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on Semiconductor and Electronics, Information and Communications Technology and Energy

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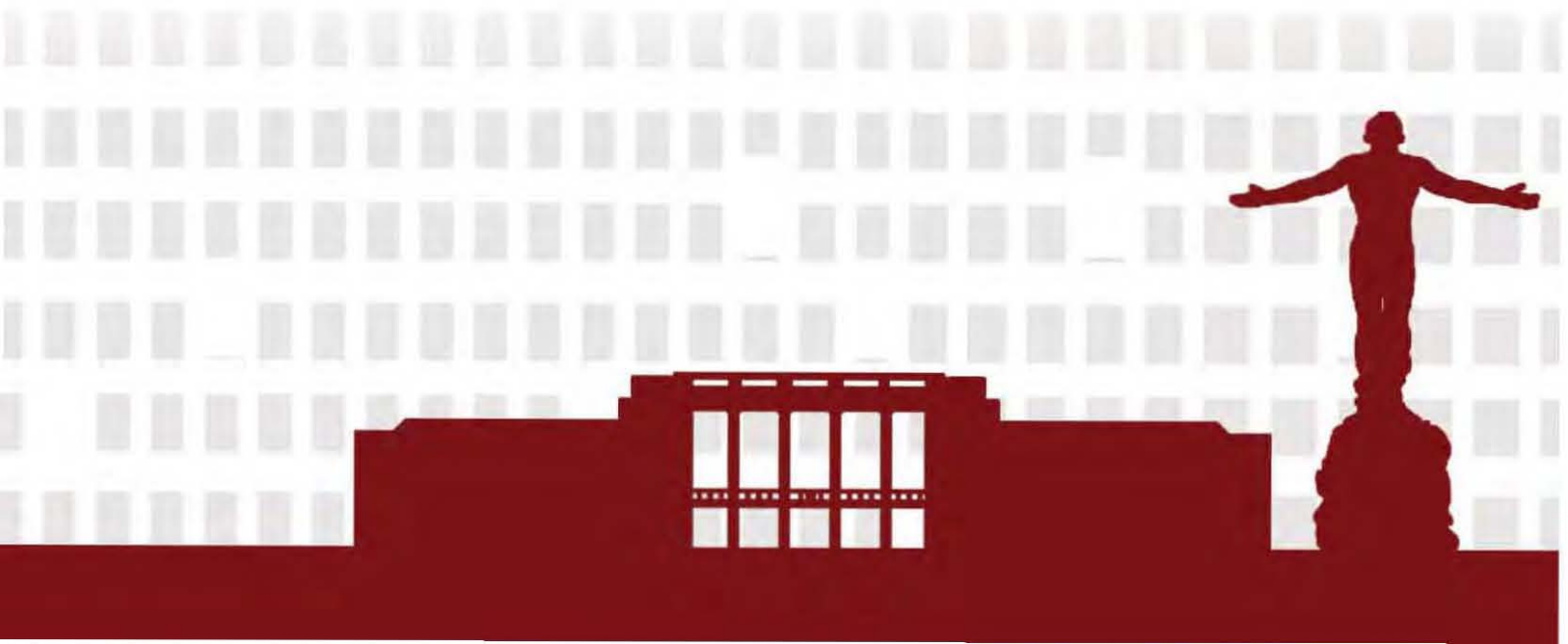
Metro Manila, Philippines



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AN ADAPTIVE OVERCURRENT RELAY PROTECTION SCHEME FOR WEAKLY MESHED DISTRIBUTION NETWORK WITH DISTRIBUTED GENERATION

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ABSTRACT

The most conventional configuration of a medium voltage distribution network (MVDN) is radial. In a radial network, feeders are extended from distribution substations towards lateral feeders, in such a way that the entire service area is supplied through feeders. Radial distribution systems experience poor load flow convergence performance due to their high R/X ratios, which in turn deteriorates the diagonal dominance of the jacobian matrix. Thus, by closing normally open switches, some loops are formed to overcome the problem and this creates a weakly meshed system. Therefore, it is reasonable considering actual MVDN's already connected as weakly meshed and they will likely become more meshed. in the future due to reliability reasons. Furthermore, if the distributed generation (DG) penetration reaches to a high level, distribution system operators (DSO's) will be certainly called to properly integrate such amount of DG into the existing electric power system, fully realizing its benefits and avoiding negative impacts on system reliability. Reduction of power losses, improvement of voltage profile, and deferment of investment resulting from reduced equipment exploitation are the main advantages expected by the adoption of DG and meshed arrangements.

