USING THE POWER OF PARALLEL COMPUTING TO BUILD A SMARTER RESERVOIR SIMULATOR

By Niels Lindeloff and Henrik Olsen

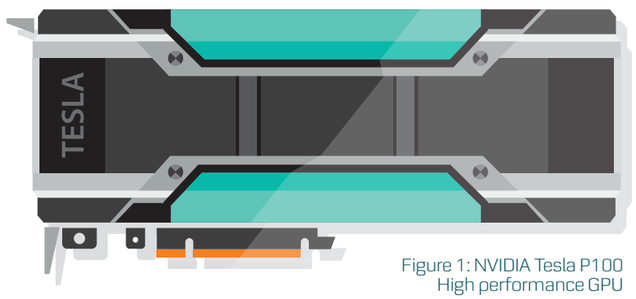


Figure 1: NVIDIA Tesla P100 High performance GPU

Computer reservoir simulators are vital tools for oil and gas field development planning. Now a company called Ridgeway Kite is taking advantage of processing units made for computer games to build a powerful simulator, specially designed for the complexities of the fields we specialise in.

The new normal in high performance computing is the use of massively parallel systems, whereby multiple processors – either central processing units (CPUs) or graphics processing units (GPUs) – work on different parts of a program. The performance curve for individual CPUs has flattened due to physical limitations on temperature, whereas the equivalent curve for the parallel systems is still climbing, in particular for the GPU systems.

Maersk Oil and Ridgeway Kite started a collaborative R&D project in 2013 to develop a new general purpose reservoir simulator – a software program that simulates the behaviour of a hydrocarbon reservoir during production. The better a field is understood, the better you can optimise the recovery scheme. The new simulator has a number of novel features that address problems of direct interest to Maersk.

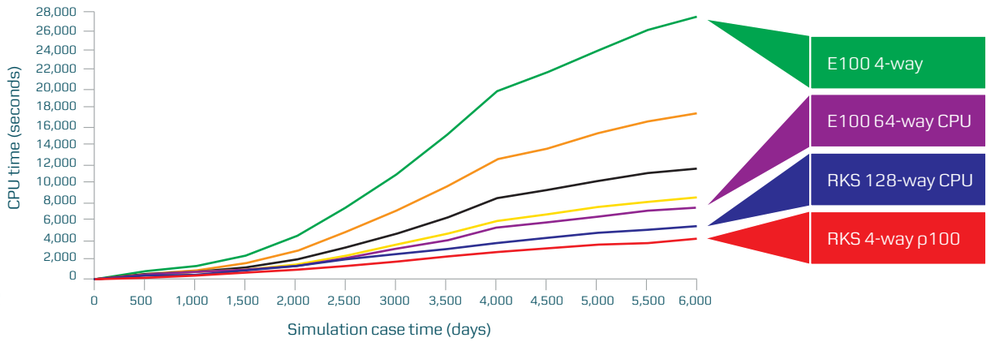
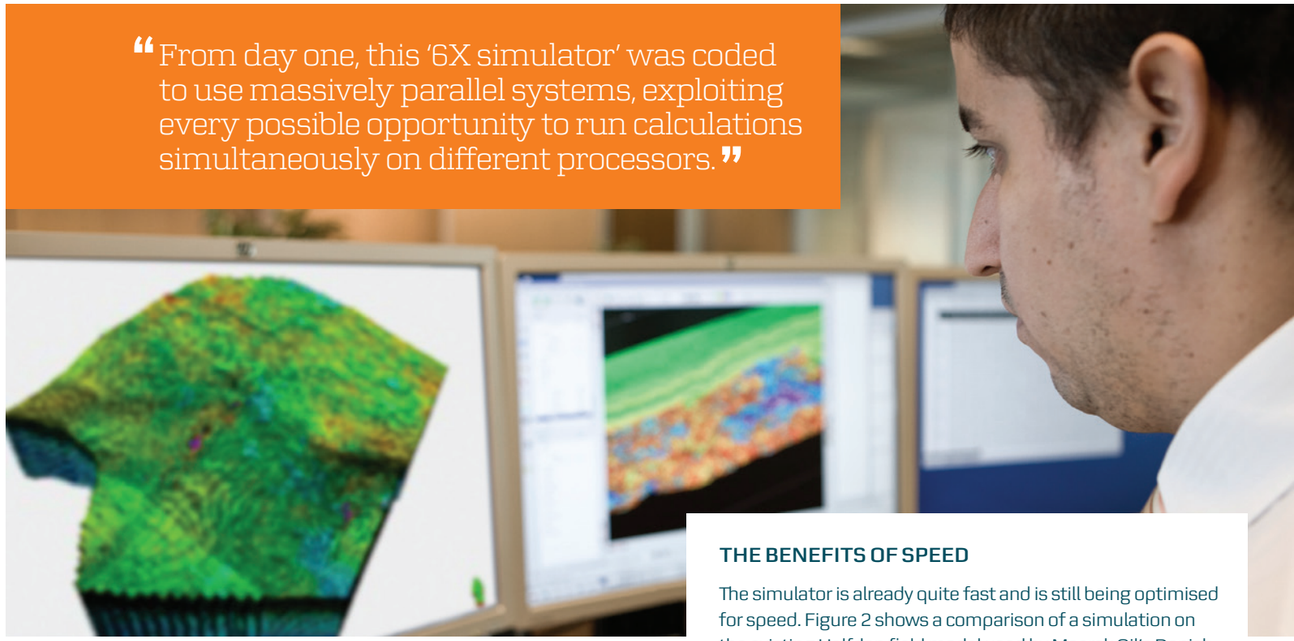


