ABSTRACT

Power system restoration following a partial or total blackout is one of the most important tasks for power system operators. It is a complex process that restores the system back to normal after an extensive outage of the system. Due to a combination of unforeseen circumstances, there is a remote possibility of a system-wide outage and it is very important not only to minimize power failure, but also restore the power system network quickly and safely. During this stressful situation, to reduce shortage of power supply, proper switching of power lines is required. The efficient switching operations require the identification of optimal path for the power flow in the network. A thriving restorative path search guidance tool will be a welcome advantage.

The objective of this work is to reconfigure the de-energized network by maximizing the amount of power restored through the optimal path. The existing Shortest Path Finding (SPF) algorithms find only the shortest path in the network. These algorithms are extended by adding the additional constraints - i) shortest distance between the generating station and demand ii) Power balance between generation and demand iii) Capacity of the line iv) Voltage limit v) Priority of loads to identify the optimal path in the power system network. The SPF algorithms such as Dijkstra, Floyd Warshall
and Bellman Ford algorithms are explained with the simple network and then it is implemented to the 19 bus, 28 lines practical network. The result obtained from the extended SPF algorithm-based technique reduces the line losses and is used to obtain an efficient restoration plan. The three SPF algorithms are compared based on execution time and space complexity and the results reveal the superiority of the Bellman Ford algorithm. While applying these algorithms to a larger network of $n$ nodes, the $n \times n$ matrix should be framed for executing the algorithms. Hence, there is a need for the reduction of the network size.

Network reduction is a process which reduces the size of a network model by replacing sets of buses and the network elements (lines, transformers, etc.) that connect them with a smaller but exact, numerically equivalent network. For a properly chosen set of buses, this equivalent network will have fewer buses and branches than the original, yet provide the correct response to faults or load flow calculations in the reduced portion. Since it is difficult to implement the SPF algorithm to a larger size power system network, a Ward network reduction technique is used to reduce the network. The Indian utility 62 bus network is reduced using this technique and the SPF algorithms could be easily applied to find the optimal path.

The existing two and four-level architecture of Multi-Agent System (MAS) is replaced with the three-level architecture of MAS. The SPF algorithms are integrated with the MAS and are used for the reconfiguration of the power system network. The MAS consists of several Demand Agents
(DAs), Source Agents (SAs), Load Dispatching Agents (LDAs) and a single Management Agent (MA). MA is positioned in the upper level. LDAs are fixed in the second level and several DAs and SAs are implemented at the third level. DAs correspond to the load characteristics while the SAs include the generator which has the different generator characteristics. LDAs are equipped with the optimal path search guidance tool to identify the power flow path. The LDAs are given suggestion for connecting the electrical subsystem to the actual network by the MA. Using SPF based three level MAS technique, a restoration plan is prepared for different time intervals.

This thesis discusses the shortest path finding algorithms to identify the optimal path for the power transmission. This is integrated with multi-agent system to prepare the restoration plan for the 19 bus practical network. This computational procedure can be used for any power network to obtain the dynamic restoration plan.