Quantitative Models for a Not So Dumb Grid

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How to dimension buffer sizes in a network on chip? What availability can be expected for the Gallileo satellite navigation system? Is it a good idea to ride a bike with a wireless brake? Can photovoltaic overproduction blow out the European electric power grid? Maybe. Maybe not. Probably? The era of power-aware, wireless and distributed systems of systems asks for strong quantitative answers to such questions.

Stochastic model checking techniques have been developed to attack these challenges [2]. They merge two well-established strands of informatics research and practice: verification of concurrent systems and performance evaluation. We review the main achievements of this research strand by painting the landscape of behavioural models for probability, time, and cost, discussing important aspects of compositional modelling and model checking techniques. Different real-life cases show how these techniques are applied in practice.

A rich spectrum of quantitative analysis challenges is posed by the 'smart grid' vision [1,4]. That vision promises a more stable, secure, and resilient power grid operation, despite increasing volatility of electric power production. It is expected to come with more decentralized and autonomous structures, and with a lot of IT put in place to manage the grid. However, that vision is in its infancy, while the reality of power production is already changing considerably in some regions of Europe. We focus on a regulation put in place by the German Federal Network Agency to increase grid stability in case of photovoltaic overproduction. We show that this regulation may in fact decrease grid stability [3]. We also propose improved and fully decentralized stabilization strategies that take inspiration from probabilistic MAC protocols. Quantitative properties of these strategies are calculated by state-of-the-art stochastic model checking tools.

References

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