# The Quake Project

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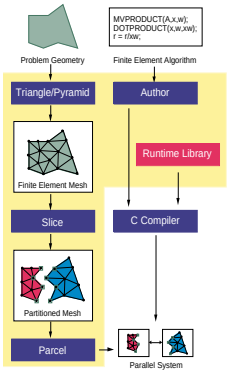
www.cs.cmu.edu/~quake/

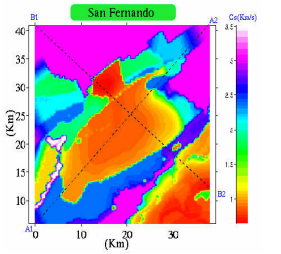


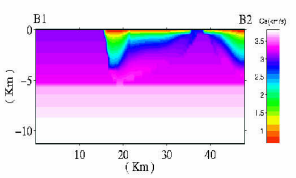

(a) Archimedes

The Quake project develops automatic techniques for building 3D FEM simulations that predict earthquake induced ground motion. The models, which are developed using a tool chain called *Archimedes* (a), are based on meshes with up to 80 million tetrahedral elements (b). Starting from a geological model of the LA Basin provided by San Diego State University (c), nodes are dispersed throughout the domain (d) and tetrahedralized (e). The resulting mesh is partitioned (f), parceled (g), and finally simulated on a parallel system (h). The key idea is that the engineers who develop the simulations write sequential codes in terms of the global equations. They are insulated from the details of parallel computation.

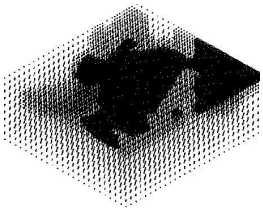
| | sf10 | sf5 | sf2 | sf1 | sf1b |
|---|---|---|---|---|---|
| nodes | 7,294 | 30,169 | 378,747 | 2,461,694 | 13,422,563 |
| elements | 35,025 | 151,239 | 2,067,739 | 13,980,162 | 76,778,630 |

(b) The San Fernando meshes

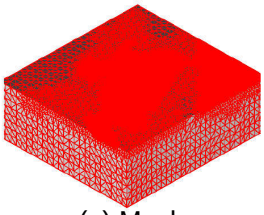


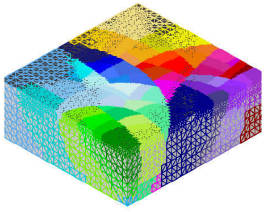

(c) Geological model



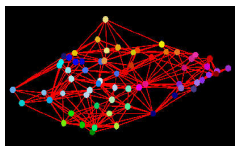
(d) Nodes



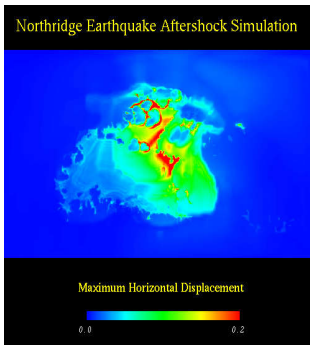
(e) Mesh



(f) Partitioned mesh

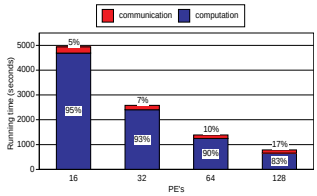


(g) Comm graph

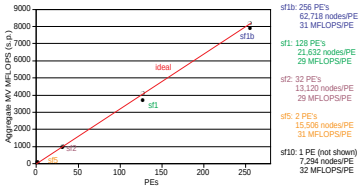



(h) Max displacement

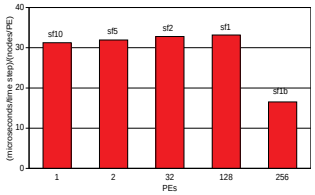
## Performance of Archimedes Quake simulations on the T3D at Pittsburgh Supercomputing Center




The codes spend at most 20% of their time in the communication phase.




Quake codes with similar workloads have similar per-PE MFLOPS rates.




The elapsed time per timestep per node on each PE is nearly constant.