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CHALLENGES AND ISSUES OF POWER DISTRIBUTION AUTOMATION USING MULTI AGENT SYSTEMS

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ABSTRACT

In Today's world, "WITHOUT POWER CAN'T DO ANYTHING". Because of electronic technology development depends up on power system. Electric power distribution system has an important role in electrical power systems to deliver the electricity to consumers by multi agent systems (MAS). Automation in the distribution field with MAS allows utilities to implement flexible control of distribution systems, which can be used to enhance efficiency, reliability, and quality of electric service. In this paper, the challenges facing in fault detection, isolation and restoration in the power system are discussed.

Keywords: power distribution, multi-agent, intelligent agents, power restoration, isolation.

1. INTRODUCTION

The survey has taken in the current state of the art in multi-agent system development and identifies current issues. A Multi-Agent System (MAS) technology is developed for some kind of application including power system restoration. MAS' technology offers a high degree of scalability, independence of network topology and flexibility because they work autonomously and make local decision. MAS's are composed of multiple interacting computing elements, called agents. There is no single definition of an agent but all the definitions are agreed that an agent is a special software component.

"An agent is a computer system, that is situated in some environment and capable of autonomous action in this environment to meet its design objectives" [1]. The flexibility and adaptability of multi-agent system make them attractive for several real world applications. Many important computer applications such as planning, process control, and communication network configurations and concurrent systems will be benefited from a multi-agent system approach. Multi-agent systems have been applied for solving problems such as reconfigurations, restorations, fault identifications, diagnosis and power system protection. A multi-agent system can make complex systems. Agents in this system can interact with each other indirectly, by acting on the environment, or directly, by communication and negotiation. An agent has some general characteristics as: autonomous, social, reactive, proactive are given below. An agent is a computer system that is capable of independent action on behalf of its user or owner

Autonomy: The agents are autonomous means they are independent and they make their own decision. No humans and no others have control over their action and behaviour. Reactivity: An agent is reactive means that the agent is able to act to changes in its environment in timely fashion and make some decision based on those changes.

Proactiveness: The capacity to exhibit a goal-directed behaviour by taking the initiative for advancing towards an objective. Social ability: An agent is social means that an agent can make contact with others agents as they can send message to each other. Agent interaction can be formed in terms of performative such as:

- **Request:** The receiver will perform the message from the sender as the sender wants.
- **Inform:** The receiver will be aware of a fact that the sender wants it.
- **Propose or CFP:** The sender wants to make a negotiation with the receiver.

The last oldest article in 1994, J. Narros and J.M. Drake showed real time fault detection and classification by using microprocessors based on the estimation of the three phase voltage phasors by mean of a set of Kalman filters, and on the calculation of the fault probability [2].

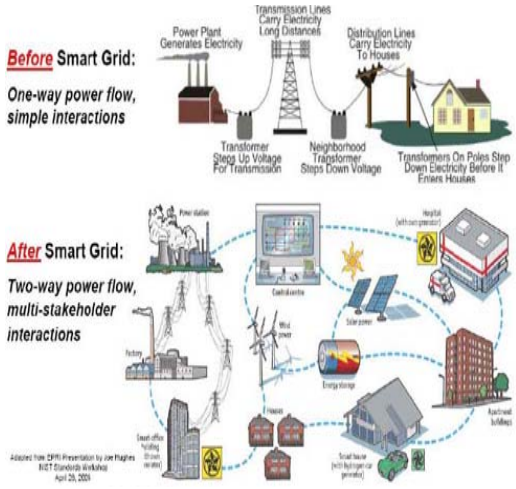

Figure-1. Smart grid system.

The Smart grid system is shown in Figure-1, has rapid, automatic system responses to grid crises and provides a platform for active communication and control. Efficient operation and maintenance of distribution system are hampered by non-availability of system topological information, current health information of the distribution components such as distribution transformers and feeders, historical data etc. Other reasons include the lack of efficient tools for operational planning and advanced methodology for quick fault detection, isolation, and service restoration, etc. All these lead to the increased system losses, poor quality and reliability of power supply in addition to the increased peak demand and poor return of revenue.

