G.PULLAIAH COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPT OF EEE

Electrical Distribution Systems

UNIT-5

BASIC TERMS AND DEFINITIONS:

Automation	The word Automation means doing the particular task automatically in a sequence with faster operation rate. This requires the use of microprocessor together with communication network and some relevant software programming
Distribution Automation	Distribution automation system (DAS) is not just a remote control and operation of substation and feeder equipment but it results into a highly reliable, self-healing power system that responds rapidly to real-time events with appropriate actions.
Sensors	A sensor is a device that detects and responds to some type of input from the physical environment. ... An oxygen sensor in a car's emission control system detects the gasoline/oxygen ratio, usually through a chemical reaction that generates a voltage.
Supervisory Control and Data Acquisition (SCADA)	Supervisory control and data acquisition (SCADA) is an industrial control system which is used in many modern industries like energy, manufacturing, power, water transportation, etc. SCADA systems organize multiple technologies that allows to process, gather and monitor data at the same time to send instructions to those points that transmit data. In today's world, almost anywhere you can observe SCADA systems, whether it's a waste water treatment plant, supermarkets, industries or even in your home.
Remote Terminal Unit	A remote terminal unit (RTU) is a microprocessor-controlled electronic device that interfaces objects in the physical world to a distributed control system or SCADA (supervisory control and data acquisition) system by transmitting telemetry data to a master system, and by using messages from the master supervisory system to control connected objects.[1] Other terms that may be used for RTU is remote telemetry unit or remote telecontrol unit.
Geographical Information System (GIS)	A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data.

Automatic Meter Reading (AMR)	Automatic meter reading, or AMR, is the technology of automatically collecting consumption, diagnostic, and status data from water meter or energy metering devices (gas, electric) and transferring that data to a central database for billing, troubleshooting, and analyzing

Concepts

Distribution Automation:

The word Automation means doing the particular task automatically in a sequence with faster operation rate. This requires the use of microprocessor together with communication network and some relevant software programming. Application of automation in distribution power system level can be define as automatically monitoring, protecting and controlling switching operations through intelligent electronic devices to restore power service during fault by sequential events and maintain better operating conditions back to normal operations. Now days due to advancement in the communication technology, distribution automation system (DAS) is not just a remote control and operation of substation and feeder equipment but it results into a highly reliable, self-healing power system that responds rapidly to real-time events with appropriate actions. Hence, automation does not just replace manual procedures; it permits the power system to operate in best optimal way, based on accurate information provided in a timely manner to the decision-making applications and devices. Distribution Automation Systems have been defined by the Institute of Electrical and Electronic Engineers (IEEE) as systems that enable an electric utility to monitor, coordinate, and operate distribution components in a real time mode from remote locations.

There are several reasons why we need distribution automation systems. Until now, the electric power industry has made remarkable progress in both quantity and quality. But, it is expected that social demand for better services would be requested. The main function of DAS is the remote control of switches to locate, isolate the fault and restore the service, when a fault occurs in the power distribution line. Now, distribution automation has to address enhancements inefficiency as well as reliability and quality of power distribution. Today utilities are more concerned about improving reliability due to the implementation of performance based rates and improving power quality due to its impact on sensitive loads. Further, Specific tools that need attention for implementation of advanced distribution automation (ADA) include tools for cost/benefit evaluation, system analysis, and reliability evaluation.

Benefits of Distribution Automation System Implementation:

The benefits of distribution automation system implementation can be classified in three major areas are as follows:

Operational & Maintenance benefits

1. Improved reliability by reducing outage duration using auto restoration scheme
2. Improved voltage control by means of automatic VAR control
3. Reduced man hour and man power
4. Accurate and useful planning and operational data information
5. Better fault detection and diagnostic analysis
6. Better management of system and component loading

Financial benefits

1. Increased revenue due to quick restoration
2. Improved utilization of system capacity
3. Customer retention for improved quality of supply

Customer related benefits

1. Better service reliability
2. Reduce interruption cost for Industrial/Commercial customers
3. Better quality of supply

Areas of Distribution Automation System Implementation:

The area distribution automation system can be divided in to two areas:

A. Distribution Substation & Feeder Automation

B. Consumer Location Automation

A) Distribution Substation and Feeder Automation:

Usually the distribution automation on substation and feeder are integrated to share common monitoring and controlling equipment and devices. Distribution substation automation includes supervisory control of circuit breakers, load tap changers (LTCs), regulators, reclosers,sectionalizers, switches and substation capacitor banks. Remote data acquisition is required inorder to achieve effective use of the supervisor control function.

