Performance Comparison between FDTD and FEM for the Simulation of Plasmonic Waveguide Operating at Optical Communication Frequency

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Due to the growing research in nano technology, the requirement of numerical tools becomes demanding for accurate and fast design. The shrinking electronic or optical devices have brought intense computational burden than ever for the accuracy-concerned refined computational meshes. Based on the above reason, high performance computers are needed to achieve multiple design tasks. At present, there are couple electromagnetic simulators available for the design of nano or THz devices. However, the performance of different algorithms may differ a lot. In this work, the performance of open-source parallel Finite-Difference Time-Domain (FDTD) software on supercomputer Eos and Ranger and the performance of a Finite Element Method (FEM) package on a single workstation are compared for plasmonic waveguide mode coupling simulation (Fig. 1). It is shown that, for the difference of numerical algorithms and material boundary treatment between FDTD and FEM, FEM performs better than FDTD for our design problem. For FDTD, the dimension of the computational window is 15.5 x 10 (all physical parameters are normalized so no unit is described) and the total number of grids is 6,200,000. Due to the nature of FDTD, long-time iteration is required to achieve numerical stability and accuracy. Table I lists the wall clock time Eos took for each submitted job with different core number requested. Based on this statistics, the simulation time cannot be reduced further with more than 96 cores. On the other hand, for the same problem, the simulation widow for FEM is also 15.5 x 10. However, the number of unknown used here is only 159,512 (~1/40 of the number used in FDTD) to achieve required accuracy and stability and the computation time is less than 1 minute.

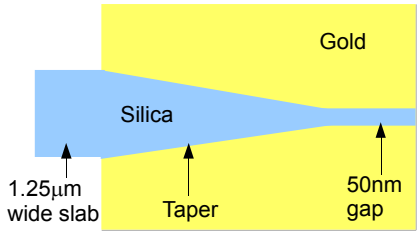

Fig. 1.

Table I. Run Time for FDTD with Different Core Number

Total Core Number on Eos	*8 Tasks/ node* (hour:minute:second)
16	10hrs:48:02
32	4hrs:51:10
48	1hr :28:48
64	1hr :09:53
80	1hr :02:16
96	00hr:48:19
128	00hr:44:51
144	00hr:43:14