Automation in Power Distribution System

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ABSTRACT: Electricity distribution in power system is an essential part of electrical power supplying to consumers. The computer-aided tracking, regulation and maintenance of the electric power distribution system is widely adopted by electrical power providers to provide certain changes in the consumer services gradually. Thus, development and research activities are carried out widely to automate the system of distribution of electrical power which is applying recent advances in the field of data communication system and information technology. Distribution automation allows services to execute efficient control of distribution systems that can be used to improve electrical service reliability, efficiency and quality. This article provides a brief overview of automation of the distribution system. A detailed description is also provided of the implementation regions, advantages and commercially available items for distribution system automation. It also addresses the emerging theories of implantation and the current challenges of development of distribution system. Finally, coordination enabled improved integration of the distribution system and its advantages are explained in detail.

KEYWORDS: Distribution Automation System, Advanced Distribution System, Power Quality and Stability, Power-Line Carrier.

INTRODUCTION

The term automation describe as automatically executing a particular task in a series with a faster rate of action. It includes the implementation of all in one microprocessor devices, communication networks and some related device programming. Automatic tracking, security and supervision of switching activities utilizing intelligent electronic devices to restore power supply by serial events during fault and to sustain operating conditions back to normal operations is a good definition of the implementation of automation at the level of delivery capacity. Today, thanks to the development and advancement of communication technologies, the distribution automation system[1] (DAS) is strengthened by a highly reliable, scalable and self-healing device in the power network and associated subsystems, offering swift, real-time and appropriate action for incidents, as well as a remote controller and substation[2] and feeder equipment operating system. There are several explanations why power supply industry need the automation systems for delivery. To date, the electric power sector has been greatly enhanced in terms of both quantity and quality factors as well as societal expectations for better services.

DAS's main function is to remotely control switches to identify and isolate the fault and recover the network when there is a malfunction in the power distribution network. The automation of distribution system presently contributes to capacity enhancement and development, as well as stability and power distribution consistency[3]. There are now significant questions regarding improved efficiency because of the introduction of performance-based prices and the increase of power quality due to its effect on vulnerable loads. Furthermore, different methods that need attention to incorporate advanced delivery automation include cost and benefit assessment software, network analysis and reliability assessment. DAS is characterized as a system which allows a remote monitoring, management and activity of distribution components by an electrical utility in real-time mode from remote locations. It is based on an embedded technology which involves collecting data and analysing information for making control decisions, implementing correct control decisions in the field and also checking that the desired outcome is achieved. The point from which management decisions are made is generally referred to as the distribution control centre. Now with this short introduction. This paper will address the advantages and difficulties of the distributed automation system[4]. Another portions of this paper are dedicated to the areas of distributed automation system design, functional specifications, technical challenges and communication protocols available in such systems. This paper is therefore an effective and quick summary of automation of the distribution system.

1.1 Advantage and difficulties of DAS System:

The automation in distribution system provides both advantages and difficulties in the supply systems control area. Such advantages and difficulties are strongly intermingled, and the actual and total opportunities are not available until some of the difficulties have been resolved, particularly the economic challenges, so waiting to resolve such challenges implies losing some of the benefits doing nothing can often be worse than doing anything.

Hence, the serious case for distribution automation is to assess the balance of advantages and difficulties, along with the possibility lost opportunity if nothing has done. For a system or its consumers no one strategy is optimal Certain function of automation of distribution are more advantageous to a few feeders in one utility, for example, VVO (Volt/VAR optimization) control in an optimum condition, while other functions may be more useful in other utilities, such as monitoring of faults, separation, and service recovery, and maybe some distribution automation functions are more advantageous to different customer groups, such as some enterprises. Harmonic reduction and power quality are very essential for certain industries while most residential customers are virtually unprofitable. Society, too, can often profit implicitly but sometimes explicitly.

1.1.1 Major Advantage of DAS System:

The examples for use and the main DAS roles are tested for the different types of benefits (utility, society and customer) that can be given. Several forms of benefits are described for each group of benefits.

- *Economics Profit:*

Includes low and stable cost of electricity, unit rate option for consumer also include in this section.

- *Power Quality and Stability:*

Including decreased blackout numbers and durations, decreased number of temporary blackouts, green power, and trustworthy distributed generation management in conjunction with load management.

- *Protection and Security:*

Along with greater visibility in dangerous or hazardous conditions, physical plant and cyber security upgrades, energy independence and privacy protection.

- *Energy Efficiency:*

Including reduced electricity consumption, reduced demand at rush hours, lower energy losses and the ability to use performance as equal production in the activity of power systems.

- *Power Resources and Environment:*

Including a reduction in the amount of toxins leaked, such as greenhouse gas emissions[5], reduced generation from unreliable sources of energy and improved use of renewable energy sources.