B) Consumer Location Automation:

Automation at the consumer's location includes the ability to remotely: read meters, program time-of-use (TOU) meters, connect/disconnect services, and control consumer loads.

Distribution Automation System Implementation Philosophies:

Implementation philosophies at distribution substation and feeder; and at consumer locations are described as follows :

Distribution Substation and Feeder Automation:

It is generally applied to that element of the distribution system which operates at voltages above 22 kV. Distribution substation and feeder automation also referred to as Primary Distribution

automation. Different functions of Primary Automation Technique are listed below.

1) Transformer Load Balancing: Transformer load balance monitoring provides remote access to near real-time information concerning the overall operation of the distribution system. This information can be used on a daily basis to verify the effects of other down line events such as capacitor switching, residential load control, and recloser operations. It is also useful on a periodic basis to fine tune the efficiency of the Utility's power distribution configuration.

2) Voltage Regulation: This feature of DAS offers utility personnel the ability to reduce line voltage during peak demand times by remotely taking control of the Load Tap Changer. It also facilitates the remotely boosting of line voltages above the local LTC settings in case of emergency situations such as back-feeding.

3) Fault Isolation and Sectionalizing: Remote monitoring of the recloser operation to the melting of a fuse link, utilities can detect the fault very fast and can take quick action to clear that fault. Even during the outage of the power supplies distribution automation devices on that line can report the data remotely. By correlating the last voltage or current measured before an outage from several points along the distribution system, an indication of the nature of the fault as well as its approximate location can be obtained.

4) Remote Interconnect Switching: Distribution automation systems can be deployed to drive remotely interconnected switches that separate different portion of the utility distribution feeders. By the use of remote interconnect switching utilities can manipulate their distribution system to provide the most efficient configuration and also will able to remotely restore power to as many consumers as possible during the time of multiple faults.

5) Capacitor Bank Switching: It is most commonly deployed automation technique in a distribution network. The most cost effective capacitor control configuration is to install a number of one-way receivers at the capacitor locations for positive control and to monitor the aggregate effects of the capacitor switching at the substation low voltage level bus. Utilities with capacitor bank switching facilities can operate with reduced losses and as a result with higher efficiency.

6) Voltage Monitoring: By monitoring the feeder voltage remotely utility personal gets advance notification about the line voltage drop due to high usage. Also recorded data of feeder voltage swill give snapshot of the actual usage patterns.

Consumer Location Automation:

Consumer location is the most challenging application area for the distribution automation system as large numbers of installation points are required and all the points should be economically viable.

1) Load Management: Load management is achieved by local appliance control. It consists of a utility activated relay that interrupts the power consumed by non-critical loads such as water heaters, air conditioners, electrical heaters, pool pumps, etc.

2) Automatic Meter Reading (AMR): For utilities, AMR is one of the cost effective way to read the residential kilowatt-hour meters. The AMR device can be initially programmed to report back to the utility based on a schedule or some pre-set usage level. Modern AMR devices incorporate the capability of remote reconfiguration of operating parameters and schedules.

3) Demand Side Management (DSM): An extension of automatic meter reading technology is the DSM application using Real Time Pricing. This application includes the functionality of monitoring the power usage during specific periods of the day as well as the control functionality of notifying the customer of the change of periods and the new rate for that period. For some utilities, this option is not cost effective.

4) Quality of Service (QoS) Monitoring: Quality of service is different things to different utilities. The most comprehensive definition includes monitoring power outages and its duration, the track record of power disturbances (such as voltage blinks, harmonics and voltage sags), and monitoring voltage wave-form distortions.