However, when DG is connected to the weakly meshed network, the impact on network protection strongly depends on the distribution of fault currents, thereby requiring a new or a redefined relay coordination scheme. Distributed generation gives a sustained contribution to the fault current and it can interfere with the correct operation of the overcurrent protection against short circuits. Several operating conflicts of integrating DG to the power system are false tripping of feeders, nuisance tripping of production units, blinding of protection, increase and decrease fault levels, ferroresonance, unwanted islanding and unsynchronized reclosing. All of these problems depend on the size, type and placement of DG on the distribution network.

The main control relay unit (MRCU) is the overall intelligence or brain of the protection network. It is a digital relay that supervise and controls the information to all other relays placed in the power system. The main contribution of this paper is on how the MRCU will perform in case of a fault under various changing conditions or the adaptive behavior. Figure 1 is an example of a weakly meshed distribution network. Digital relays are placed on strategic parts of the network and are controlled by the MRCU located at the substation.

The digital relays also monitor the voltages and currents in the system. The digital relays continuously gather these measurements and will send the data to the MRCU. If the MRCU detects a new system condition such as generator outage or a line outage, the MRCU will send predetermined relay settings to the digital relays.

The behavior of MRCU is shown in Figure 2. Based on collected field information, the MRCU will select the network condition using the offline results of the load flow study. The performance index (PI) is used for the selection of the cases. After the MRCU selects the network condition, the predetermined relay settings will be sent to the digital relays to isolate the faulted zone. If the network condition is not on the database, the MRCU will now select the worst case scenario or the default settings. Then, the process will go back again to the monitoring of the voltages and currents after the MRCU determines the new network scenario.

