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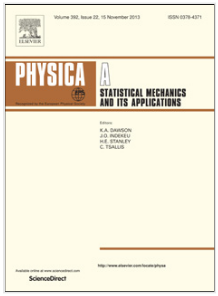

Cascade failure analysis of power grid using new load distribution law and node removal rule

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Cascade failure analysis of power grid using new load distribution law and node removal rule

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Abstract The power grid is a directional complex network of generators, substations, and consumers. We propose a new load distribution law to emulate the power grid. We assume that the power flow is transferred through all the paths connecting generators and consumers according to their efficiency. The initial generation of generators and the initial loads of substations are calculated according to the path efficiency and the load of the consumers. If a node fails, it is removed from the power grid, and all paths passing through it will fail to transfer power. In that case, the loads of the corresponding consumers are redistributed within the whole network. During the failure cascading and propagation procedure, our node removal rule is to remove the first overload node along the opposite direction of power flow, then the network distributes load and goes on the cascade procedure. Our new removal rule for nodes does suppress the large scale cascading failures. This work would be very helpful for designing the protective relay system and the tolerant parameters of the grid.

Keywords Cascade failure · Load distribution law · Node removal rule · Node capacity

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1 Introduction

Our lives are filled with an increasing variety of networks, such as transportation networks, internet, power grids, and communication networks. In those networks, cascading failure means that one or several nodes or edges failure leads to failure of other nodes. Cascading failure might ultimately lead to the failure of a considerable number of nodes or the entire network.

Over the past decades, research on cascading failure has become an important topic in the theory of complex networks [1]. Several different models of cascading failure have been proposed. These models can be roughly divided into two categories. In the first category, only the topology of the network is considered, and the dynamics and properties of the nodes are neglected [2–22]. In the second category, both the dynamics of the nodes and the topology of the network are considered [23–25].

Cascading failure was investigated in a congested complex network [2, 3]. In this model, the congestion effect, defined as link performance function or cost function, maps link flow to travel time. The node failure results in longer traveling times, while the failure does not affect the topology of the network. Wu *et al.* proposed a model to study the cascading failure triggered by link

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