SCADA(Supervisory Control and Data Acquistion):

Supervisory control and data acquisition (SCADA) is a system of software and hardware elements that allows industrial organizations to:

- Control industrial processes locally or at remote locations
- Monitor, gather, and process real-time data
- Directly interact with devices such as sensors, valves, pumps, motors, and more through human-machine interface (HMI) software
- Record events into a log file

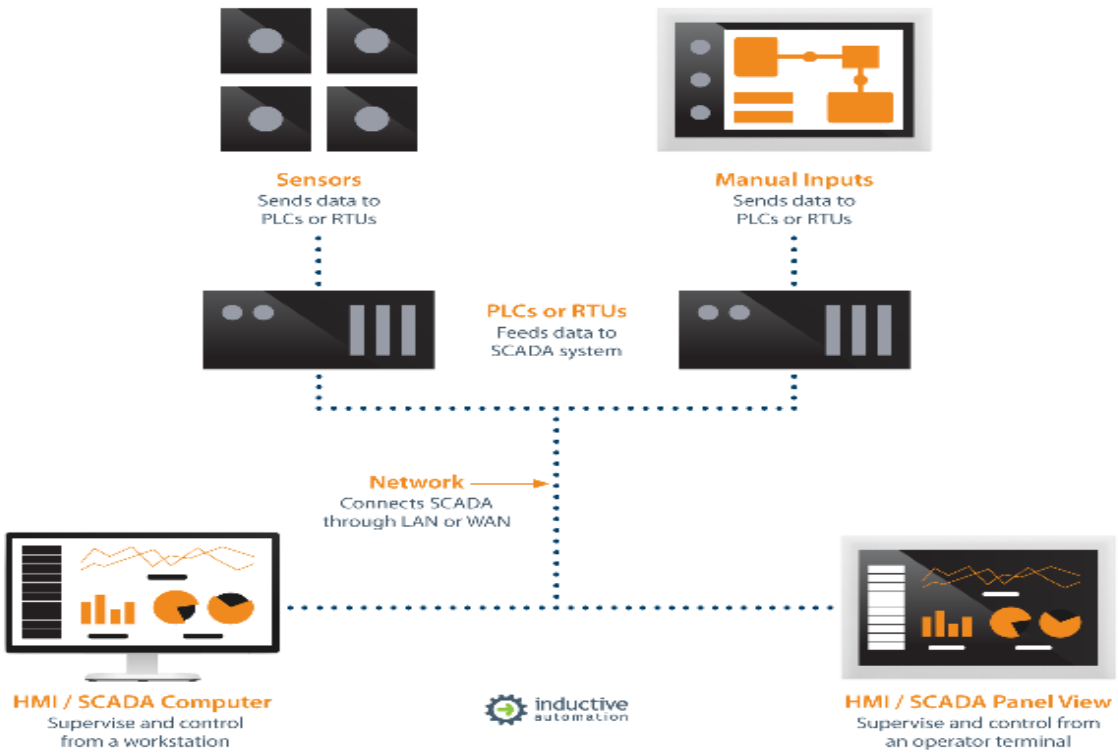
SCADA systems are crucial for industrial organizations since they help to maintain efficiency, process data for smarter decisions, and communicate system issues to help mitigate downtime.

The basic SCADA architecture begins with programmable logic controllers (PLCs) or remote terminal units (RTUs). PLCs and RTUs are microcomputers that communicate with an array of objects such as factory machines, HMIs, sensors, and end devices, and then route the information from those objects to computers with SCADA software. The SCADA software processes, distributes, and displays the data, helping operators and other employees analyze the data and make important decisions.

For example, the SCADA system quickly notifies an operator that a batch of product is showing a high incidence of errors. The operator pauses the operation and views the SCADA

system data via an HMI to determine the cause of the issue. The operator reviews the data and discovers that Machine 4 was malfunctioning. The SCADA system's ability to notify the operator of an issue helps him to resolve it and prevent further loss of product.

Basic SCADA Architecture:



Who Uses SCADA?

SCADA systems are used by industrial organizations and companies in the public and private sectors to control and maintain efficiency, distribute data for smarter decisions, and communicate system issues to help mitigate downtime. SCADA systems work well in many different types of enterprises because they can range from simple configurations to large, complex installations. SCADA systems are the backbone of many modern industries, including:

- Energy
- Food and beverage
- Manufacturing
- Oil and gas
- Power
- Recycling
- Transportation
- Water and waste water

- And many more

Virtually anywhere you look in today's world, there is some type of SCADA system running behind the scenes: maintaining the refrigeration systems at the local supermarket, ensuring production and safety at a refinery, achieving quality standards at a waste water treatment plant, or even tracking your energy use at home, to give a few examples.

Effective SCADA systems can result in significant savings of time and money. Numerous case studies have been published highlighting the benefits and savings of using a modern SCADA software solution such as Ignition.

