A structural perspective on resilience of uncertain switching network topologies

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Abstract

Nowadays, due to the unprecedented connectivity options made available by the latest advancements of ICT, system networks play a crucial role in a wide variety of fields, like, e.g., communications, power distribution, assistance and surveillance, industrial automation. Meanwhile, system networks are exposed to a risk of cyber intrusions never experienced before. Hence, a considerable deal of research effort has been devoted to the study of appropriate strategies to assess and enforce networks' resilience – i.e., their ability to survive major disruptions with tolerable performance degradations and to recover ordinary working with acceptable delays. A main feature of multiagent networks is that a system-level objective or task is accomplished through the cooperation of agents on the basis of only local information. Hence, a topological perspective on analysis and synthesis problems stated for multiagent networks appears to be particularly effective. In this perspective, multiagent networks are modeled by graphs (i.e., agents are represented by nodes and their interconnections by edges) or, equivalently, by structured linear systems (i.e., single integrators correspond to nodes and an adjacency matrix carries the information about the edges). Nevertheless, to encompass frequently observed phenomena like evolving topology and missing links, switching structured linear systems have recently proven to be a more appropriate representation. In this context, concepts like opacity (a confidentiality property used to handle important aspects of privacy and security), anonymity and secret are introduced and, consequently, the concept of cyber attack is formally characterized. Algorithms capable to identify anomalous behaviors or intrusions in switching structured linear systems are derived, in primis, by formulating and solving properly conceived problems stemming from unknown input observation and fault detection and isolation.