tNavigator scales to GPU's

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In 1965 Gordon Moore, one of the Intel co-founders, predicted that the number of transistors in a dense integrated circuit doubles approximately every two years. This is known as Moore's law and the statement has proved to be true over the last 40+ years. These days we have technology that grows even faster than the CPU's – graphical processing units (GPU).

Recently, new generation of GPU became available for general purpose computing with the support of double precision floating point operations, necessary for dynamic reservoir simulations. The graphics cards currently available on the market have thousands of computational cores that can be efficiently utilized for high-performance simulations, Figure 1.

In addition to the number of cores, the latest GPU's also have significantly greater memory bandwidth, which is equally important for efficient parallel simulations as it is effectively the speed of communication between the cores. The progress in this component is so rapid that we can expect further breakthroughs in this direction and significant changes in the hardware world in the nearest future.

The software development team in Rock Flow Dynamics has recently implemented capabilities to run simulations in hybrid CPU-GPU mode, utilizing all computational power available. The hybrid parallelization algorithms distribute the workload between CPU and GPU hardware components so that all computer resources are utilized for the best simulation performance.

The results have shown that utilizing of combination of CPU and GPU in the simulations, balancing the workload between them, significantly improves the simulation time. For example, let us consider the well known SPE10 case, which is often used as a benchmark for simulation performance. The model is strongly heterogeneous and has large differences in the reservoir properties, which is always quite a challenge for the simulation software. The figure 2 shows comparison of the simulation time on 3 various platforms: regular laptop

