

**THE ROLE OF THERMODYNAMICS IN THE CONTROL OF LARGE-SCALE DYNAMICAL
SYSTEMS AND NETWORK CONTROL**

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ABSTRACT

Due to advances in embedded computational resources over the last several years, a considerable research effort has been devoted to the control of networks and control over networks. Network systems involve distributed decision-making for coordination of networks of dynamic agents and address a broad area of applications including cooperative control of unmanned air vehicles, microsatellite clusters, mobile robotics, battle space management, and congestion control in communication networks. In this presentation, we will present a thermodynamic-based framework for addressing almost sure consensus problems for nonlinear stochastic multiagent dynamical systems with fixed communication topologies. Specifically, we present distributed nonlinear controller architectures for multiagent coordination over random networks with state-dependent stochastic communication uncertainty. The proposed controller architectures involve the exchange of generalized charge or energy state information between agents guaranteeing that the closed-loop dynamical network is stochastically semistable to an equipartitioned equilibrium representing a state of almost sure consensus consistent with basic thermodynamic principles. Furthermore, extensions for the design of semistable protocols over random networks for achieving coordination tasks in finite time are also presented. Finally, we discuss the notion of energy- and entropy-based hybrid decentralized controllers for the control of complex large-scale dynamical systems that guarantee that each subsystem–subcontroller pair of the hybrid closed-loop system is consistent with basic thermodynamic principles. Several illustrative aerospace examples are given to demonstrate the efficacy of the proposed framework.

Keywords: Energy- and entropy-based stabilization, semistability, consensus protocols, distributed control, nonlinear networks, thermodynamic protocols, communication uncertainty, Markov processes