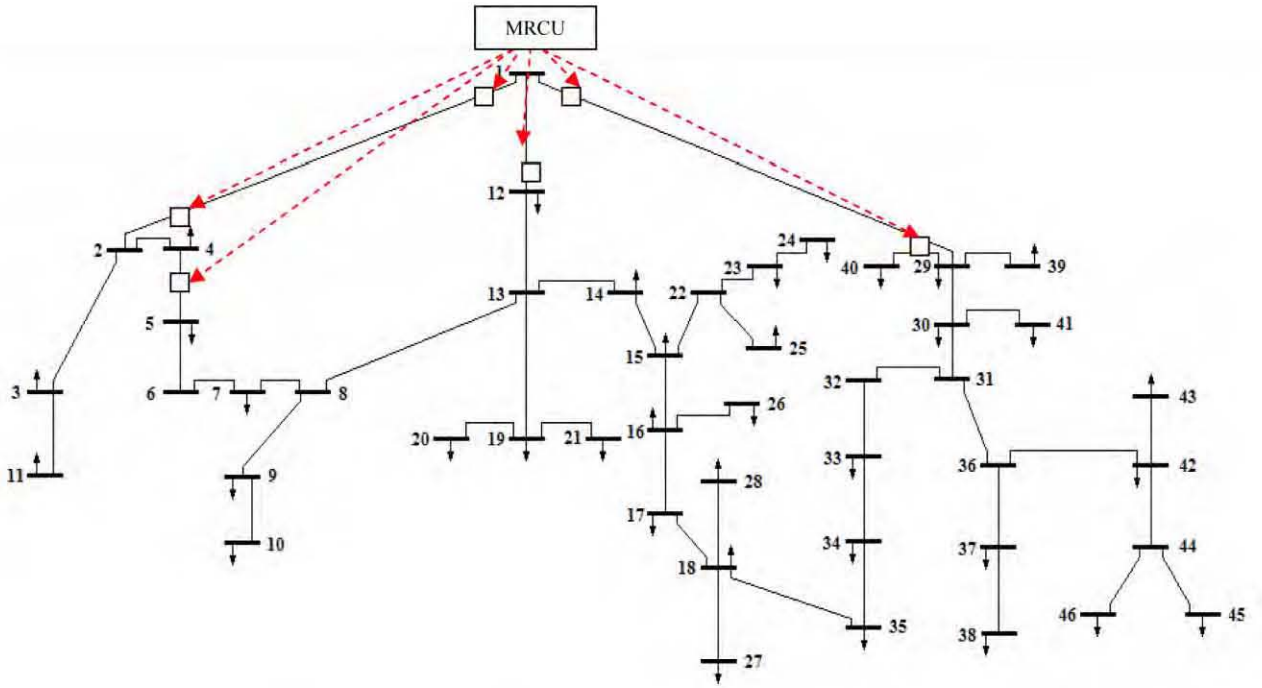

Figure 1. A weakly meshed network with adaptive protection behavior

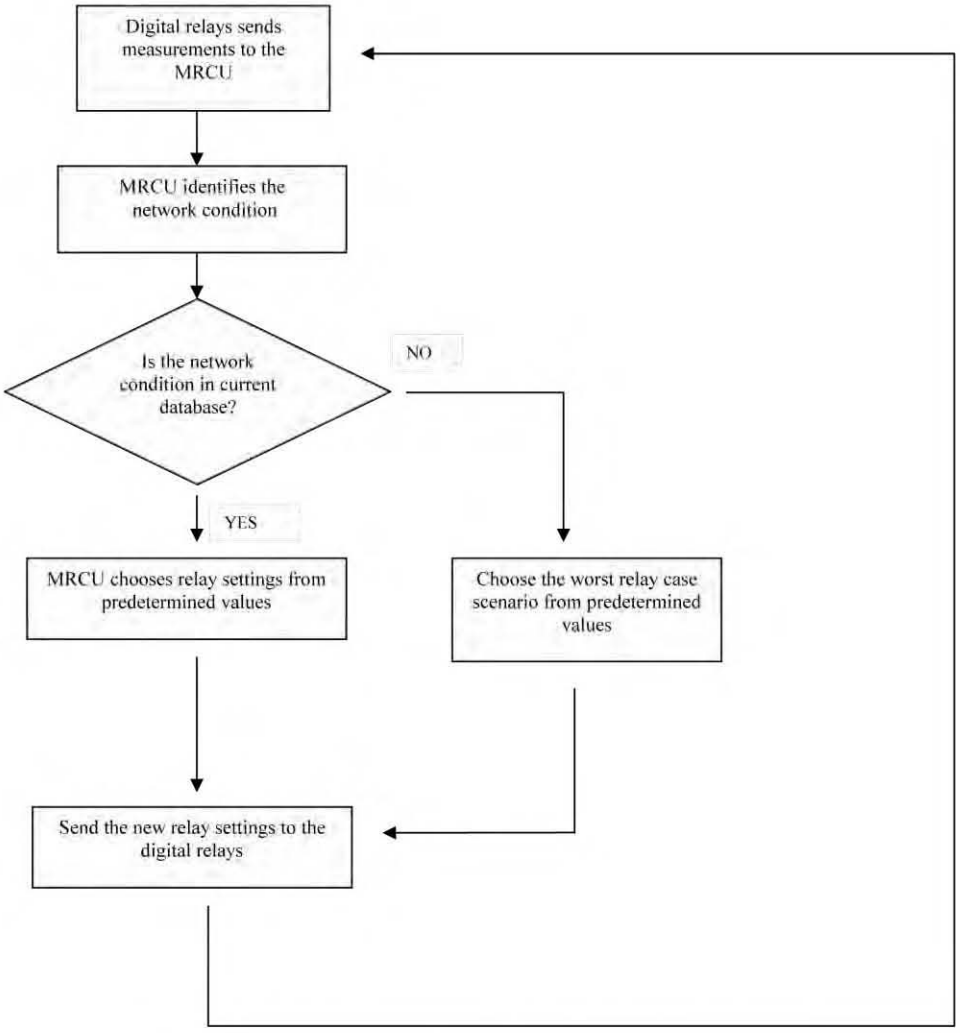

Figure 2. Flowchart of the proposed OC adaptive protection scheme

Keywords: Adaptive Protection, Digital Relay, Distributed Generation, Main Relay Control Unit, Overcurrent Protection, Protective Relaying.

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