Tri-level transmission expansion planning under intentional attacks: virtual attacker approach – part I: formulation

G.R. Yousefi; H. Nemati; M.A. Latify

Abstract-

The first part of this two-part paper proposes tri-level transmission expansion planning (TTEP) under physical intentional attacks. In the first level, the network planner looks for an optimal transmission expansion plan to fortify the power network. In the second level, the attacker tries to maximise damages to the network. In the third level, the adverse effects of the attacks on the network operation are minimised by the network operator. Since the third level problem is a linear programming (LP) problem, the second and third levels are converted into a single-level model by using primal-dual transformation, and consequently, TTEP is converted into a bi-level programming problem. To achieve a single-level model, instead of assuming a unique attacker, a cooperative game of multiple virtual attackers (VAs) of which every VA is to maximise the damage by attacking one transmission line is introduced and modelled. The conditions that enforce Nash and Pareto equilibria of this game are derived as linear constraints which are lower level equivalent. By using this equivalence, the aforementioned bi-level TTEP model is converted into a single-level model that can be recast as a mixed integer LP problem.
The numerical results are provided in the second part.

Index Terms-

Citation: