Adaptive Modelling, Simulation, and Optimization of Gas and Water Supply Networks

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The operation of gas transmission or water supply networks involves many challenges for the network operators in the real market. Fed in by multiple suppliers, gas or water has to be routed through the network to meet the consumers' demands. At the same time, the operational costs of the network like energy consumption of compressor and pumping stations or contractual penalties have to be minimized. This leads to an optimal control problem on a network.
For the optimization task, reliable simulation results are necessary. We address this task by using a goal-oriented adaptive strategy for the simulation. Besides refinement in space and variable time stepping, we want to use simplified models in regions of the network with low activity, while sophisticated models are used in regions where the dynamical behaviour of the flow needs to be resolved in detail. We introduce a posteriori error estimators to assess the discretization and model errors with respect to a quantity of interest. These error estimators are derived using adjoint techniques, which are also suitable for optimization. We then present a strategy to balance these errors regarding a given tolerance. Finally, we will show some numerical experiments for the adaptive simulation algorithm as well as the applicability in an optimization framework.