Parallel 3D Adaptive Mesh Refinement in Titanium

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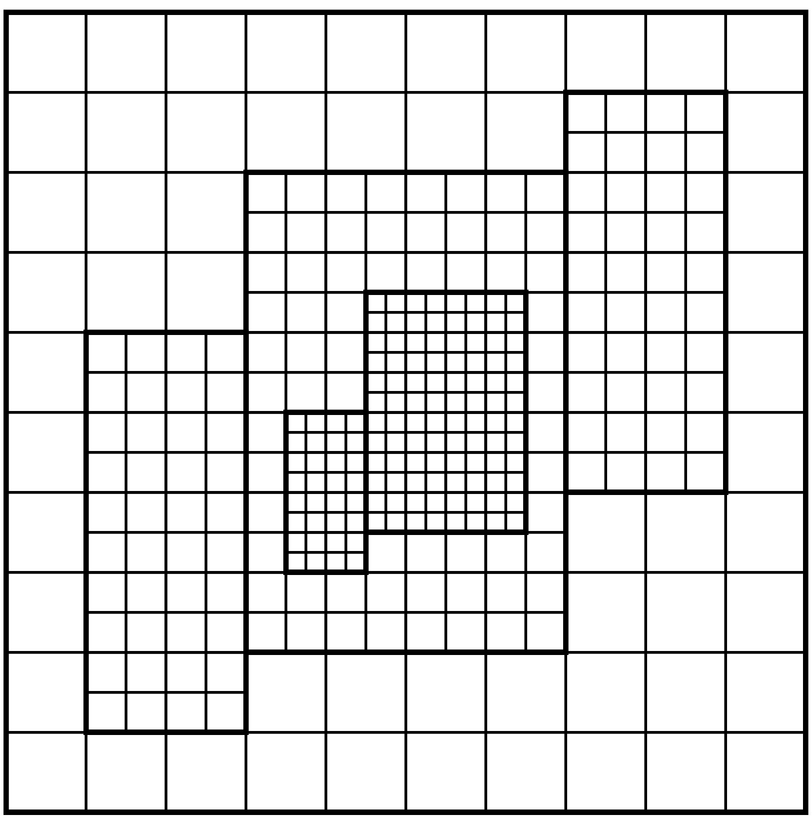
AMRPoisson

- Goal is to solve Poisson's Equation
- Similar to Multigrid, more efficient
- Patch-based algorithm



Titanium

- based on Java
- extensions for scientific computing
- SPMD parallelism
- shared address space
- efficient
- portable

Titanium Example

```
foreach (p in rhs.domain() / [2, 2, 2]) {
    field[p * 2] += factor[p * 2] * (
        field[p * 2 + [ 0, 0, 1]] +
        field[p * 2 + [ 0, 0,-1]] +
        field[p * 2 + [ 0, 1, 0]] +
        field[p * 2 + [ 0,-1, 0]] +
        field[p * 2 + [ 1, 0, 0]] +
        field[p * 2 + [-1, 0, 0]] -
        6 * field[p * 2] -
        h * h * rhs[p * 2]);
}
```

Preliminary Results

sequential 3D multigrid:

(64x64x64 problem size)

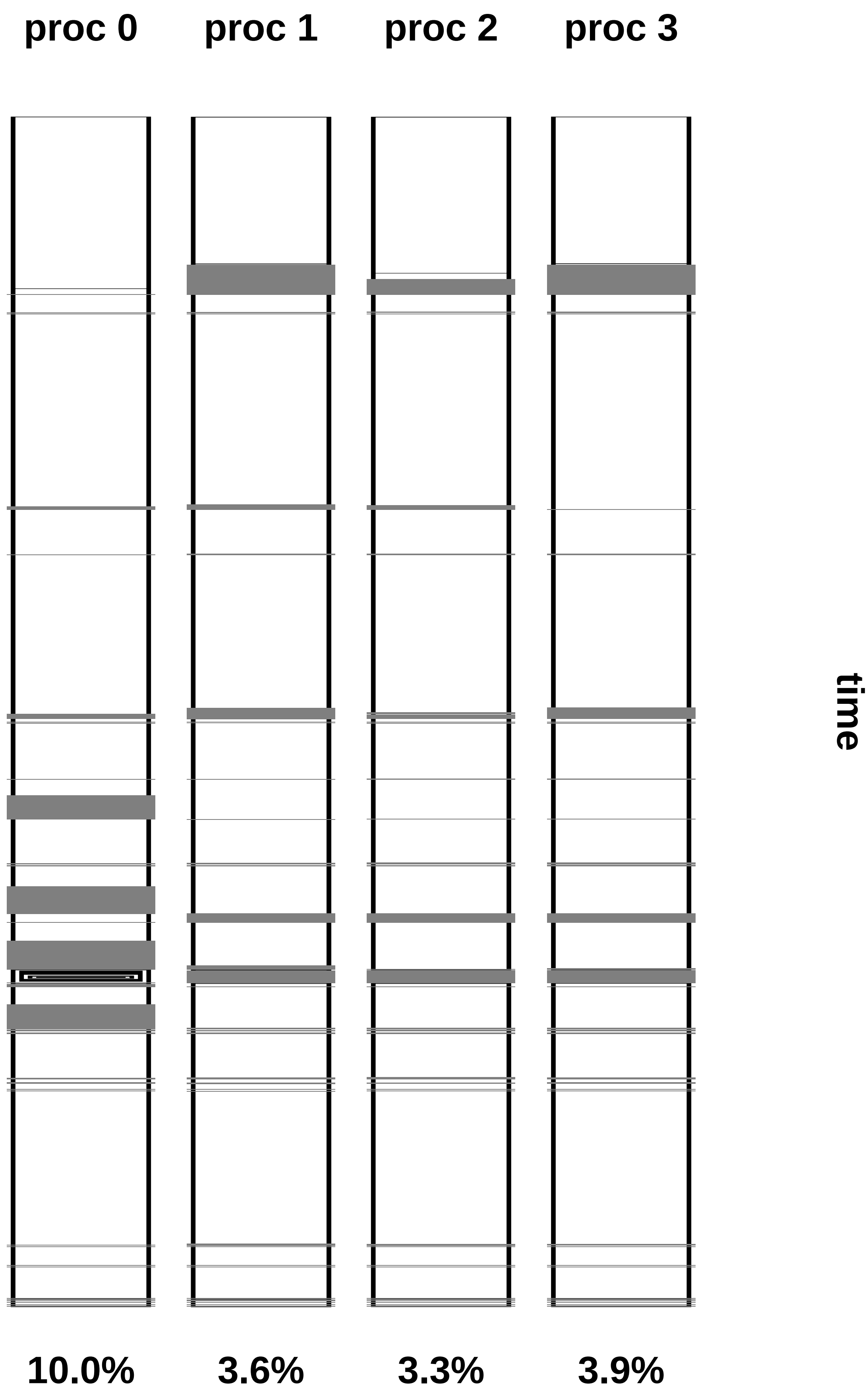
within about 20% of FORTRAN

parallel 3D AMR:

(on a fixed well-balanced problem
8 patches of size 72x72x72 at finest level)

5x to 5.5x speedup on 8 procs

Timeline with Barriers



Conclusions

What makes it work:

Titanium Programming Model
amrvis (LBNL/CCSE) for visualization
Profiling tools beyond gprof

Future Work:

Adaptivity
Combine with larger application
(e.g., self-gravitating compressible flow)