

This note describes how various configurations of workstations/server systems performed for COMSOL metamaterial simulations. The benchmarking simulation (WaveOptics module) was a frequency domain study of a metamaterial model with periodic conditions and PML layers at the top and bottom. The simulation had 2813822 degrees of freedom (mesh had 417057 elements). I used a direct solver, PARDISO. Three systems were used, none as a cluster, only as standalone workstations. All three were dell dual core Xeon based workstations. Configurations are as follows:

Brown → Dell poweredge T620 with 16 core (2x8) Xeon E5-2650 @ 2.0GHz, 128 GB RAM (DDR3 assumed), Linux only

Bob → Dell power edge C6220 II, 20 cores (2x10) Xeon E5-2660 v2 @ 2.2 GHz, 160 GB RAM (DDR3), Linux only

Thunder → Del Precision Tower 7910 , 20 cores (2x10) Xeon E5-2687w v3, 256 GB RAM (DDR4 2Rx4 RDIMM 2400Mhz, 32GB sticks), with SSD. RAM was configured to have one module per channel, as suggested by COMSOL (<https://www.comsol.com/support/knowledgebase/866/>) . Win7 and Linux.

Hyperthreading (HT) was most likely enabled on Brown and Bob, I had no control over this hence cannot turn it off. I tested Thunder with and without the HT. Table 1 shows the results of simple controlling the number of cores being used and the best possible times from the three machines that could be achieved. Time is in minutes (decimal value is seconds/60) for solving a single frequency point.

| Cores | Brown | Bob | Thunder (Win7, HT off) | Thunder (Linux, HT off) |
|-------|-------|------|------------------------|-------------------------|
| 20 | | 11.4 | 9.8 | 7.99 |
| 16 | 13.5 | 12.4 | 10.3 | 8.8 |
| 14 | 14.5 | 13 | 10.86 | 9.68 |
| 10 | 18.5 | 17.2 | 13.55 | 11.86 |
| 8 | 22 | 21.4 | | |
| 6 | 29 | 26.6 | | |

Table 1: Time results for the benchmarking

These were also plotted in figure 1 with additional benchmarking tests as well. It is quite evident that the trend of increasing core counts helps up to roughly 16 cores, beyond which the reduction in time is subtler. However increasing the core speed certainly drop as we can see that from 2 GHz (Brown) to 2.2 GHz (Bob), the overall times drop for the same core counts. Thunder (3.1Ghz) being 1.5 times faster than Brown, gives almost double the speed for the simulation time with Linux. The memory is of great importance as well as the older systems have DDR 3 whereas Thunder has 2400 MHz DDR4 which is nearly 1.5 times higher in clock speeds. The newer v3 Xeon processors also have higher overall bus speeds (Thunder with 9.6 GT/s) should be quite important here as well. I believe that quite a bit of the overhead falls from memory communications and hence should be optimized. Hence the single DIMM per channel configuration.

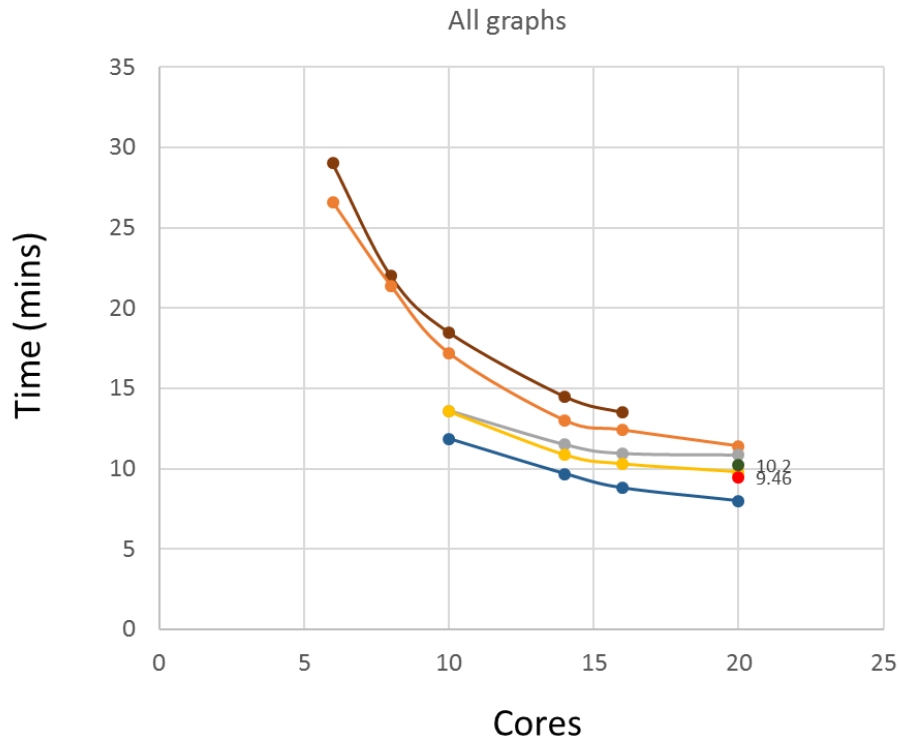


Figure 1: Plot of benchmarking. Brown (Brown line), Bob (orange), Thunder with Win7 HT on (Grey), Thunder with Win7 HT off (Yellow), Thunder with Linux and HT off (Blue). There are two separate points for Thunder Win7 without multicore control enabled in COMSOL for HT on (green) and HT off (red).

HT does add an overhead and this gets worse for more cores as can be seen with the Win7 results in figure 1. Interestingly, even though people mentioned on forums that swapping between Linux and Win7 shouldn't matter, results show that it matters a lot. I used Scientific Linux (v7) and the time for 20 cores dropped by nearly 2 mins!!! Also Win7 won't be able to make use of the 256 GB of RAM, it is limited to 192GB, hence for higher mesh simulations requiring over 200GB (some crazy simulations I plan to do!), Linux would need to be used. From experience, using a batch script to run the simulation also drop a bit of time, probably due to with the GUI using the resources. All the results for Brown and Bob were with script runs for optimal results, I have not done so with Thunder as yet. On Win7 closing any additional CPU monitors or programs shaved a few seconds as well. Lastly, unchecking the multicore control changed simulation times slightly as well, though this could be just a bit of variation from sim to sim, it increased for when HT was on and decreased when HT was off. I hope this helps others!

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