Substation Automation System Using SCADA

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Abstract- ***Electricity is now an absolute necessity. The electricity demand is extremely strong. One of the most important areas to regulate in this high-demand environment is power management. The demand for substation automation is growing in India, and it is one of the components of power control. The main goal is to automate the control and monitoring of electrical subsystems. In range areas, it will be able to monitor and run the device remotely. When a fault occurs in the line, protection relays are essential to protect the power Intelligent Electronic Devices (IEDs), which are part of the substation and are responsible for protecting the system and detecting faults. We can manage and track all data near the station through the Substation Automation System (SAS). The Human Machine Interference (HMI), which is used for the control, observation, and protection of devices, is released through Supervisory Control & Data Acquisition (SCADA). The Substation Automation System saves time and money in real-time and contributes to full availability, performance, reliability, security, and data integration. The new International Standard for the Automation of Observation and Modification Substation Device for IEC 61850.***

Indexed Terms- IEDs, IEC 61850, RTUs, SAS, SCADA,

I. INTRODUCTION

A substation is the principal part of the generated power transfer and distribution. Quality energy and electricity generation are the most demanded. The Automation Substation System controls the substation automatically with the control system. Intelligent Electronic Devices Automation System is gathering knowledge from (IEDs). The automation system is primarily designed to manage, secure and track the system. Many electronics and communications systems are developed to operate the system for substation automation. The High-Speed Remote Terminal Unit (RTUs) is used for controlling the substation automation system. In present days IEC 61850 is the version using for substation automation. Before UCA2/MMS has been used and now it is upgraded to IEC 61850 or converted to DNP3.

Fig 1: IEC 61850 standard

II. SUBSTATION AUTOMATION STRUCTURE

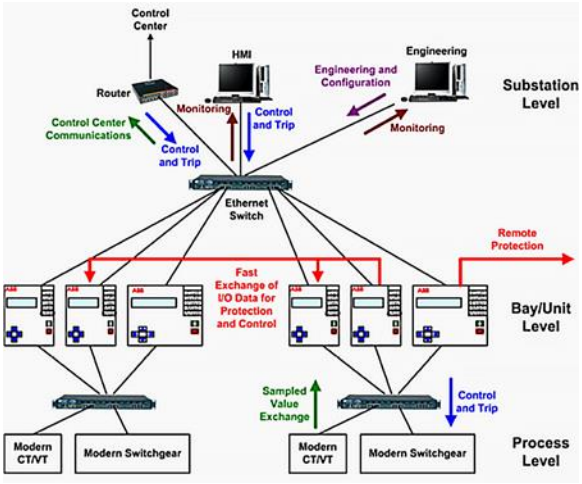

Fig 2: Substation Automation System

2.1 Station Level

The station level is the higher level wherever the centralized solutions provide a central database system, Human Machine Interface, and operating functionality at the substation level. The substation communication network system is part of the solution. It will interconnect and merge the bay-level intelligent electronic devices using the accurate standard of IEC 61850. They are easy to use and adapt to the needs of the consumer. The Substation Automation System solutions for 600 stations include remote control and monitoring functions for all kinds of substations from substations at the distribution level, to high-voltage substations at transmission levels.

Fig 3: Station level Operation

2.2 Bay level

The bay level is the middle level of the protection distributed control system is located. A bay system comprises circuit breakers, relays, isolators, and instrument transformers. At the bay level, the Intelligent Electronic Device (IEDs) provide all the bay level functions like controlling (command outputs), monitoring (status indications, recorded values), and protection. The IEDs are directly connected to the switchgear system without interfacing any more transducers into the system. These devices will collect the information from Instrument transformers, relays, and tripping-related issues.

2.3 Process Level

The process is the lowest level where the protection equipment is located including sensors and actuators that are used to monitoring and operating the switchgear protection system. In the process, the level consists of hardwired copper cables and optical fibre cables which are connected to Bay level IEDs.

