ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
Vol. 2, Issue 5, May 2013

WORKING PHASES OF SCADA SYSTEM FOR POWER DISTRIBUTION NETWORKS

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ABSTRACT: The aim of this paper is, firstly, to recall the basic concepts of SCADA (Supervisory Control and Data Acquisition) systems, to present the project management phases of SCADA for real time implementation, and then to show the need of the automation for Power Distribution Companies (PDC) on their distribution networks and the importance of using computer based system towards sustainable development of their services. Most control actions are performed automatically by RTUs. Host control functions are usually restricted to basic overriding or supervisory level intervention A proposed computer based power distribution automation system is then discussed. Finally, some projects SCADA system implementation in electrical companies over the world is briefly presented.

Keywords: SCADA system, Project Management Phases, Power distribution Networks.

I.INTRODUCTION

The modern power system is rapidly increasing by forming the grid systems, and it is also impossible to control and monitor each system separately. The present situation of the developed countries is also using different electricity services such as air-conditioner, refrigerator, TV, computer system, etc. These services are possible with the availability of a sustained, reliable and good quality of the electric power supply. Nevertheless the electric power distribution networks are susceptible to interruptions caused by a variety of reasons such as adverse weather conditions, equipment failure, accidents, etc. The Power Distribution Companies (PDC) normally identify the faulty section of the network and restore the power supply using their own resources which are mostly based on classical methods and techniques. Today the rapid growth of Information Technology (IT) tools has promoted many PDC to bring up to date their fault diagnosis as well as troubleshooting systems. Among new technologies used for this purpose, SCADA systems are considered as the widely appropriate tool used for such processes. SCADA is the acronym for "Supervisory Control and Data Acquisition". SCADA systems are widely used for supervisory control and data acquisition of diverse kind of processes. Such process can be industrial, infrastructure or facility [1]. SCADA systems Play a vital role providing power related utilities with valuable knowledge and capabilities that are key to a primary business function - delivering power in a reliable and safe manner. A quality SCADA solution is central to effective operation of a utility's most critical and costly distribution, transmission, and generation assets.

The challenging issues for SCADA systems and projects today are not the same as they were a few years ago. There is increased importance placed on integration, functionality, communication and network technologies, reliability, security, and other purposes. Today's SCADA systems, in response to changing business needs, have added functionalities that are aids for strategic advancements. A well planned and implemented SCADA system not only helps utilities deliver power reliably and safely to their customers but also helps to lower costs, achieve higher customer satisfaction and retention and enable increased operational and tariff flexibility.

The SCADA system usually consists of the following subsystems [2]:

- A human–machine interface or HMI is the apparatus or device which presents process data to a human operator, and through this, the human operator monitors and controls the process.
- A supervisory (computer) system, gathering (acquiring) data on the process and sending commands (control) to the process.

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- Remote terminal units (RTUs) connecting to sensors in the process, converting sensor signals to digital data and sending digital data to the supervisory system.
- Programmable logic controller (PLCs) used as field devices because they are more economical, versatile, flexible, and configurable than special-purpose RTUs.
- Communication infrastructure connecting the supervisory system to the remote terminal units.
  Various process and analytical instrumentation

In fact, most control actions are performed automatically by RTU or by programmable logic controllers(PLC). Host control functions are usually restricted to basic overriding or supervisory level intervention.The main objective of this work is to show the need of the automation for PDC on their distribution networks and the importance of using computer based system towards sustainable development of their services. The operations involved in power system require dispersed and functionally complex monitoring and control system. The monitoring and supervisory control that is constantly developing and under improvement in its control capability

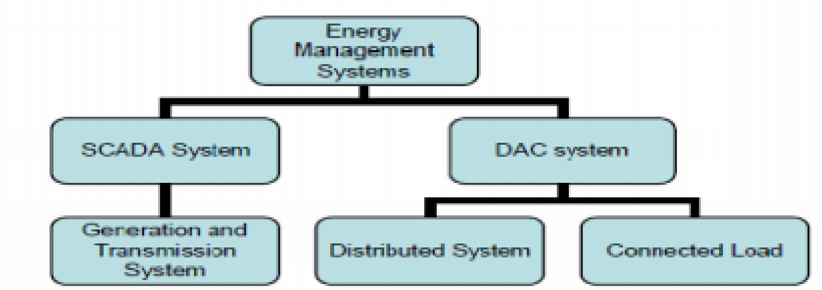

Fig.01 Real time monitoring and controlling of an Electric power system

Fig 01 shows the importance of SCADA in the PDC. The Energy Management system work is to exercise over all control over the total system. SCADA it covers the generation and transmission systems. The Distribution and Automation it oversees the distribution system including connected loads. Automation monitoring and real time control have always been a part of SCADA system. With enhanced emphasis on IT in power systems, SCADA has been receiving a lot of attention in today days.

