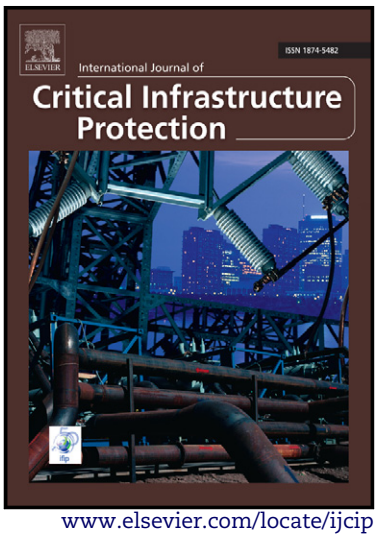

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Multilayer hybrid modeling framework for the performance assessment of interdependent critical infrastructures

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Abstract

The heterogeneity and tight coupling of modern critical infrastructures make it challenging to create tractable descriptions of their emergent behaviors. Classic analytical methods do not provide adequate insights into system behavior and do not fully capture the complexity of infrastructure interdependencies. Meanwhile, modeling approaches developed to represent the diverse physics and operations of critical infrastructures fail to provide a unifying framework for analyzing performance. This paper attempts to address these challenges by proposing a multilayer hybrid modeling framework that supports the detailed understanding and holistic analysis of critical infrastructure systems. A critical infrastructure is viewed as a combination of integrated subsystems structured in interdependent layers: (i) systems under control; (ii) operational control system; and (iii) human-organizational social system. The systems under control and operational control system constitute the technical components of a critical infrastructure. The human-organizational social system is the non-technical component of a critical infrastructure that captures the human and social factors that influence system performance. The modeling framework is demonstrated using the Swiss electric power supply system, which comprises three interdependent layers: the power grid, a supervisory control and data acquisition (SCADA) system and human operators. The framework can help guide the identification of strategies for designing, maintaining and enhancing the performance of critical infrastructures.

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