Taming the Many-Core Beast: a View from Industry on Impact of Changing Architectures on Preconditioner Design

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The design of robust linear solvers, thus preconditioners, has always closely followed the developments in the semi-conductor industry (core count as well as memory size). This is especially relevant in industrial computational scientific software, such as reservoir simulation for the oil and gas domain. Reservoir simulation plays an important role in optimizing existing assets in a cost efficient way by enabling the evaluation of different production strategies using data from the field. The increasing fidelity of seismic surveys as well as the increased usage of complex enhanced oil recovery strategies puts a hard constraint on the problem sizes the software should be able to handle as well the robustness of its driving algorithms. The introduction of (clusters of) multi- and many-core machines enables companies to run ever larger, but foremost faster and thus more simulations for their assets. This cocktail of increasing problem size, increasing complexity of the algorithms and an abundance of computational resources, makes it paradoxically difficult to design preconditioners that are both robust as well as scalable. It proves to be difficult to strike the right balance between exposing parallelism and the robustness of the preconditioners.

In this talk we will review different approaches to design preconditioners that are robust, performant and scalable within the constraints of an existing matured code base. We will talk about the close interaction between the time integration, nonlinear and linear solver and discuss if a 'silver bullet' preconditioner exists. We will review work that has been done in recent years in the reservoir simulation domain as well as ongoing research.

We would like to refer to [1, 2, 3, 4, 5, 6] for more detail on state-of-the-art linear and nonlinear preconditioners in the reservoir simulation domain.

References

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