II. WORKING OF SCADA

SCADA systems are used to monitor and control a plant or equipment in various industries such as power, telecommunications, water and waste control, oil and gas refining and transportation. These systems include the transfer of data between a SCADA central host computer and a number of Remote Terminal Units (RTUs) and/or Programmable Logic Controllers (PLCs), and the central host and the operator terminals. These systems can be comparatively simple, such as one that monitors environmental conditions of a small office building, or very complex, such as a system that monitors all the activity in a nuclear power plant or the activity of a municipal water system. Traditionally, SCADA systems have made use of the Public Switched Network (PSN) for monitoring purposes. Today many systems are monitored using the infrastructure of the corporate Local Area Network (LAN)/Wide Area Network (WAN). Wireless technologies are now being widely deployed for purposes of monitoring. A SCADA system can be implemented with the hardware and software components that constitute a whole SCADA system. Using SCADA system the various application programs that can be implemented in power supply systems are fault location, load balancing, load shedding etc. Now a detailed description of hard ware components, software components and application programs is given.

2.1 Hardware Components

The components of a SCADA system are field instrumentation, remote stations, Communication Network (CN) and Central Monitoring Station (CMS).

a) Field instrumentation

Field instrumentation generally comprises sensors, transmitters and actuators that are directly interfaced to the plant or equipment and generate the analog and digital signals that will be monitor by the remote station. Signals are also conditioned to make sure they are compatible with the inputs/outputs of the Remote Terminal Unit (RTU) or a Programmable Logic Controller (PLC) at the remote Station. It also refers to the devices that are connected to the equipment or machines being controlled and monitored by the SCADA system. These are sensors for monitoring

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

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certain parameters and actuators for controlling certain modules of the system.

b) Remote stations

The remote station is installed at the remote plant with equipment being monitored and controlled by the central host computer. This can be a RTU or PLC. Field instrumentation, connected to the plant or equipment being monitored and controlled, is interfaced to the remote station to allow process manipulation at a remote site. It is also used to gather data from the equipment and transfer it to the central SCADA system.

Fig.02 RTU on pole top

c) Communication Network

The Communication Network (CN) refers to the communication equipment needed to transfer data to and from different sites. The medium used can be cable, telephone, radio, and fiber optic or satellite communication system.

2.2 Software Components

a) Data Acquisition and Processing

This serves as a data collector from the devices to our SCADA system is connected and presents it as a processed data to user. Data acquisition can be done in multiple scan rates and uses different protocols. The data can be fetched as a whole or as a group and also report by exception. Data processing means conversion of fetched data into engineering conversions, zero suppression, reasonability check, and calculation subsystem. So, user can use this processed data for future purposes.

b) Control

Users are allocated to groups, which have defined read/write access privileges to the process parameters in the system and often also to specific product functionality. The allocated users can have the access to the devices, which are to be controlled. Control can be single or group, open or closed loop control. The execution of control can be executed at selective places, can be immediately executed, can be executed at required time etc.

c) Man machine interface

The products support multiple screens, which can contain combinations of synoptic diagrams and text. They also support the concept of a "generic" graphical object with links to process variables. These objects can be "dragged and dropped" from a library and included into a synoptic diagram. Most of the SCADA products that were evaluated decompose the process in "atomic" parameters (e.g. a power supply current, its maximum value, its on/off status, etc.) to which a Tag-name is associated. The Tag-names used to link graphical objects to devices can be edited as required. The products include a library of standard graphical symbols, many of which would however not be applicable to the type of applications encountered in the experimental physics community. Standard windows editing facilities are provided: zooming, re-sizing, scrolling etc. Online configuration and customization of the MMI is possible for users with the appropriate privileges. Links can be created between display pages to navigate from one view to another.

d) Alarm handling

Alarm handling is based on limit and status checking and performed in the data servers. More complicated expressions (using arithmetic or logical expressions) can be developed by creating derived parameters on which status or limit checking is done by the data server. The alarms are logically handled centrally, i.e., the information only exists in one place and all users see the same status (e.g., the acknowledgement), and multiple alarm priority levels (in general many more than 3 such levels) are supported Most of the SCADA products that were evaluated decompose the process in "atomic" parameters (e.g. a power supply current, its maximum value, its on/off status, etc.) to which a Tag-name is

