Abstract

After a major disturbance, the power system behavior is highly dependent on protection scheme behavior and system dynamics. Improving power systems situational awareness requires proper and simultaneous modeling of both protection schemes and dynamic characteristics in power system analysis tools. Historical information and ex-post analysis of blackouts reaffirm the critical role of protective devices in cascading events, thereby confirming the necessity to represent protective functions in transient stability studies. This thesis is aimed at studying the importance of representing protective relays in power system dynamic studies. Although modeling all of the protective relays within transient stability studies may result in a better estimation of system behavior, representing, updating, and maintaining the protection system data becomes an insurmountable task. Inappropriate or outdated representation of the relays may result in incorrect assessment of the system behavior. This thesis presents a systematic method to determine essential relays to be modeled in transient stability studies. The desired
approach should identify protective relays that are critical for various operating conditions and contingencies. The results of the transient stability studies confirm that modeling only the identified critical protective relays is sufficient to capture system behavior for various operating conditions and precludes the need to model all of the protective relays. Moreover, this thesis proposes a method that can be implemented to determine the appropriate location of out-of-step blocking relays. During unstable power swings, a generator or group of generators may accelerate or decelerate leading to voltage depression at the electrical center along with generator tripping. This voltage depression may cause protective relay mis-operation and unintentional separation of the system. In order to avoid unintentional islanding, the potentially mis-operating relays should be blocked from tripping using out-of-step blocking schemes. Blocking these mis-operating relays, combined with an appropriate islanding scheme, help avoid a system-wide collapse. The proposed method is tested on data from the Western Electricity Coordinating Council. A triple line outage of the California-Oregon Intertie is studied. The results show that the proposed method is able to successfully identify proper locations of out-of-step blocking scheme.