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Time Stepping Challenges for Partitioned Multi-Scale Multi-Physics in preCICE

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Using the partitioned approach specialized single physics solvers with different numerical properties may be combined to solve a multi-physics setup. This allows to use expert solvers for every considered phenomenon. However, it often leads to an inhomogeneous setup: The solvers may use non-matching meshes and discretization techniques to handle their respective problem in the most efficient way – both in the spatial and temporal domain (multi-scale).

The coupling library preCICE [1] provides methods for a correct treatment of non-matching spatial meshes, but it currently lacks advanced techniques for the treatment of the temporal dimension. To maintain order and stability of the time stepping, special care has to be taken and simply exchanging nodal values at the coupling interface does not suffice (e.g. [2, 3]).

In this talk, an overview over different setups that arise in partitioned multi-physics problems is given. Different temporal scales are considered as well as different discretization techniques. Challenges and requirements that stem from the partitioned approach are derived and various candidate techniques for advanced time stepping are introduced and evaluated. Implementation aspects are presented – with the final goal of an implementation of advanced time stepping in preCICE. Convergence studies for simple benchmark scenarios are shown.

References

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