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Modern Trends in Power System Communication: A Review

Vineeta S.Chauhan[1], Rashmi Sharma[2], Hinal Shah[3]

Asst. Professor Dept. of Electrical & Electronics Engineering, Indus University, Ahmedabad, India[1]

Asst. Professor Dept. of Electrical & Electronics Engineering, Indus University, Ahmedabad, India[2]

Asst. Professor Dept. of Electrical Engineering, Indus University, Ahmedabad, India[3]

ABSTRACT: Power-system communications play a vital role in the safe and efficient operation of the electric power grid. Real-time automation and control of electric utility generation, transmission and distribution systems are dependent upon reliable and secure communication networks. Through an ever-expanding role, the communications' networks enable the application of more computer and microprocessor-controlled devices. These networks and devices support the better utilization of extensive EMS and corporate information technology infrastructure. The use of SCADA in the distribution system has now become the norm for most new distribution equipment that has an electronic control. SCADA allows operators in the control center to monitor the activity and status of field devices, such as reclosers, pulse closers, switches, and other electronically controlled devices as long as they are equipped with long-range communications capability. The future of the developed, developing, and emerging countries in a global economy will depend even further on the availability and transport of electric energy. It is believed that in the near future the global consumption of electrical energy will grow to unprecedented levels. Furthermore, security and sustainability have become major priorities to both industry and society. Consequently, deployment of sustainable/renewable energy sources is crucial to a healthy relationship between man and his environment. The conventional power systems with sophisticated Information and Communication Technologies (ICT) are expected to evolve into a new grid paradigm called, a "Smart Grid". The Smart Grid (SG) can also be thought of as a conventional power system with additional digital layers. Here, in this paper, a humble attempt is made to present the current state of art with reference to the various research works reported in literature so far in the communication sector as applicable to Electrical Power Systems. The technological developments achieved in the domain of Power system communication starting from Power Line Carrier communication to the recently evolved Cognitive Radio Network based communication are considered for discussion.

KEYWORDS: EMS, SCADA, ICT, SG, Cognitive Radio Network

I.INTRODUCTION

The need for communication is to have speech, tele-protection, data signal, Tele metering and Tele- control. A communication infrastructure is an essential part of the future power systems. The basic communication system consists of Information to convert the data /voice signals into carrier signals suitable for transmission over the selected medium and devices to retrieve information from the carrier signals. Some of the Modern Trends in Power System Communication have been discussed in this paper so that Electic power grids can work safely and efficiently.[1]

II.CURRENT POWER SYSTEM DATA COMMUNICATION MEDIA

Communication has always played a critical role in power systems and will become even more critical when it comes to implementing an end-to-end and two-way open communication grid infrastructure. Electric utilities made avail of several types of communication media in the power system are highlighted in the following sections .Fibre optics will be the ideal choice for future communication infrastructure, with more and more bandwidth required. In this paper, Different methods are briefly explained which are helpful in Power System Communication.[1]

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III. POWER LINE CARRIER (PLC)

PLC operates by transmitting radio band of frequency signals between 10 kHz to 490 kHz over the transmission lines.PLC with power output 150 W can be used to 240 km. Power-line communication (PLC) is a communication method that uses electrical wiring to simultaneously carry both data and electric power. Power line networking (PLN) uses existing electrical wiring, whether in a building or in the utility grid, as network cables, meaning they also carry data signals. It can be a means of extending an existing network into new places without adding new wires. The power line is transformed into a data line via the superposition of a low energy information signal to the power wave. Since electricity is 50 or 60 Hz, data is transmitted at atleast 3 kHz to ensure that the power wave does not interfere with the data signal. A technical challenge is that, because the power wiring is unshielded and untwisted, the wiring acts as an antenna, so that the wiring emits radio energy, causing interference to the existing users of the same frequency band.PLC does not offer a reliable solution for wide area data transmission.[1]

IV. SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

SCADA system is a common industrial process automation system which is used to collect data from instruments and sensors located at remote sites and to transmit data at a central site for either monitoring or controlling purpose. The collected data from sensors and instruments is usually viewed on one or more SCADA host computers that are located at the central site. Based on the information received from the remote stations, automated or operator-driven supervisory commands can be pushed to remote station control devices, which are often referred to as field devices.

