Holistic Optimization of Distribution Automation Network Designs Using Survivability Modeling and Power Flow Equations

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Abstract

Smart grids are fostering a paradigm shift in the realm of power distribution systems. Whereas traditionally different components of the power distribution system have been provided and analyzed by different teams, smart grids require a unified and holistic approach taking into consideration the interplay of distributed generation, distribution automation topology, intelligent features, and others.

In this tutorial, we present how transient survivability metrics can be used to create better distribution automation network designs. Our approach combines survivability analysis and power flow analysis to assess the survivability of the distribution power grid network.

We first describe the reliability challenges power utilities face and discuss the additional challenges and opportunities introduced by a smarter grid with features such as fault detection, isolation, and restoration. We then lay the foundations by introducing relevant reliability metrics and by putting survivability metrics into the broader context of dependability metrics.

We then describe how two complex systems such as a telecommunications server and a smart grid distribution automation grid could be modelled using survivability metrics. Specifically, we show how a smart grid distribution automation grid can be modelled in an abstract way using a Markov reward model and how this model is parameterized with results from power flow analysis and measured data from the utility.

Finally, we present an initial approach to automatically optimize available investment decisions with respect to survivability and investment costs and highlight its benefits by applying it to the design of a real distribution automation circuit.

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