Abstract

As the society relies more on electric technologies, efficient generation and delivery of electric power becomes increasingly important. Smart grids provide a promising solution to the increasing electricity needs. Whereas smart grids have a number of advantages over traditional grids, one of their main disadvantages is the susceptibility to cyber-attacks, which have not been the focus of studies on smart grids. In this paper, a game-theoretic model is developed to identify optimal defenses and attacks at three different levels (i.e., electric generation plants, transmission, and distribution systems). We define parent and child networks. For example, electricity generation network is the parent network of transmission network, which is in turn the parent network of distribution network. Network failure could be due to either direct attacks, cascading failure caused by intense attacks on its parent network, or inadequate maintenance. We identify the best responses and equilibrium strategies of both the attacker and the defender, who interact at three system levels: distribution, transmission, and electricity generation. The results show that the best response of the defender is not only a function of direct attacks but also of the spread from connected networks. Furthermore, we also conduct sensitivity analyses of the equilibrium strategies. Results show that if the probability of a successful attack against electricity generation plants is above a certain level, the defender enhances efforts in protecting electricity generation plants. On the other hand, the efforts of attacking at any of the three levels is not influenced by such a probability. This paper yields some interesting insights to modeling and analyzing the strategic interactions between the attacker and the defender of smart grid networks, which plays an increasingly important role in modern societies.

Citation

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