Electrical & Computer Engineering

S E M I N A R

Louisiana State University

Systemic Risk in Networked Control Systems: Challenges & Perspectives

Christoforos Somarakis

Lehigh University

Abstract—Real-world dynamic networks operate under structural deficiencies and imperfections. Due to their importance in the fabric of the modern way of life, any failure they may experience can have severe social and economic impacts. A resilient network of communicating cyber-physical systems must be designed in the face of uncertainties and some statistical knowledge, at best, about how the real operating environment will look like. From a network analyst perspective, this implies that system design constraints may need to be envisioned in terms of safety margins instead of exact requirements. We introduce notions of risk of systemic events in interconnected dynamic systems. The risk measures are leveraged as surrogates of fragility regarding output observables of interest. Our case study regards linear multi-agent rendezvous and platooning co-ordination problems, selected as simple yet rich benchmarks for the study of autonomy in networked control systems. Our risk measures evaluate the effect of the distributed feedback laws towards stochastic disturbances and communication delays. A novel robust analysis framework is derived via the calculation of explicit bounds of tolerable safety margins, before our network defaults or fails. Furthermore, we highlight how the interplay between time- delay restrictions and noise, results in fundamental limits on risk improvement via network design methods. In addition, we argue by theory and experiment that in real-world inter-connected systems, increasing connectivity can increase the risk of systemic failure.

Bio—Christoforos Somarakis received the Diploma in Electrical and Computer engineering from the National Technical University of Athens, Athens Greece, in 2007, and the M.Sc. and Ph.D. degrees in applied mathematics and statistics and scientific computation from the University of Maryland, College Park, in 2012 and 2015, respectively. He is currently a Postdoctoral Associate with the Mechanical Engineering and Mechanics Department, Lehigh University. His research interests include analysis and optimal design of networked control systems with applications in distributed control and cyber-physical systems.

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