On Coupled MOR-Multirate Schemes: Derivation and Error Analysis

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A system of ODEs that fits well for multirate integration schemes often consists of at least one large scale subsystem with slow dynamic behaviour compared with the remaining subsystems. Such systems naturally occur in multiphysics coupled problems. It is an intuitive idea to apply a model order reduction (MOR) to the large scale, slow changing subsystem to save computational effort. Since the subsystems are coupled one has to apply MOR methods for coupled systems like in [1].
In this talk we will present a suitable definition of a reduced order, slow changing subsystem. We will focus on the definition of the coupling interface to the other subsystems so that the input-output behaviour of the reduced order slow subsytem and the resulting complete ODE system is well approximated.
A model order reduction of one or more subsystems will cause additional errors in a time domain simulation. Furthermore the multirate integration scheme requires some special error investigation because different time schales for different subsystems are used [2]. We will provide an extension to the existing error analysis for multirate θ-methods that includes the error of the model order reduction of the slow changing subsystem.

[1] T. Reis, T. Stykel, Stability analysis and model order reduction of coupled systems. Math. Comput. Model. Dyn. Syst., 13(5), 2007, pp. 413-436.

[2] W. Hundsdorfer, V. Savcenco, Analysis of a multirate theta-method for stiff ODEs. Applied Numerical Mathematics, 59, 2009, pp. 693–706.