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Vectorized implicit time discretion

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Numerical software to approximatly solve partial differential equations (PDE) is of central importance in many instationary application. Constantly increasing model details require almost unlimited computer power, but the way increased hardware performance is achieved has changed fundamentally in recent years.

To use modern hardware efficiently new dedicated numerical methods are necessary. Particular challenges are posed by the increasing parallelism, especially the instruction level parallelism, as well as the ever increasing gap between memory and computing speed.

We will discuss a novel approach to increase the arithmetic intensity and to make full use of instruction level parallelizem, like AVX512. The idea is to reformulate the space-time problem such that it yields a matrix equation, similar to the approaches taken in parallel in time (PiT) methods. The fundamental difference to PiT methods is that we do not aim at using more nodes, but to increase the local efficiency on the individual nodes. The arising matrix equation is then solved efficiently using block-Krylov methods.

We will discuss how to efficiently implement and vectorize block-Krylov methods and investigate how the increase performance of a single Krylov iteration and the decreased convergence rate (due to our reformulation) can be balanced to achieve the best over-all performance.