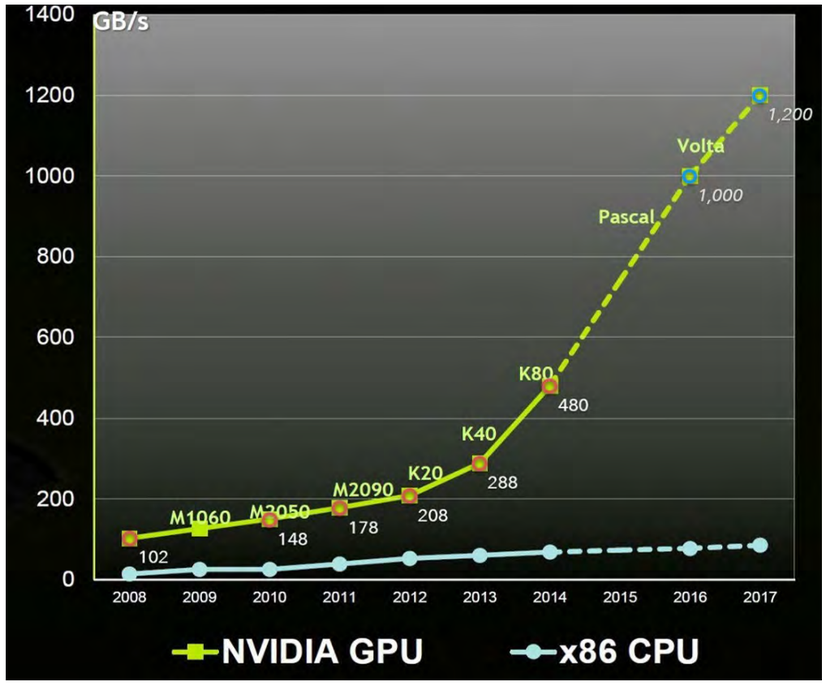


Figure 1. Memory bandwidth progress for GPU and CPU platforms

SPE Norway — Reservoir simulation

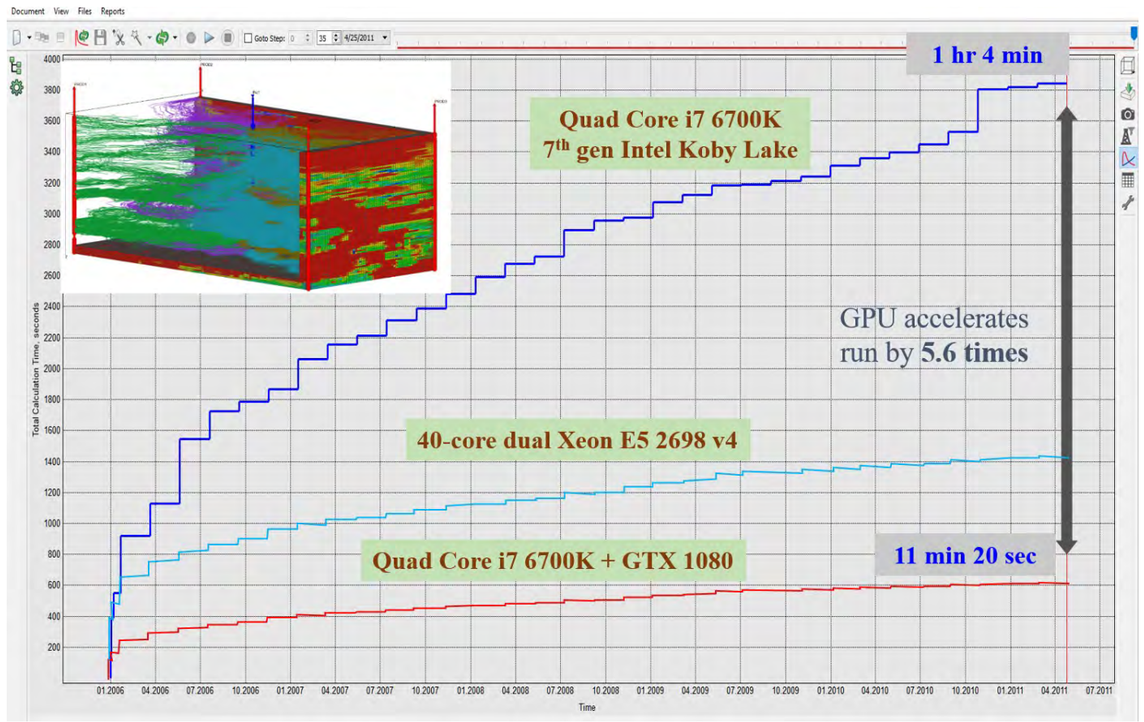
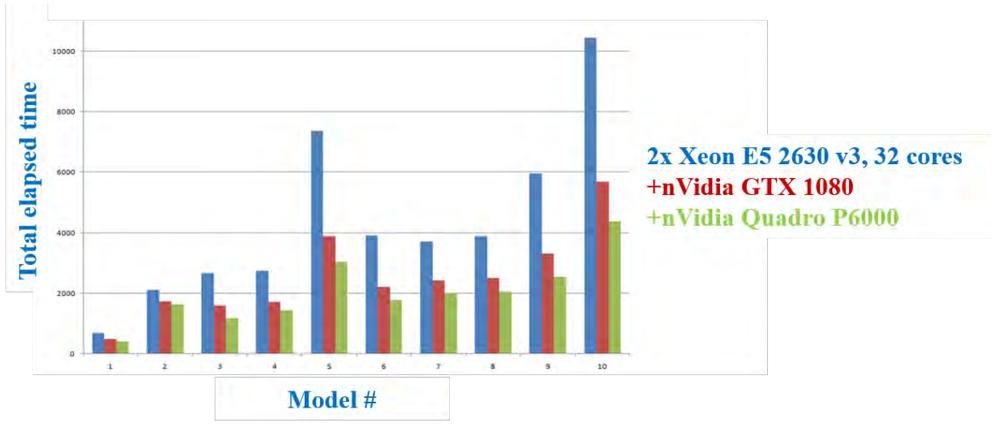


Figure 2. SPE 10 benchmark for simulation time. 4-cores laptop – dark blue line; Dual-CPU workstation – light blue line; 4-cores laptop with GPU – red line.

with 4-cores CPU, powerful dual-CPU workstation (somewhat like HP z840) and the laptop from the first test but with GPU enabled for computations. As you can see form the figures, the difference in the simulation time between the cases with and without GPU is 5-6 times. The simulation time is reduced significantly, without too much investment in hardware. You can find a laptop of this kind in any hardware shop for about $2000. It is also worth mentioning that a machine like this outperforms a significantly more expensive workstation with 40 CPU cores (~$15000) by about 2 times.

It is actually quite difficult to predict where the hardware competition is going to go in the near future. Even before the end of this year we can expect several releases of the new chips by Intel, NVidia and AMD. Time will tell who is going to deliver the best results, but there is no doubt that the high-performance hardware world is changing rapidly these days and we can expect reservoir simulations to run significantly faster in the near future. The race is definitely going to be interesting…



Comparison of the simulation time on 10 random real-field 3-phase black-oil models.