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Power blackouts, sudden death, and flash crashes: The physics of interdependent networks

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Recent disasters ranging from abrupt financial "flash crashes" and large-scale power outages to sudden death among the elderly dramatically exemplify the fact that the most dangerous vulnerability is hiding in the many interdependencies among different networks. This talk reports recent work quantifying failure mechanisms in interconnected networks, and demonstrates the need to consider mutually dependent network properties in designing resilient systems. Specifically, we have uncovered new laws governing the nature of switching phenomena in coupled networks, and found that phenomena that are continuous "second order" phase transitions in isolated networks become discontinuous abrupt "first order" transitions in interdependent networks [J. Gao, S. V. Buldyrev, H. E. Stanley, and S. Havlin, "Novel Behavior of Networks Formed from Interdependent Networks," Nature Physics **8**, 40 (2012)]. We also report parallel efforts to understand the phenomenon of spontaneous recovery in dynamical networks as occurs, e.g., immediately after a flash crash [A. Majdandzic, B. Podobnik, S. V. Buldyrev, D. Y. Kenett, S. Havlin, and H. E. Stanley, "Spontaneous Recovery in Dynamic Networks," Nature Physics **9**, No. 1 (2014)].