ECHELON

CASE STUDY // BILLION CELL SIMULATION

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ECHELON ENABLES THE MODELING AND SIMULATION OF GIANT CONVENTIONAL RESERVOIRS.

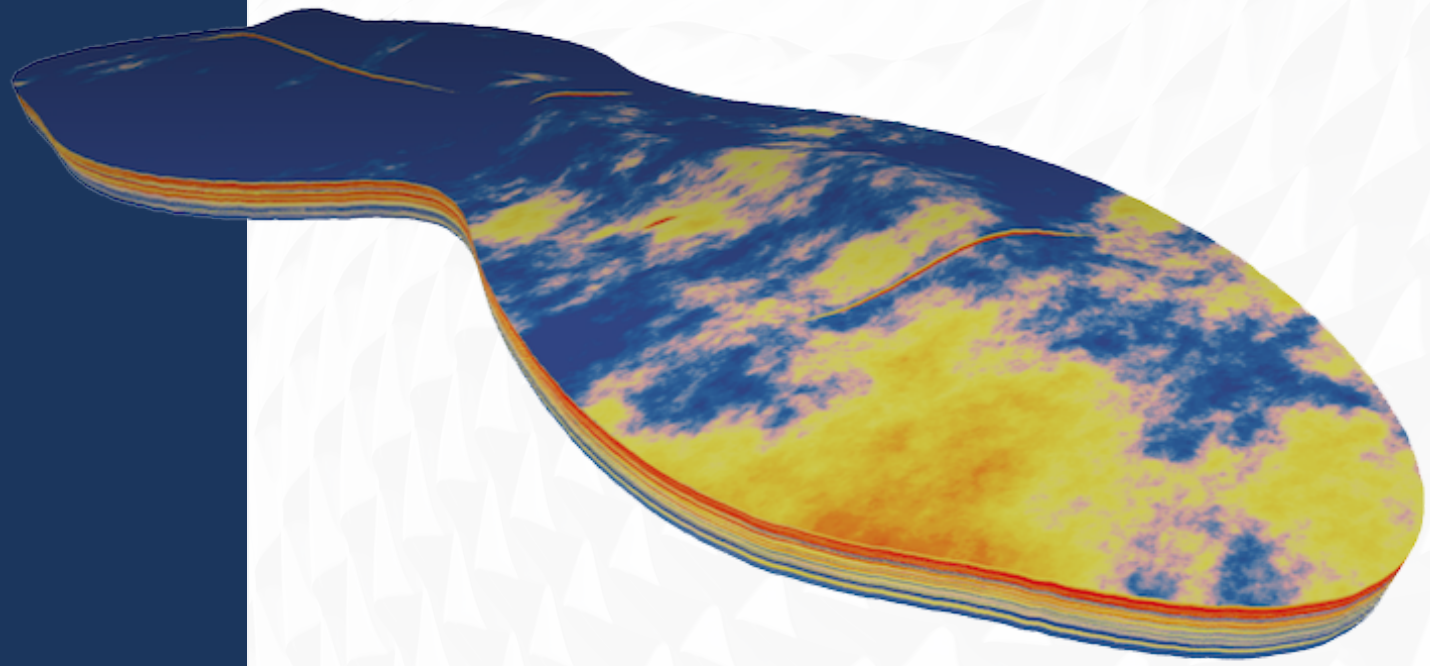
1
BILLION CELLS

1.5
HOURS

30
IBM POWER NODES

"ECHELON IS ONE OF THE MOST DISRUPTIVE TECHNOLOGIES I'VE SEEN IN MY CAREER DOING SIMULATION. IT HAS PROVEN ABILITY TO RAPIDLY RUN VERY LARGE, MULTI-MILLION CELL, FULL-PHYSICS MODELS USING MASSIVE PARALLELISM. FOR IRESERVOIR, THIS HAS LED TO IMPROVED UNDERSTANDING OF COMPLEX SYSTEMS BY ALLOWING FOR BROAD RANGING SENSITIVITY ANALYSIS IN VASTLY REDUCED TIME FRAMES."

- DR. JIM GILMAN, IRESERVOIR INC.



CHALLENGE

For the vast majority of simulation cases a billion cells is several orders of magnitude larger than is commonly used. At this "hero-scale" the main goal is to stress-test simulators and to show off capability. Typical reservoir models used in the industry range in size from a few hundred thousand to a few million cells. If we think of one of these models as a standard definition HDTV, then the billion-cell example would have 250 times the resolution of a 4K television. It gives enormous resolution and clarity, but comes with high computational cost. The purpose of our billion-cell calculation was to highlight ECHELON's capabilities and the efficiencies that GPU computing offers. With help from colleagues at iReservoir, we created a model using publicly available log data collected from a large Middle East carbonate field. We built a three-phase model with 1.01 billion cells and 1,056 wells.

Figure 1. IBM Power NVLINK server with 4 NVIDIA Tesla P100 GPUs used for running ECHELON.

SOLUTION

We simulated this model in 92 minutes on 30 IBM POWER8 nodes each with 4 NVIDIA TESLA P100 GPUs (Figure 1). In contrast, previous billion cell calculations used over 500 nodes and took 20 hours. The calculation and the results powerfully illustrate i) the capability of GPUs for large scale physical modeling ii) the performance advantages of GPUs over CPUs and iii) the efficiency and density of solution that GPUs offer.

RESULTS

ECHELON is a massively parallel, fully-implicit, extended black-oil reservoir simulator built from inception to take full advantage of the fine-grained parallelism and massive compute capability offered by modern Graphical Processing Units (GPUs). These GPUs provide a dense computing platform with ultrahigh memory bandwidth and extreme arithmetic throughput. Massively parallel GPU hardware, modern solver algorithms and careful implementation are combined in ECHELON to enable efficient simulation from hundreds of thousands to billions of cells. This is accomplished at speeds that enable the practical simulation of hundreds of realizations of large complex models in vastly less time, all while using far fewer hardware resources than CPU based solutions. The principle conclusion we draw from our results is that ECHELON used an order of magnitude fewer server nodes and two orders of magnitude fewer domains to achieve an order of magnitude greater calculation speed than those reported by analogous CPU based codes.

"BY RUNNING ECHELON ON IBM POWER SYSTEMS, USERS CAN ACHIEVE FASTER RUN-TIMES USING A FRACTION OF THE HARDWARE. THE PREVIOUS RECORD USED MORE THAN 700,000 PROCESSORS IN A SUPERCOMPUTER INSTALLATION THAT OCCUPIES NEARLY HALF A FOOTBALL FIELD. STONE RIDGE DID THIS CALCULATION ON TWO RACKS OF IBM POWER SYSTEMS MACHINES THAT COULD FIT IN THE SPACE OF HALF A PING-PONG TABLE."

- SUMIT GUPTA, IBM

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