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e) Logging and Archiving

The terms logging and archiving are often used to describe the same facility. However, logging can be thought of as medium-term storage of data on disk, whereas archiving is long term storage of data either on disk or on another permanent storage medium. Logging is typically performed on a cyclic basis, i.e., once a certain file size, time period or number of points is reached the data is overwritten. Logging of data can be performed at a set frequency, or only initiated if the value changes or when a specific predefined event occurs. Logged data can be transferred to an archive once the log is full. The logged data is time-stamped and can be filtered when viewed by a user.

f) Automated mapping and facilities management

SCADA systems can be made use to have GUI system. GUI system can be used to have maps, graphical representation of the required area, and graphical representation of required data. Using SCADA these maps can be layered, zoomed, scrolled and planned. The historical data of the machine can also be used.

We present in this part, types of SCADA systems reviewed that include those for electric power generation, electric power transmission, electric power distribution, and process control. Many research had done on the SCADA for different industrial sectors here we are giving a brief details Poon H.L. [6], has tried to make a survey of the current development of data acquisition technology. The various practical considerations in applying Data Acquisition Systems and advanced applications are investigated. Later Researchers, Ozdemir E. & al. [7], have used a Java-enabled mobile as a client in a sample SCADA application in order to display and supervise the position of a sample prototype crane. Researcher, Horng J.H. [8], has presented a SCADA of DC motor with implementation of fuzzy logic controller (FLC) on neural network (NN). After designed a FLC for controlling the motor speed, a NN is trained to learn the input-output relationship of FLC.

Researchers, Patel M. & al. [11], have presented a SCADA system that allows communication with, and controlling the output of, various I/O devices in the renewable energy systems and components test facility RES Lab. This SCADA system differs from traditional SCADA systems in that it supports a continuously changing operating environment depending on the test to be performed. The SCADA System is based on the concept of having one Master I/O Server and multiple client computer systems. Researchers, Ralstona P.A.S., & al. [12], have provided a broad overview of cyber security and risk assessment for SCADA and DCS, have introduced the main industry organizations and government groups working in this area, and have given a comprehensive review of the literature to date. Researchers, Avlonitis S.A. & al. [13], have presented the structure and the installation of a flexible and low cost SCADA system. The design and installation of the automation system, which includes the software and hardware, is simple and easily accessible. The system has reduced the labor cost, and has increased the labor productivity of the operation due to the remote supervision of the process.

III. PROJECT MANAGEMENT PHASES OF A SCADA SYSTEM

In this part, we present the different project management phases of SCADA system implementation. In fact, SCADA project can be composed into five phases. The first phase consists on the identification of need. The scope of the project is essentially defined at this point. In fact, the SCADA project will be required for some of the following reasons: to reduce power costs; to reduce staffing; to improve level of service; to avoid environmental incidents; to comply with regulators requirements; to replace an existing aging system, etc.

The second phase, which is the initiation, consists on the validation of the project need; the establishment of concepts and scope; the establishment of the summary Work Breakdown Structure (WBS). At this stage some small amount of funding has been approved to undertake the preliminary investigations, and prepare a preliminary project management plan. It will be necessary to firm up on the scope, identify the main technologies to be used, and gain agreement and approval of the potential users of the system. If the system is being introduced to improve productivity, then it is important that user management understand how they can use the SCADA system to change work practices. Although the work should be concentrating on the functional requirements, it is necessary to keep an eye on the technical capabilities offered by suppliers.

The third phase consists on the definition of the project. The work at this stage should still be concentrating on the functional requirements. At this stage the project is starting to get serious. A project team is in place, and organizational and reporting processes are established. The scope is being finalized (sites, functions, etc.). It is important to firmly identify the benefits of the system, to develop benefit realization plans and develop plans to manage risks.

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The fourth phase consists on the design of the SCADA project. This phase normally involves preparing the specification, and developing tender evaluation plans. It is probable that a prequalification phase could proceed at this time to overlap the tender preparation, and the prequalification phases. The modern approach is to use design and construct contracts, and pay for performance. The fifth phase consists on the acquisition. In this phase the SCADA project will go through a number of steps: design configuration of SCADA master software; development of custom software; assembly of RTU's in factory, and testing; field installation of instrumentation, communications, and RTU's; commissioning; site acceptance testing; customer training. Subsequent to this, the system normally has a defects liability period, and beyond that maintenance must be contracted for. The last phase, which is the project closeout, consists on the establishment of the project final report; the closeout of any outstanding defects and nonconformities; the final completion and the post implementation review (PIR) as required.

Fig.03. Different phases of a SCADA project.