In certain benefits, primarily those that specifically decrease utilities costs, customers also profit from either lower tax rates or minimize tariffs, even if the connection may not be straightforward. Benefits to society are often more difficult to measure and evaluate, but it can be equally serious when determining a certain function's overall profits. The intangible advantages involved with each of the tasks can be converted into measurable measures, indicating dollars for the "strong" income possible and an estimated value for the "soft" benefits. Nonetheless, this modification could only happen when the functions generate unique, comprehensive usage cases, so only then can the numbers be defined. Then those subjective metrics can be used in real business scenarios. Nevertheless, simple calculations can be presented to explain how to render these conversions.

1.1.2 Major Difficulties in DAS System:

The major technical difficulties for the implementation of DAS system include:

- *Electronic Appliances:*

Electronic appliances includes all computer-based or microprocessor-based field appliances, including sensors, remote terminal units, smart electronic devices, computers devices used in the field, mobile devices, information transmitter, and so on. The real power machinery, such as breakers, switches or condenser, would be included in this list, as the power machinery and its electronic controller equipment are processed together, however the primary focus is on the control and data parts of the machinery.

- *Software Application and System Integration:*

Software applications include algorithms, program, data analysis, calculations and other computer which provide additional distribution automation functionality. For electronic devices, control panel, computers, portable devices or any other computer-based system, such software applications can be used. System integration involves connectivity and information sharing among several different systems. Key problems include compatibility of integrated networks, access control, cyber security, system-wide user identification, messaging protocols, etc.

- *Data Management:*

Data management provides an overview of data collection, review, storing and planning for consumers and devices, including data detection, testing, precision, monitoring, time marking, information integrity, etc. Methods of data management which function well for small amounts data can often struggle with huge amounts of data a common situation of delivery management and customer information or become too onerous.

It is clearly identified that economic difficulties play important roles in determining the value benefit of any particular distribution automation system, as well as legal and regulatory difficulties. It could be very difficult to measure the impact of these economic difficulties since they can be vastly different for different services, the innovations are evolving so quickly that any estimate becomes obsolete even before it is published, and often the costs are directly related to particular regulatory and tariff conditions.

IMPLEMENTATION OF ADVANCED DAS SYSTEM

ADA (Advanced distribution automation[6]) will be comprised of many features and programs. Included are several new systems, facilities, and software that will be part of the overall ADA programs. You may establish five significant functional specifications for the entire system.

- Infrastructure for connectivity and management that contributes to the incorporation of all delivery facilities and end user devices into the ADA framework.
- Automation for all functional distribution devices and systems to maximize reliability and performance and network modification management.
- Installation of advanced technologies including power electronic equipment for advanced control and enhancement of system performance.
- Implementation of the tools for distributed generation and storage.
- Designing and true-time simulation methods for output enhancement use predictive control and perturbation response.

2.1 Infrastructure of Control and Communication System:

It is not possible to implement ADA without the detailed coordination between the controllable machines and one or more control units[7]. Many times, the control unit can be a central processor and at other occasions, as in peer-peer networking, it may be another controllable computer. Adding connectivity connections to specific delivery products is becoming more common and widespread, partially due to reduced communication costs. Recent developments in technology and increased competition result in reduced communication costs. Economic analysis is more likely to show that the cost of adding contact connections is balanced by enhancing network stability and improving output and management performance.

For the communications media distribution automation[8] the following three main categories are specified-

- Wireless.
- Landline
- Power-line carrier

Power line carrier[9] networks were most effective in the implementation of automated meter reading and load management. Power-line carrier in delivery systems suffers from the issue of open circuit. Or put it another way, contact with computers on the far side of an open circuit is lost. This problem severely restricts the utility of power line carrier networks for applications including recloses, switches, sectionalisation and prevention of blackouts.

The connectivity solutions for landline networks include cellular and fibre optics. The telephone lines are not often used for distribution control because of costs involved with the installation of the telephone line, the dielectric insulation system and the monthly costs.

Wireless solutions are the greatest possibility for automating distribution networks[10], since they connect at a very low cost almost everywhere. Companies exploring wireless solutions have two options; install a wireless network operating private or owner, or use an existing public network infrastructure. Private wireless networks enable utilities to have more leverage of their communications system which require substantial initial infrastructure investment as well as ongoing maintenance costs.

ADA devices can often add contact and control features that embed the application of demand response and real-time pricing mechanisms into end-use technologies. Such devices can help optimize the efficiency of individual distribution systems as well as provide the means of charging characteristics for the increased match generation tools.