III. SUBSTATION AUTOMATION USING SCADA

As long as control systems are in place, SCADA (Supervisory Control and Data Acquisition) is around. The first SCADA systems used the acquisition of data by meter panels, light panels, and strip charts. Industrial process control systems for remote or local industrial devices such as engines, valves, pumps, relay systems, sensors, etc are used centrally for monitoring and controlling. SCADA is a measurement and data acquisition combination. It's not just the hardware but software that SCADA is. It's a machine combined with unique hardware, programming, and protocols. For example, in a SCADA system, the SCADA control system can be used by the PLC to control the chamber of the refrigeration as part of an industrial process. The host control feature will be used by the supervisor to set the cooling chamber temperature at the same time. It may also have alarms and record temperatures and report back to the PLCs and RTUs for the collection of data, such as meter readings, instrumentation standards, etc. The data is retained for further review in the database or monitored to take appropriate steps as required by the supervisor. SCADA systems normally deploy a distributed database, usually known as a tag database,

containing data elements called tags or points. A point is a value that is monitored or regulated by a single input or output.[1][6][7]

There are various types used in the SCADA, they are

3.1 Emerging technologies in communications

For substation automation systems the development of communications technologies is an important step towards increasing the functionality the most important technologies can be found below the serial communication and local area networks.

3.1.1 Serial communication

Serial communication is the method of transmission of data one bit by one line. Parallel communication, on the contrary, needs more lines, as bits in a word are passed on. At the start of the digital technology intrusion into substations, this type of communication is used, particularly for relief connections through an RS-232 interface. In recent years, Ethernet networking has gained a position rather than serial communication.[3][5][7]

3.1.2 Local Area Network

Local communication between a group of computers or devices occurs. In the substation for transfer and communication, the usage of LANs is growing. This approach was committed to the office environment and was subsequently implemented for industrial use, including substations.[3][5][7]

3.2 Intelligent Electronic Devices

It refers to any system that has one or more microprocessors capable of receiving/sending information to another element. The following forms are used in the substation for the most appropriate intelligent electronic devices:

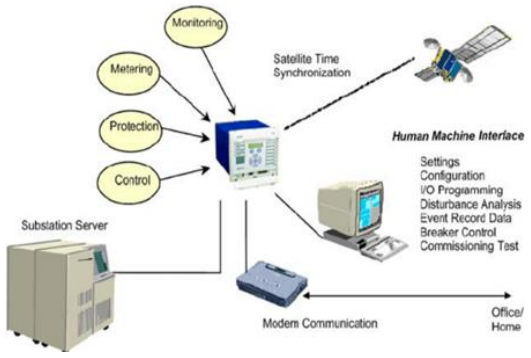

Fig 4: Intelligent Electronic Devices

3.2.1 Functional Relays

Digital relays are devices that accept inputs and process them with logical algorithms to produce outputs that take decisions that produce trip commands and alarms. They are also known as computer relays, numerical relays, or microprocessors-based relays. This sort of relay was developed in an early stage to replace existing electronic or electromechanical protective relays and was then expanded to be used for power and control functions some years later.

3.2.2 Integrated Digital Units

To improve the efficiency of the secondary substation system to decrease the aggregate cost of the asset by incorporating several functions, such as security, monitoring, and communications in one element, integrated digital units were created. In particular, for medium voltage substations, where availability is not a critical feature, this type of system is commonly used.

3.3 Networking Media

A physical LAN structure comprises cable segments and networking devices that allow the sharing and communication of data between computers and other IEDs connected to the LAN. In the past, these components consist of copper wires and uniform ports of communication. Nowadays, these networking media are made with the following resources. [5][7]

3.3.1 Fiber-Optic Cables

The use of optical technology eliminates the need for thousands of copper wires in a substation and replaces them with a few fiber-optic cables, making savings derived from installation and maintenance work while at the same time increasing worker safety and power system reliability. The main technical advantages in using fiber-optic cables in substations include high immunity to electrical interference and generous bandwidth. Today, the industry offers standardized fiber systems compatible with IEC 61850 devices oriented at reducing the chance of mistakes and minimizing costs in testing and commissioning activities.[5][7]

3.3.2 Network Switches

These components are essential in the LAN for networking several devices. Its main role is to transfer

data on the same network from one computer to another. They do this effectively as data can be guided without impacting other devices on the same network. The Ethernet switch with different functions or functions is the most common network switch used in substations today.[7]

3.4 Communication Standards

Currently, the formulation of standards is like the SAS evolution 'engine.' Initially, the IEC 61850 standard had solved a major paradigm of vendor dependency, which blocked advances for several years in digital SAS installation. The IEEE 803.2 standard allows the networking facility and functionality to be expanded. The two standards embody SAS design and implementation state-of-the-art, as we know it today, and provide consistent rules for manufacturers' hardware design trends and more faith in SAS users around the world.[3][7]