This paper is organized as the issues and requirements of MAS in section 2. The fault restoration system is discussed in Section 3 and in Section 4 methodology is described. Followed that, conclusion is given in Section 5.

2. ISSUES AND REQUIREMENTS OF MAS

The anomaly detection will provide detection of the fault as early as possible, while minimising the dependence on information of how defects are reflected in the data. The alarms raised by the incipient anomalies detected can easily be traced back to the data parameter in which it was identified, leading to an opportunity for the identification of the degrading component in time before it fails and is required to be replaced. Arevena *et al* presented an integrated approach to the problem of power system fast fault detection and isolation. The idea is to use concepts from signal processing and wavelet theory to create fast and sensitive fault indicators. The indicators can then be analyzed by standard statistical hypothesis testing or by artificial neural nets to create intelligent decision rules [3].

Automatic capture and conditioning / formatting of relevant data, Automatic interpretation of the conditioned /formatted data, to identify incipient and serious defects, Discrimination between a sensor failure and an actual plant failure, Provision of clear and concise defect information and advice supplied to the operators and extensibility and flexibility to include further interpretation techniques and monitoring technologies are the required information to detect the fault in power system. The high-level software has developed using a Multi-Agent framework which composed of five types of agents consisting of three detection modules, an interface agent with which the user can interact and receive information and, finally data parser agents to handle the data.

Master DA Software and Engineering Analysis Software are the two key software elements at the distribution control centre (DCC). The master DA software acquires the system data (both static and dynamic) and converts it into an information system. The engineering analysis software provides the control decision utilizing the system information, available at the DCC. The decision making feature of the distribution automation distinguishes it from the normal SCADA (Supervisory Control and Data Acquisition) system. In the conventional SCADA system, control decision is supervisory, i.e., the control decision is taken manually on the basis of experience and the available real time data. It is then executed through the man machine interface. On the other hand, computer based control decisions are taken in the DA (Distributed Automation) system and these control decisions are executed in either automatic mode or in semi-automatic mode through human intervention.

3. FAULT RESTORATION SYSTEM

In a power distribution network fault management, service restoration is very important component. When an electric power supply interruption is caused by a fault, the system should restore the power quickly to an optimal target configuration after the fault. The problem of obtaining a target configuration is called as a power system restoration. Generally the approaches to study service restoration can be roughly grouped into two categories: centralized methods and distributed methods. Centralized methods include Heuristics, Experts Systems (ESs), Mathematical programming (MP) and Soft Computing. Each of these have their ability to solve a problem, and of course with some weakness. Heuristics and ESs have been used in industries but they have their own lacks to the optimality to the solution.

MP is good to obtain the optimal solution after the formulation, but it needs some engineering judgment in formulating restoration problems. In year 2010 the symmetrical pattern and PCA based frame work for fault detection and classification by Qais alsafasfeh and team researchers proposed in applied mathematics and signal processing developed the techniques for the detection and classification [4]. Soft computing methods are easy to implement, but they need long computation time until solution. Hassan Feroze (2009) proposed control

algorithms for intelligently managing the limited supply from a distributed energy resources during emergencies to secure critical loads, and at the same time supporting non-critical loads when the users need the most [5]. Now a day's soft computing techniques are analyzed to detect and diagnosis the fault before failure occurs. Eisa Bashier M Tayeb (2013) implemented neural network NN architecture for fault detection in a transmission line power system [6]. Guojiang Xiong (2013) implemented fuzzy reasoning spiking neural P systems (FRSN P systems) for fault diagnosis of power systems for the first time [7].

The distributed methods mainly based on multi agent system technology which has more attention recently to handle complex power system research and development. The foundation for intelligent physical agencies (FIPA) is an IEEE standard organization that promotes the agent based technology and compatibility with other technologies. T. Nagata (2002) proposed a multi-agent approach to power system restoration system. It consists of number of bus agents (BAGS) and a single facilitator agent (FAG). BAG is developed to decide a suboptimal target configuration after a fault occurrence by interacting with other BAGS based on only locally available information, while FAG is to act as a manager in the decision process [8].