IV. APPLICATION OF SCADA TO ELECTRIC POWER DISTRIBUTION SYSTEMS

To avail a reliable power to the customers the distribution companies should supply good quality power irrespective of load. In developing countries like India, Ethiopia, Pakistan, Jordan, china, etc the power sectors are also improving rapidly. To control each power plant for economic growth and development the country a reliable power distribution system is an essential component for the economic growth and development of a country. Therefore, a modern electric power network system must be capable of performing 365 days a year and 24 hours a day with a high quality of uninterrupted power supply, even during the peak hours, to improve the performance of services to the customers. In view of the extensive size of the distribution networks, this can be achieved only by proper computer-based monitoring and control system as well as by efficient distribution and metering.

The "Monitoring and Control System" is the main part of a distribution automation network. This system was defined by IEEE as "A system that enables an electric company to remotely monitor, coordinate and operate distribution components in a real-time mode from remote location". The location from where control decisions are initiated is generally called Distribution Control Center (DCC). Within this center, different kinds of application software are used, which cooperate among themselves to achieve the control task. Many other types of equipments will also be used to support such automation of a power network. They include Automatic Meter Reading (AMR), Data Concentrator Unit (DCA), Remote Terminal Unit (RTU), Supervisory Control and Data Acquisition (SCADA), etc.

1. Generating stations

At the generating stations SCADA is playing a major role to operate the input fuel flow rate to the turbine. At every time the SCADA is monitoring the speed and frequency because these have to maintain within the permissible limits. Some of the important operations are doing Power plant control and protection systems, Electrical Balance of plant (HV, LV), Turbine and generator components and Communication system and Networks.

2. Distribution Management Systems

A Distribution Management System (DMS) is a collection of applications designed to monitor & control the entire distribution network efficiently and reliably. It acts as a decision support system to assist the control room and field operating personnel with the monitoring and control of the electric distribution system. Improving the reliability and quality of service in terms of reducing outages, minimizing outage time, maintaining acceptable frequency and voltage levels are the key deliverables of a DMS.

A DMS takes an Outage Management System to the next level by automating the complete sequences and providing an end to end, integrated view of the entire distribution spectrum. It accesses real-time data and provides all information on a single console at the control centre in an integrated manner. The typical data flow in a DMS has the

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Supervisory Control and Data Acquisition (SCADA) system, the Information Storage & Retrieval (ISR) system, Communication (COM) Servers, Front-End Processors (FEPs) & Field Remote Terminal Units (FRTUs)

3. Distribution Load forecasting

In generally the load is not a constant one it is always a unpredictable thing so the persons who are working at the generating stations should vary according to load so it is not possible for 24hours and 365 days. So in order to vary according to load SCADA is playing a major role.

In addition to this applications there should be having more applications in the electrical industry, like fault allocation, automatic meter reading, Automatic generation control, Load frequency control, Load control and Load balancing. Hence, the implementation of SCADA in the power network automation system will provide better services to PDC customers and improve the power quality and reliability of the electric supply services, which would satisfy the following goals:

- Respond to customer service interruptions more quickly.
- More efficiency of the power system by maintaining acceptable power factors and reduced losses.
- More control and limit of peak power demand.
- Ability of PDC engineering staff to monitor and control the power system during normal and abnormal conditions by providing more reliable and appropriate real time data.

V. LIST OF MAJOR MANUFACTURERS AND SCADA SYSTEMS.

S.NO	Manufacturer	Implementation
1	ABB	Process Portal A/Operate IT, Ranger
2	ACS	Prism
3	Ormazabal	Power station Management Software
4	Siemens Crop	Power distribution Software
5	Rada Systems	Power distribution System
6	Emerson network power	SCADA for generator load demand control
7	Entherns Inc	SCADA for input and output digital modules
8	Edison Automation Inc	SCADA telemetry systems
9	Efacec USA Inc	SCADA for power distribution systems.

VI.CONCLUSION

This paper presents, what is the need of SCADA in the present electrical industry, the SCADA system is used for monitoring and controlling power industry from remote areas.we presented the importance of SCADA and the integration of Hardware and Software components to the power industey. Working phases of SCADA projects and then a computer based power distribution automation system is discussed. Moreover, we proved the importance on using computer based system for sustainable development in the automation of the power distribution network to improve the customers' service and the reliability of the network. Also the paper outlines the general concepts and required equipments for the automation of such power networks. Some projects of SCADA system implementation in electrical companies over the world have been presented.

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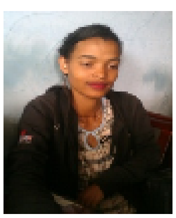

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