Excessive communication hinders performance in MPI;
- FVLib's templates were a problem;
- Further optimization would be difficult;

Roadmap

- Converting structures to SOA;
- Optimize for OpenMP;
- Finally try a CUDA implementation;

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