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Stabilization of Networked Control Systems with Sparse Controller Networks

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Abstract

We consider stabilization of networked control systems (NCS), consisting of *N* subsystems coupled via a directed network with topology using sparse control networks. Each subsystem comprises of a plant and a controller. The interaction of plants with each other forms the *plant network*. Control signals are exchanged using the *control network*, a.k.a. information, communications, or feedback network. For networks with arbitrary topology, the key question concerning the design of the control network is one of *topological information requirements* and can be framed as: *Which nodes should be given the state and output information of a particular node, in order for the local controllers to be able to satisfy a global control objective?* This question is critical in the design of massively distributed control systems, such as the Smart Grid.

In addressing this key question, the goal is often to find the sparsest control network that satisfies the requirements. Considering various settings, we first develop stability conditions that guarantee global asymptotic stability, using the Lyapunov direct method. We then use these conditions to explore the problem of designing a sparse control network for a given plant network with arbitrary topology.