Automatic meter reading:

Automatic meter reading, or AMR, is the technology of automatically collecting consumption, diagnostic, and status data from water meter or energy metering devices (gas, electric) and transferring that data to a central database for billing, troubleshooting, and analyzing. This technology mainly saves utility providers the expense of periodic trips to each physical location to read a meter. Another advantage is that billing can be based on near real-time consumption rather than on estimates based on past or predicted consumption. This timely information coupled with analysis can help both utility providers and customers better control the use and production of electric energy, gas usage, or water consumption.

AMR technologies include handheld, mobile and network technologies based on telephony platforms (wired and wireless), radio frequency (RF), or power line transmission. Touch technology With touch-based AMR, a meter reader carries a handheld computer or data collection device with a wand or probe. The device automatically collects the readings from a meter by touching or placing the read probe in close proximity to a reading coil enclosed in the touchpad. When a button is pressed, the probe sends an interrogate signal to the touch module to collect the meter reading. The software in the device matches the serial number to one in the route database, and saves the meter reading for later download to a billing or data collection computer. Since the meter reader still has to go to the site of the meter, this is sometimes referred to as "on-site" AMR. Another form of contact reader uses a standardized infrared port to transmit data. Protocols are standardized between manufacturers by such documents as ANSI C12.18 or IEC 61107.

AMR Hosting:

AMR Hosting is a back-office solution which allows a user to track his/her electricity, water, or gas consumption over the Internet. All data is collected in near real-time, and is stored in a database by data acquisition software. The user can view the data via a web application, and can analyze the data using various online analysis tools such as charting load profiles, analyzing tariff

components, and verify his/her utility bill.

Radio frequency network:

Radio frequency based AMR can take many forms. The more common ones are handheld, mobile, satellite and fixed network solutions. There are both two-way RF systems and one-way RF systems in use that use both licensed and unlicensed RF bands.

In a two-way or "wake up" system, a radio signal is normally sent to an AMR meter's unique serial number, instructing its transceiver to power-up and transmit its data. The meter transceiver and the reading transceiver both send and receive radio signals. In a one-way “bubble-up” or continuous broadcast type system, the meter transmits continuously and data is sent every few seconds. This means the reading device can be a receiver only, and the meter a transmitter only. Data travels only from the meter transmitter to the reading receiver. There are also hybrid systems that combine one-way and two-way techniques, using one-way communication for reading and two-way communication for programming functions.

RF-based meter reading usually eliminates the need for the meter reader to enter the property or home, or to locate and open an underground meter pit. The utility saves money by increased speed of reading, has less liability from entering private property, and has fewer missed readings from being unable to access the meter.

The technology based on RF is not readily accepted everywhere. In several Asian countries, the technology faces a barrier of regulations in place pertaining to use of the radio frequency of any radiated power. For example, in India the radio frequency which is generally in ISM band is not free to use even for low power radio of 10 mW. The majority of manufacturers of electricity meters have radio frequency devices in the frequency band of 433/868 MHz for large scale deployment in European countries. The frequency band of 2.4 GHz can be now used in India for outdoor as well as indoor applications, but few manufacturers have shown products within this frequency band. Initiatives in radio frequency

AMR in such countries are being taken up with regulators wherever the cost of licensing outweighs the benefits of AMR.

Geographic Information System:

A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data. The acronym GIS is sometimes used for geographic information science (GIScience) to refer to the academic discipline that studies geographic information systems and is a large domain within the broader academic discipline of geo informatics. hat goes beyond a GIS is a spatial data infrastructure, a concept that has no such restrictive boundaries.

In general, the term describes any information system that integrates, stores, edits, analyzes, shares, and displays geographic information. GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations. Geographic information science is the science underlying geographic concepts, applications, and systems.

GIS can refer to a number of different technologies, processes, and methods. It is attached to many operations and has many applications related to engineering, planning, management, transport/logistics, insurance, telecommunications, and business.For that reason, GIS and location intelligence applications can be the foundation for many location-enabled services that rely on analysis and visualization.

Important Questions:

1. Explain the benefits of Distribution Automation as applied to: (a) Substation automation
   (b) Feeder automation.
2. What are the components of SCADA in distribution automation?
3. Enumerate the following.
   a.Consumer Information Service (CIS)
   b .Geographical Information System (GIS)
   c. Automatic Meter Reading (AMR)
4. Explain the necessity of distribution automation?
5. What are the benefits of distribution automation?