Analyzing Conflicts in Natural Gas Networks

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Abstract: In this talk we discuss how to analyze conflicts, i. e., infeasibilities in subproblems, arising for different reasons in the mathematical description of natural gas networks in real-world applications. In the considered case the network is given by a mixed integer linear program (MILP). More precisely, the MILP describes the nomination validation on this network, i. e., whether or not it is possible to transport a given flow amount with specific supply and demand nodes.

Infeasibility in this MILP can arise from defective data caused by typing errors, by out-of-date data or by a misunderstanding in format. Furthermore, the chosen description of the underlying physics might not fit together, e. g., the pressure loss calculation on pipes may be too small so that given pressure bounds cannot be reached. Last, but not least, the $nomination$ itself can be infeasible. This occurs also in the course of booking validation (checking whether every balanced nomination smaller than the booking value is satisfiable) and boundary value optimization, and has a special meaning in topology planning. Here, the operator particularly wants to know where the "bottlenecks" in the network are.

Our main purpose is to find a $physical$ reason for the infeasibility of a given instance. To achieve this, we implemented and tested various approaches based on slack models. Here, we concentrate on relaxing specific appointed physical attributes, such as given pressure and flow bounds, the pipe description or the supplied flow amount. In addition, we investigated the explanatory power of irreducible infeasible subsystems; since it is possible to calculate them at least in a heuristic way, the remaining task is to transfer the gained information from MILP back to the network. Complementing the modeling aspects we present computational results and derive cautious suggestions as to which model should be used, depending on the task at hand.

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