Modeling and Simulation of Network DAEs with a Switching Control Function

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Abstract: We consider network Differential-Algebraic Equations (DAEs) of the form

$$A(s(t))x'(t) + f(x(t), s(t), t) = 0$$

with a discontinuous parameter switching function $s(\cdot)$. Such DAEs appear in the control of dynamic flow networks when controlling elements as pumps or valves are switched on or off at certain time periods. As a consequence, the matrix $A(s(t))$ may change its rank and the network DAE may become unsolvable or not uniquely solvable over certain time periods.

We present the detailed structure of such network DAEs and a topological analysis enabling a consistent reformulation as DAE system providing a unique solution (for consistent initial values). Additionally, we present a difference modeling approach for such network DAEs that allows an efficient simulation for several similar control switching functions.

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