

The statistical spread of transmission outages on a fast protection time scale based on utility data

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In response to a system fault, the power grid's protection system operates on a rapid timescale (under one minute) to automatically disconnect one or more transmission lines. The specific set of lines removed during such an event creates a distinct outage pattern within the network.

This work involves extracting these outage patterns directly from utility data. We first analyze this data to identify key statistical properties of the patterns. Based on these statistics, we then develop a method for generating new, synthetic patterns that are statistically consistent with the observed data.

This generative approach offers a novel and practical way to represent the aggregate behavior of the protection system across a large-scale transmission network. We anticipate this new, data-driven protection model will enhance disturbance simulations for large grids, leading to improved quantification of blackout risks. Furthermore, an analysis of the observed pattern sizes points to a potential index for describing the propagation of outages within the network on this fast timescale.