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TITLE OF THE THESIS : SUBSTATION AUTOMATION DESIGN AND CONFIGURATION USING IEC 61850 DEVICES

FINDINGS

SUBSTATION AUTOMATION DESIGN AND CONFIGURATION USING IEC 61850 DEVICES

The significant contributions of this Ph.D. thesis are as follows:

1. Testing and evaluating the performance of various functionality of protection relay IED

A novel algorithm was developed to test the protection relay IED. The model of the desired fault scenario was developed in PSCAD and the generated voltage and current signal were recorded and saved in COMTRADE format. This COMTRADE file, consisting of voltage and current values of a fault, was played to the relay to be tested using a Universal Tester. The relay which had already been set to protect the simulated transmission line tripped on being subjected to the fault data and indicated the type of fault, fault location and the time taken by the relay to trip and the results can easily be compared with the already known values. Mostly universal tester is directly used to test the relay IEDs which normally requires detailed calculations and settings for testing of a particular IED. By the help of algorithm developed it is easy to compare the test results as the details of the simulated fault are known.

2. Integration of IEDs (supporting IEC61850 protocol) to the control centre software (supporting legacy protocol), thus implementing the concept of merging old technology with new technology

With the rapid advancement in technology systems and equipments become obsolete very fast. At the same time it is very expensive to change the complete set up every time there is a technological advancement, thus necessitating some amount of retrofitting. In order to understand the migration process of old legacy system to new system, the IEDs (IEC 61850 compliant) are integrated with the available control centre software SCADA PORTAL (supporting old proprietary protocol) through a Protocol converter. A complete substation

automation laboratory was designed, commissioned and tested in the process and is functional in Jamia Millia Islamia.

3. Modeling of a transmission substation with all important protection schemes attempted using appropriate software

Software modeling of relays is essential for the reliable operation of a modern power system. It not only helps to evaluate the protection system performance during faults and other conditions but also generates useful data that can be used in the event of a fault, to understand what happened a**s** it is difficult to get real time data for analysis from the actual substations. A 400/220 kV transmission substation with all the protection scheme has been modeled which helps to generate data under various fault scenarios. Several types of relays such as distance, directional earth fault (DEF), over voltage, auto-reclose function, local breaker backup, and differential were modeled. Different fault scenarios were applied to the simulated networks and the robustness and functional accuracy of the model was verified.

4. Simulation of substation events at different locations for a) generation of data, b) processing of Data generated from simulated substation events, c) knowledge extraction from the Data using "Rough Set Theory" and d) delivery of information to the major utility departments in substations.

Presently, most of the information captured by the advanced numerical relay IEDs is not being used as the data generated by these IEDs is in large volume and utilities are completely confused about the useful information hidden in the data. A computational intelligence approach using rough sets at the station level of the substation has been used in this thesis. It not only generates useful and easily readable rules but also allows faster knowledge acquisition and information transfer to streamline the decision making process in the control center. Useful information extracted from the data is to be transmitted to the different utility departments, to enable them to take right decision at the right time. Thus, data received at the master station is processed and information about various voltage, current values, relay and breaker operation along with the problem identified was presented to different user groups, to achieve better decision making. The information required by the most important utility departments, namely operation, maintenance, planning have been developed in Visual studio. The useful information extracted from the data by rough set theory is communicated to these departments, as per their requirement.