

Application of high performance computing: earthquake hazard and infrastructure risk assessments

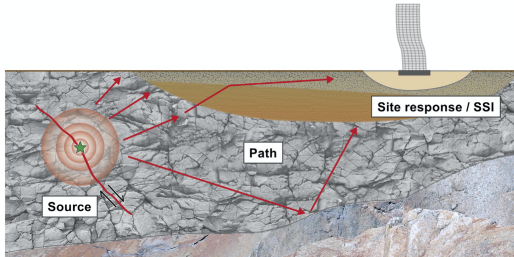
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02/18/2021

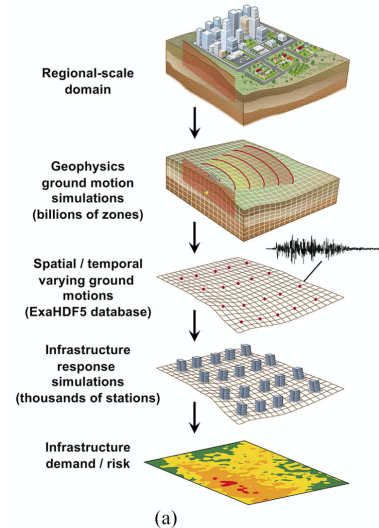


Application problem: fault-to-structure regional-scale simulations of ground motion and building response.



Algorithms:

- ▶ Earthquake ground motion simulation: SW4 (Seismic Waves, 4th order) a Summation-By-Parts (SBP) finite-difference program
- ▶ Infrastructure system response: implicit, nonlinear finite element representations



Super Computer: Cori and Summit (No.2 in the the Top500 list)

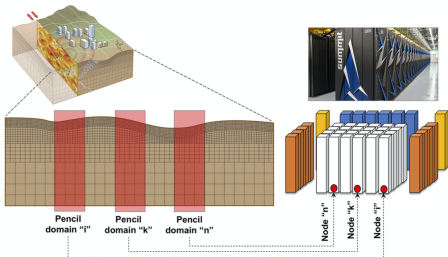
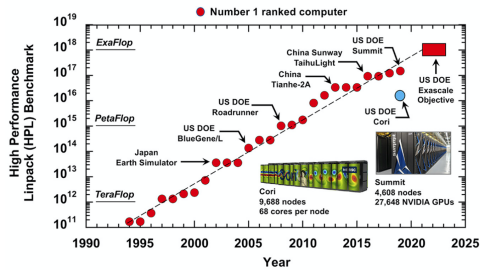


Table 1. Progression of EQSIM ground motion simulations with SW4

Benchmark simulation (platform)	Code attributes	Frequency resolution (Hz)	Number of compute nodes	Wall clock time (h)	Figure of merit
A (Cori)	Initial run of SW4 ported to Cori	3.67	2048	23.9	1.0
B (Cori)	SW4 with optimized hybrid MPI/OpenMP loops	4.17	6528	12.0	3.32
C (Cori)	SW4 with Cartesian mesh refinement	4.17	4000	6.0	6.63
D (Cori)	SW4 using all of the Cori computer	5.0	8192 (all of Cori)	9.2	8.95
E (Summit)	Initial run of SW4 ported to the Summit computer	10.0	1200 (1/4 of Summit)	19.9	66.2
F (Summit)	Most recent run of SW4 including enhance I/O, curvilinear, and Cartesian mesh refinement	10.0	1024 (<1/4 of Summit)	6.9	189

SW4: Seismic Waves, 4th order.

US Department of Energy (DOE) Exascale Computing Project
Top 1 computing project in National Energy Research Scientific Computing Center (NERSC)

Reference: McCallen, David, et al. "EQSIM—A multidisciplinary framework for fault-to-structure earthquake simulations on exascale computers part I: Computational models and workflow." Earthquake Spectra (2020): 8755293020970982.