In Navy sector current reconfiguration techniques are centralized methods and cannot meet the needs for fight-through survivability and high reliability. Huang Qiaoliang, (2011) implemented a novel multi-agent based reconfiguration approach to perform system restoration for navy ship. Each zone agent in this system communicates with other agents [9]. Felix (2012) reviewed the state of the art technologies such as Multi Agent Systems (MAS) used in distribution system restoration and highlights the major advantages of the same. In this paper centralized, decentralized and hybrid control strategies, implemented to control agents in restoration framework are discussed [10]. Ghorbani, J (2012) proposed a decentralized multi agent system (MAS) which works in real time with a power distribution system for fault detection applications [11].

4. METHODOLOGY

When a fault is detected, the FDIR immediately opens the nearest boundary line switches to isolate the faulted feeder section from both directions. The upstream out of service sections are then restored by closing the circuit breaker of the distribution feeder. To restore the electricity service for the downstream unfaulted sections, a restoration strategy is derived by maximizing the area of service restoration with the minimum number of switching operations.

Agent based computation has been studied for several years in the field of distributed artificial intelligence and applied to power systems such as a strategic power infrastructure defense system, protection systems, energy management systems, power restoration system, power markets, a transformer condition monitoring system and distribution system restoration. J.M. Solanki *et al* presented MAS with three types of agents using Java Agent Development Framework (JADE) as a multiagent framework to exchange information and determine a feasible restoration strategy [12]. Solanki, J.M (2005) proposed a decentralized solution of multi-agent system approach, to isolate the fault and restore the power supply quickly and autonomously [13]. He has developed a simulation of three phase unbalanced system a three-phase PQ load model in virtual test bed (VTB) with MATLAB.

H. Lim (2008) proposed distributed restoration method applying Multi-Agent for increasing the efficiency and saving time of the restoration time of blackouts [14]. Feeder Remote Terminal Unit (FRTU) in distribution network performs restoration and separates minimized fault section itself by exchanging information using communication to each other, the efficiency and time of the restoration can be enhanced. Chia-Hung Lin (2009) developed a multi-agent-based Distribution Automation system (DAS) is developed for service restoration of distribution systems after a fault contingency [15]. It has Remote Terminal Unit (RTU) agents, Main Transformer (MTR) agents, Feeder Circuit Breaker (FCB) agents, and Feeder Terminal Unit (FTU) agents of the Multiagent System (MAS) are used to derive the proper restoration plan after the faulted location is identified and isolated. Chao-Shun Chen (2009) enhanced the cost effectiveness of the distribution automation system, this paper proposes the immune algorithm (IA) to derive the optimal placement of switching devices by minimizing the total cost of customer service outage and investment cost of line switches [16].

The demand of reduced outage rates (both quality and duration) has led most electric companies to reconfigure their distribution networks from radial to normally opened looped, so once faulted section is isolated, power can be restored to the rest of the network from an alternative sources. This task is economically achieved by introducing distribution automation switches which are remotely controlled from a central control room. In this manner, quality and continuity of service to the customer are vastly improved as is user convenience. Therefore, the focus of electric research and development activities worldwide is to automate the electric power distribution system utilizing recent advancement in the area of Information Technology and data communication system.

5. CONCLUSIONS

Electric power utilities worldwide are increasingly adopting the computer aided monitoring, control and management of electric power distribution system to provide better services to electric consumers. There was number of general, interesting research challenges are emerged from this automatic distribution for fault detection and restoration. Thus the literature

survey organised in the power system, how to distribute the power without any interruption and how to rectify the fault with immediate effect and restore the system with normal load. Apart from the challenges mentioned, a number of other opportunities are available with MAS technology for distribution automation. Because it can be implemented in the updated communication, Intelligent Agents are promoted for easy and speed fault detection, isolation and restoration.

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