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Urban earthquake simulation of Tokyo metropolis using full K computer

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Reflecting detailed urban geographic information data to earthquake simulation of cities is expected to improve the reliability of damage estimates for future earthquakes. Such simulations require high resolution computation of large and complex domains and thus fast and scalable finite element solver capable of utilizing supercomputers are needed. Targeting massively parallel scalar supercomputers, we have been developing a fast low-ordered unstructured finite element solver by combining multi-precision arithmetic, multi-grid method, predictors, and techniques for utilizing multi-cores and SIMD units of CPUs. In this talk, I will show the developed method and its scalability/performance on the K computer. Together, I will show some small scale measurement results on Intel Haswell CPU servers for checking performance portability. As an application example, I will show an urban earthquake simulation targeted on a 10 km by 9 km area of central Tokyo with 320 thousand structures. Here the surface ground is modeled by 33 billion elements and 133 billion degrees-of-freedom, and its seismic response is computed using the whole K computer with 82944 compute nodes. The fast and scalable finite element method can be applied to earthquake wave propagation problems through earth crust or elastic/viscoelastic crustal deformation analyses and is expected to be useful for improving resolution of such simulations in the future.