2.2 Automation of Controllable devices:

The installation step must follow the automation phase, in which the hardware and knowledge will be fastened. Integrating security, monitoring, and data acquisition functions into a small number of platforms would result in reduced capital and operating costs, capacity for the panel and control centre, and removal of obsolete hardware and repositories. The first level of automation takes place at the substation, as connections at this point are the most readily available. To order to optimize the production, reliability and reaction of the overall system, potential ADA programs must improve the control output on the distribution system and even into consumer facilities.

2.3 Management of Distributed Energy Resources:

In order to fulfil the ADA dream, the distribution system will have to transition from a single function or power delivery system to a multifunction or energy exchange device. The electricity contracts do not need to contribute to a physical delivery in the energy exchange networks. The complexity of monitoring and management will need to be improved and this capability will be implemented throughout the distribution system with the dispersed tools. A significant technical goal of the ADA is the integrated incorporation of small power supply and storage devices. Ideally, this merger would increase DER's income and mitigate some of its potential liabilities. The implementation of simplified DER[11] network interconnection networks would simplify and speed up the integration of new DER services on the framework. When part of system performance control these applications need to be combined with the overall delivery automation system. The electrical infrastructure would require the ability to break up into micro grids or self-supporting islands to enhance the stability and power quality benefits associated with DER, during certain power system disruptions or even to improve stable performance.

2.4 Application of DAS System:

Optimizing the output and the distribution system reaction can contribute to developments in power electronics technology in the future. Significant benefits of applications for power electronics technologies[1] will include-

- Quick, transient-free switching for better response to disruptions and reconfiguring the device.
- Constant voltage and Volt amp reactive power regulation, and harmonic distortion regulate.
- Run via systems to increase the quality of energy and consumer dependability that involve the above level of service.

CONCLUSION

This paper discusses the excellences and advantages of the distribution automation system Distribution automation enhances a supplier's efficiency, quality, and profitability, as well as gives consumers quality and reliability of supply. Often addressed are commercially available technologies for distribution automation operation. The main stimulant to embrace distribution automation in developing countries such as Iran is to increase the operational capacity and distribution system output. It reflects a global interest in the integration of production at present and in the future. Universities are showing an interest in introducing classes and research and development activities in the field of DA in regular academic education planning now, paying more attention to the interest of power utilities for distribution automation. Data acquisition method consistency is an important factor that significantly influences the quality and reliability of ADA networks and also the output and reliability of the power distribution network. Remote control and tracking of storage facilities along with data acquisition are important aspects of process automation. It is a natural and motivated decision to merge the monitoring of distribution facilities with the monitoring of power efficiency.

REFERENCE

[1] J. M. Gers, *Distribution system analysis and automation*. 2013.

[2] A. Sachan, "Microcontroller Based Substation Monitoring and Control System with Gsm Modem," *IOSR J. Electr. Electron. Eng.*, 2012, doi: 10.9790/1676-0161321.

[3] A. T. Elsayed, A. A. Mohamed, and O. A. Mohammed, "DC microgrids and distribution systems: An overview," *Electric Power Systems Research*. 2015, doi: 10.1016/j.epsr.2014.10.017.

[4] L. I. Dulau, M. Abrudean, and D. Bica, "Automation of a distributed generation system," in *Proceedings of the Universities Power Engineering Conference*, 2014, doi: 10.1109/UPEC.2014.6934734.

[5] M. T. Abberton, "Greenhouse gas emissions," in *Genomics and Breeding for Climate-Resilient Crops: Vol. 2 Target Traits*, 2013.

[6] R. Greer, W. Allen, J. Schnegg, and A. Dulmage, "Distribution automation systems with advanced features," in *Papers Presented at the Annual Conference - Rural Electric Power Conference*, 2011, doi: 10.1109/REPCON.2011.5756721.

[7] L. Chhaya, P. Sharma, G. Bhagwatikar, and A. Kumar, "Wireless sensor network based smart grid communications: Cyber attacks, intrusion detection system and topology control," *Electronics (Switzerland)*. 2017, doi: 10.3390/electronics6010005.

[8] C. H. Lo and N. Ansari, "The progressive smart grid system from both power and communications aspects," *IEEE Commun. Surv. Tutorials*, 2012, doi: 10.1109/SURV.2011.072811.00089.

[9] P. Poudereux, Á. Hernández, R. Mateos, F. A. Pinto-Benel, and F. Cruz-Roldán, "Design of a filter bank multi-carrier system for broadband power line communications," *Signal Processing*, vol. 128, pp. 57–67, 2016, doi: 10.1016/j.sigpro.2016.03.014.

[10] A. K. Das and S. Zeadally, "Data Security in the Smart Grid Environment," in *Pathways to a Smarter Power System*, 2019.

[11] M. F. Akorede, H. Hizam, and E. Pouresmaeil, "Distributed energy resources and benefits to the environment," *Renewable and Sustainable Energy Reviews*. 2010, doi: 10.1016/j.rser.2009.10.025.