From reduced complexity to large scale computation

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Many multi-physics problems allow for a complexity reduction. In this talk, we present surface and volume based coupling schemes which give rise to one or bi-directionally coupled algebraic systems. In most cases, no analytical solution can be found and one has to exploit fast and reliable numerical schemes to obtain accurate approximations. The discretization has to be stable and flexible to result in efficient numerical solvers. Firstly, we discuss dimensional reduced models for flow problems, e.g., subproblems of co-dimension one or two. Secondly, we illustrate how simple and lean low order methods go hand in hand with highly scalable parallel solvers. Here special focus is on locally conservative methods, e.g., for energy, surface traction or mass. To get a better understanding, we illustrate spurious numerical oscillation for non-conservative methods. Although optimal a priori order estimates are attractive from the computational point of view, they do not necessarily give rise to short run-times on modern architectures. Here we show how domain partitioning strategies can be used to obtain excellent performance. Part of this work is supported by the DFG priority programme “Software for exascale computing”.