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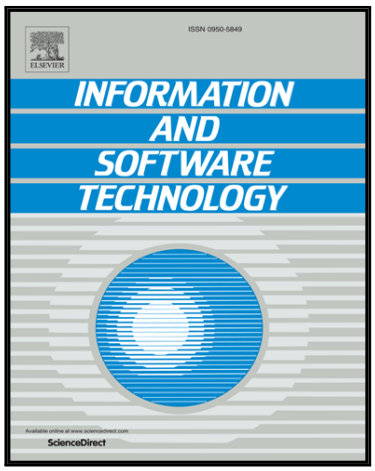

Dependability-Enhanced Unified Modeling and Simulation Methodology for Critical Infrastructures

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Dependability-Enhanced Unified Modeling and Simulation Methodology for Critical Infrastructures

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Abstract

Context: Critical infrastructures (CIs) are mission-critical, large-scale systems that provide essential products and services for everyday life. Modeling and simulation (M&S) technique is one of useful methods for understanding the complex and emergent behavior of CIs. However, the several characteristics of CIs, such as interdependence, adaptability, dependability, etc., can disturb modelers' activities to develop the quality models for CIs. The quality of these models can affect the reliability of simulation results as well as the reusability of the models in further simulations.

Objective: In this paper, we propose a M&S methodology that aims to improve the quality of CI models by means of focusing on dependability, which is one of important characteristics of CIs.

Method: First, we propose a system to model and simulate CIs based on discrete event system specification, a belief-desire-intention model, and a role-oriented command hierarchy model. Next, we integrate several modeling methods, such as goal modeling, agent-based modeling, and object-oriented modeling, into a unified M&S methodology (UMAS) to seamlessly develop CI models from initial requirements to final modeling artifacts. Finally, we propose a dependability-enhanced UMAS (DUMAS) that can deal with the dependability of CI models.

Results: In our case study of applying the DUMAS into the M&S of a smart grid, we show how the DUMAS reflects the characteristics of CIs on the overall modeling artifacts.

Conclusion: The DUMAS provides a novel method that can improve the quality of CI models through elaborating on the activities of requirements engineering with regard to the dependability of CIs. Therefore, modelers can systematically develop quality models from requirements analysis to implementation in compliance with the DUMAS.

Keywords: critical infrastructure, modelling and simulation, dependability

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