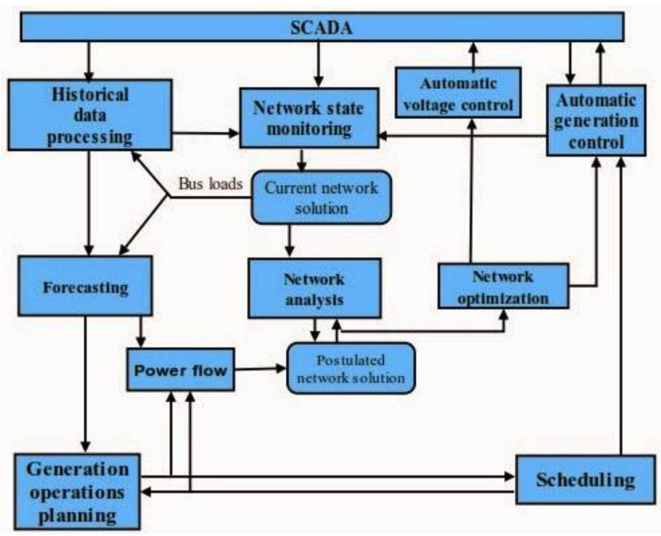

Fig. 1 SCADA for Power Generating Stations

With the use of Programmable Logic Controllers (PLC) hardware and powerful bus communication links along with SCADA software and hardware’s in power generating stations, delivering an optimal solution for each and every process operation is flexible with advanced control structures. The Fig.1 shows the SCADA structure in power generation where it supervises several operations, including protection, controlling and monitoring. The functions of SCADA in power generation include:

- Continuous monitoring of Speed and Frequency
- Geographical monitoring of coal delivery and water treatment processes
- Supervising the status of circuit breakers, protective relays and other safety related operations

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- Generation operations planning
- Active and reactive power control
- Turbine protection
- Load scheduling
- Historical data processing of all generation related parameters

SCADA for Power Distribution System

Power distribution system deals with transmission of electric power from generating station to the loads with the use of transmission and distribution substations. Most of the power distribution or utility companies rely on manual labour to perform the distribution tasks like interrupting the power to loads, all the parameter hourly checking, fault diagnosis, etc. The implementing SCADA to the power distribution not only reduces the manual labour operation and its cost but facilitates automatic smooth operations with minimizing disruptions.

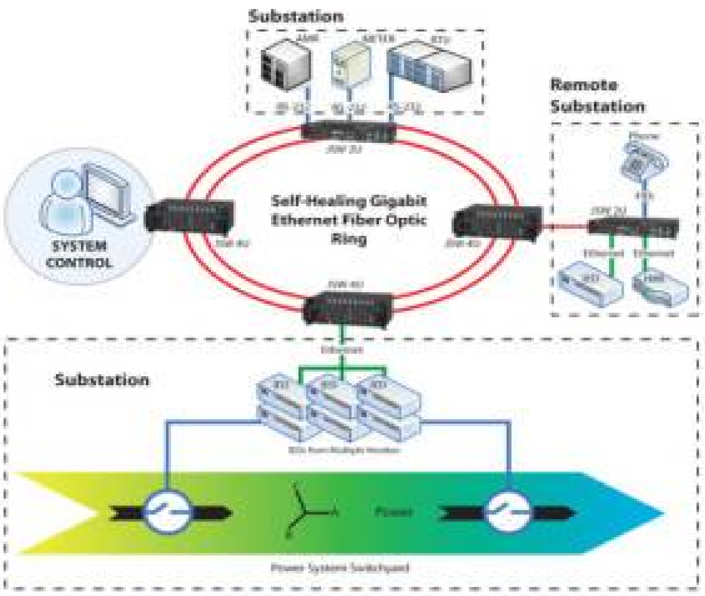

Fig.2 SCADA for Power Distribution Stations

The Fig.2 shows the structure of SCADA in power system where it collects the entire data from various electrical substations (even at remote locations) and correspondingly process the data. Programmable logic controllers in substations continuously monitor the substation components and corresponding transmits that to centralized PC based SCADA system. In the event of any outages of power this SCADA allows to detect the exact location of fault therefore without waiting for the calls from customers SCADA gives an alarm system to the operators for identifying and preventing it. And also in substations SCADA automatically controls isolator switches and circuit breakers for violating parameter limits, thereby continuous inspection of parameters are performed without a line worker. Some of the functions of SCADA in power distribution system are given below.[5]

- Improving power system efficiency by maintaining an acceptable range of power factor
- Limiting peak power demand
- Continuous monitoring and controlling of various electrical parameters in both normal and abnormal conditions
- Trending and alarming to enable operators by addressing the problem spot
- Historian data and viewing that from remote locations

- Quick response to customer service interruptions

V. FIBRE OPTICS

In order to overcome communications obstacles, optical fiber products are used in communication with protection, monitoring, and control devices.. Additional benefits of optical fiber include its easy field connector termination easy testing with visible light, damage resistant cable, and electrical isolation. Events such as a ground fault or very high currents cause a difference in electrical potential from one location to another. This change in potential can damage equipment and injure people. Optical fiber provides the necessary electrical isolation to drastically reduce the risks to people and equipment. Fig .3 shows the Structural diagram of Fibre Optics.