3.4.1 IEC Standard 61850 (Communication Networks and Systems for Power Utility Automation)

This Standard is a series of publications intended to meet the current and evolving requirements of the power transmission industry that maintain interoperability as the main objective (allowing IEDs provided by different vendors to exchange data and work together acceptably). The Standard is focused on ongoing experiments and studies by respected institutions including UCA, CIGRE and IEEE, and the IEC. The current reach of the standard is mostly covered by:

- Determine methods of communication and their consistency characteristics technically.
- Direct guidance for SAS project and network engineering.
- Offer SAS testing and commissioning recommendations.
- Set up coordination protocols between sub-stations.
- Define communication methods between remote control systems and substations.
- Set out broad control and monitoring guidelines. Guidelines.

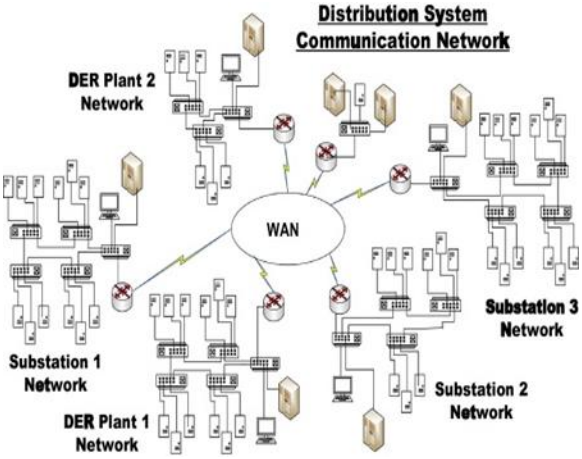

Fig 5: IEC Standard 61850 (Communication Network)

3.4.2 132/33 kV station design for protection

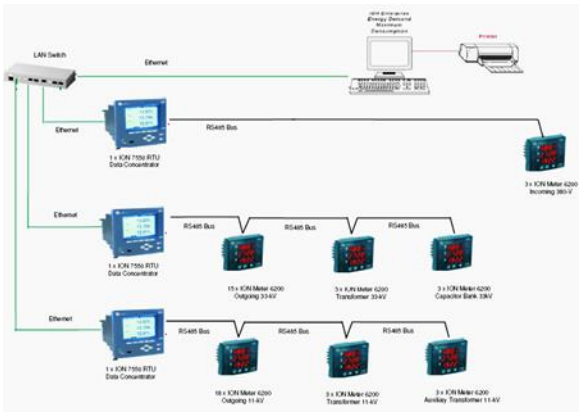

Fig 6: 132/33 kV station design for protection

3.5 Merits & Demerits of SCADA

3.5.1 Merits of SCADA

- The system provides a facility to store a large amount of data.
- The data will be shown in various formats as per user requirements.
- It provides an interface to connect thousands of sensors across a wide region for various monitoring and controlling operations.
- It is possible to obtain real data simulations with the help of operators.
- Many types of data can be gathered from RTUs (Remote Terminal Units) connected with the master unit.
- With the advanced protocols and application software, the data can be monitored from anywhere and not just from the local site.
- The redundancy of units is incorporated in the SCADA system to have a backup in the event of

faults or failures. This makes the system more robust.
- It is fast in obtaining a response.
- It is scalable and flexible in adding additional resources.
- It is used in wide industries and departments including telecommunications, energy, transportation, oil & gas, water, military, meteorological, etc.

3.5.2 Demerits of SCADA
- The PLC-based SCADA system is complex in terms of hardware units and dependent modules.
- As the system is complex, it requires skilled operators, analysts, and programmers to maintain the SCADA system.
- Installation costs are higher.
- The system increases unemployment rates.
- The system supports the use of restricted software and hardware pieces of equipment.

CONCLUSION

The advantages of advanced power system management need automation for local operations and the collection, evaluation, and forwarding of data on the power system status and plant condition to higher-level systems. IEC 61850 standard is mostly for Substation Automation System. The Substation Automation Solutions (SAS) provide remote control and monitoring functions for all kinds of substations, starting from the distribution level up to extra-high voltage substations, and are designed for maximum safety, efficiency and reliability. The results are future-proof systems with interoperability for optimal lifecycle management and low lifecycle cost.

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