Figure 2

> "From day one, this '6X simulator' was coded to use massively parallel systems, exploiting every possible opportunity to run calculations simultaneously on different processors."



DRIVING PERFORMANCE USING GPUS

From day one, this '6X simulator' was coded to use massively parallel systems, exploiting every possible opportunity to run calculations simultaneously on different processors. GPUs were used as well as CPUs. A modern GPU contains around 4000 processing units in a single card, and on a price/performance basis this new simulator can often outperform today's commercial simulators that have multi-CPU systems.

The simulator itself is compatible with industry-standard data formats (Petrel and Eclipse) and has introduced a number of innovative features:

- It can run multiple 'realisations' or scenarios, allowing a better understanding and analysis of uncertainties about the subsurface.
- Initial conditions can be defined for a reservoir which is not in hydrostatic equilibrium, a typical feature of the tight carbonate reservoirs that Maersk Oil specialises in developing.
- Complex saturation-height initialisations and SCAL (Special Core Analysis) models can be implemented in the simulator. This is a very important feature for modelling tight carbonate reservoirs – currently you have to use three different software packages to achieve this in a single simulation.

THE BENEFITS OF SPEED

The simulator is already quite fast and is still being optimised for speed. Figure 2 shows a comparison of a simulation on the existing Halfdan field model used by Maersk Oil's Danish Business Unit (which has approximately 2 million active grid cells in the simulation) using the Eclipse simulator against our new simulator modelling the same field.

You might wonder if being faster means we can reduce our cost by doing the same thing in less time. The answer is maybe or maybe not. The main benefit is being able to do more, and more efficiently. This means we will be better at quantifying uncertainty and providing a better basis for making good decisions.

You might also wonder about the Ridgeway Kite name. According to the founders of the company, the name is inspired by the Red Kite, a very pretty bird of prey that has recently returned to the Ridgeway national trail close to Harwell, UK, where the company is based. ■

At a glance

Purpose:
Improved oil recovery in tight carbonate rock

Technology:
New reservoir simulation workflows on high performance computing systems

Impact:
More efficient quantification of subsurface uncertainty