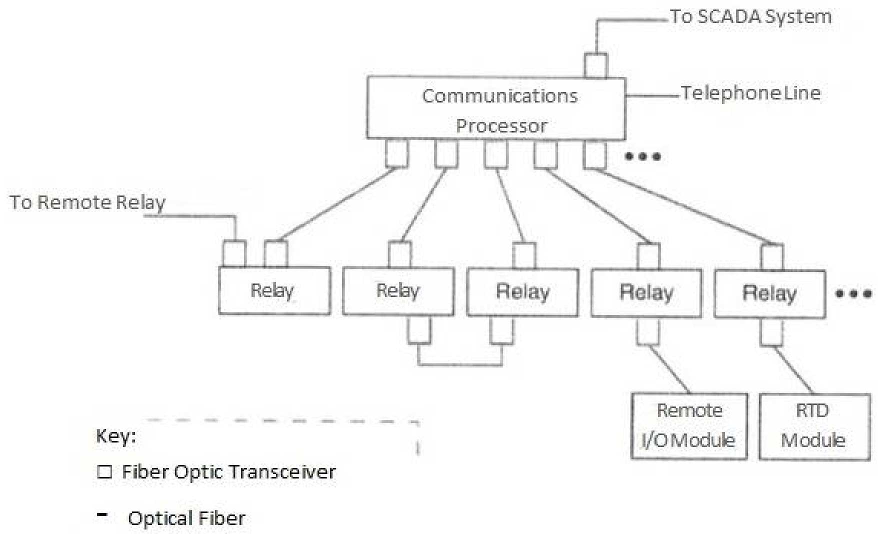

Fig.3 Fibre Optics and its Structure

The combination of the relay and optical fiber provides internal diagnostics so that the relay can remain in service without interruptions for periodic testing. Although the primary function of the relay is protective in nature, the relay includes automatic control to restore service, metering and demand metering reports, sequential event reports, and event reports with fault type and location and oscillographic data snapshots. It is the most suitable data transmission medium for power system control ,protection and monitoring function. The characteristics of the optical fibres that make them so useful are: low attenuation, high bandwidth, electromagnetic interface immunity and security.[6]

VI INFORMATION MANAGEMENT METHODOLOGY

As the electricity industry becomes increasingly competitive, knowledge concerning the capacity constraints and reliability of electric system will become a commodity of great value. Electricity markets can be fast changing understanding the implication of these changes before others can give an important competitive advantage. IT plays an important role to cater to the great needs of information exchange in power system. A methodology for efficient information consolation, exchange and sharing is required. As the volume of information holding increases, this need will become increasingly more critical Power systems have grown recently in size and complexity to unprecedented levels. This means that planning and operation of power systems cannot be made possible without the aid of information tech-no logy tools and instruments. Even small systems need such aid because of the complexity factor. On

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the other hand, new trends have recently emerged to solve the problems arising from increased size of power systems. These trends are related to the market structure, legal, and business issues. Other trends also cover technological developments, and environmental issues. Moreover, power systems have special characteristics and features that are not duplicated in other infrastructures. All these issues confirm the need for special information technology tools and instruments which aid in planning and operation of power systems.[1]

VII. COGNITIVE RADIO NETWORK

A cognitive radio (CR) is a radio that can be programmed and configured dynamically to use the best wireless channels in its vicinity. Such a radio automatically detects available channels in wireless spectrum, then accordingly changes its transmission or reception parameters to allow more concurrent wireless communications in a given spectrum band at one location. This process is a form of dynamic spectrum management. With the rapid increase in world population and power demand, the aging infrastructure of the existing power grid has caused many problems to electric utilities and customers in terms of system reliability, power quality, and customer satisfaction. Field tests show that the power grid has harsh and complex environmental conditions, dynamic topology changes, connectivity problems, interference, and fading, which make wireless communication very challenging in power grid environments. Recently, cognitive radio (CR) network is recognized as a promising technology to address the communication and networking problems of next-generation power grid, i.e., smart grid (SG).[8]

VIII. RESULTS & DISCUSSIONS

In this paper, we have studied different methods used in Power System Communication. These methods play a great role in the safe and efficient operation of the electric power grid. The communication network of an electric power system has the important role of conveying information for ensuring a stable supply of electricity. This information is used to adjust output from power stations, and to prevent power outages from spreading to wider areas when they occur. In this paper, an attempt is made to present the current state of art with reference to the various research works reported in literature so far in the communication sector as applicable to Electrical Power Systems.

IX. CONCLUSION

The restructuring of the electric utility industry has created the need for a mechanism that can effectively coordinate the various entities in a power market, enabling them to communicate efficiently and perform at an optimal level. Communication in Electric Power Systems, the first resource to address its subject in an extended format, introduces various techniques as a compelling solution to this critical problem. The proper communication scheme is used to transfer the data catch from the outdoor units to the control centre for controlling and protecting power system.

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