

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

LECTURE 1: INTRODUCTION

1.1 Introduction:

SCADA is an acronym that stands for Supervisory Control and Data Acquisition. SCADA refers to a system that collects data from various sensors at a factory, plant or in other remote locations and then sends this data to a central computer which then manages and controls the data. SCADA systems are used not only in industrial processes: e.g. steel making, power generation (conventional and nuclear) and distribution, chemistry, but also in some experimental facilities such as nuclear fusion. The size of such plants range from a few 1000 to several 10 thousands input/output (I/O) channels. However, SCADA systems evolve rapidly and are now penetrating the market of plants with a number of I/O channels.

Definition of SCADA: A collection of equipment that will provide an operator at remote location with enough information to determine the status of a particular piece of a equipment or entire substation and cause actions to take place regarding the equipment or network.

What is SCADA?

How : By collecting Information from plant / Load centre bend reducing it to the EMS

Where : Control Centre. Both at Plant and Load

Why : To gather Information as here (voltage, current, frequency, power, circuit breaker status) and To perform online actions

SCADA systems are used to monitor or to control chemical or transport processes in municipal water supply systems, to control electric power generation, transmission and distribution, gas and oil pipelines, and other distributed processes. *Supervisory control and data Acquisition (SCADA)* achieves this requirement collecting reliable field data through remote terminal units (RTUs) Intelligent Electric Devices (IEDs) and presenting them to user requirement. The user interface or the man machine interface (MMI) provides various options of data presentation according to specific application and user needs. There are many parts of a working SCADA system. A SCADA system usually includes signal hardware (input and output), controllers, networks, user interface (HMI), communications equipment and software. All together, the term SCADA refers to the entire central system. The central system usually monitors data from various sensors that are either in close proximity or off site.

An industrial measurement and control system consisting of a central host or master (usually called a master station, master terminal unit or MTU); one or more field data gathering and control units or remotes (usually called remote stations, remote terminal units, or RTU's); and a collection of standard and/or custom software used to monitor and control remotely located field data elements. Contemporary SCADA systems exhibit predominantly open-loop control characteristics and utilize predominantly long distance communications, although some elements of closed-loop control

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system usually includes signal hardware (input and output), controllers, networks, user interface (HMI), communications equipment and software. All together, the term SCADA refers to the entire central system. The central system usually monitors data from various sensors that are either in close proximity or off site (sometimes miles away).

Systems similar to SCADA systems are routinely seen in factories, treatment plants etc. These are often referred to as Distributed Control Systems (DCS). They have similar functions to SCADA systems, but the field data gathering or control units are usually located within a more confined area. Communications may be via a local area network (LAN), and will normally be reliable and high speed. A DCS system usually employs significant amounts of closed loop control. SCADA systems on the other hand generally cover larger geographic areas, and rely on a variety of communications systems that are normally less reliable than a LAN. Closed loop control in this situation is less desirable.

SCADA generally comes under the branch of Instrumentation Engineering. The term SCADA stands for Supervisory Control And Data Acquisition. SCADA systems are used for controlling and monitoring chemical or transport processes and can be used in a factory environment such as electric power generation, water supply systems, gas and oil pipelines or any other distributed processes. A typical SCADA system comprises of i/o signal hardware, controllers, software, networks and communication. SCADA system is normally used to monitor and control a remote site or a distribution that is spread out for a long distance. An RTU (Remote Terminal Unit) or a PLC (Programmable Logic Controller) is usually used to control a site automatically. The SCADA system also provides a host control functions for the supervisor to control and define settings. For example, in a SCADA system a PLC can be used to control the flow of cooling water as part of an industrial process. At the same time the supervisor can use the Host control function to set the temperature for the flow of water. It can also have alarms and can record the flow of water temperature and report back to the SCADA system. The RTUs and PLCs are responsible for data collection such as meter readings, equipment status etc and communicate back to the SCADA system. This data can be stored in a database for later analysis or monitored by a supervisor to take appropriate actions if required.

SCADA systems typically implement a distributed database, commonly referred to as a tag database, which contains data elements called tags or points. A point represents a single input or output value monitored or controlled by the system. Points can be either "hard" or "soft". A hard point is representative of an actual input or output connected to the system, while a soft point represents the result of logic and math operations applied to other hard and soft points. Most implementations conceptually remove this distinction by making every property a "soft" point (expression) that can equal a single "hard" point in the simplest case. Point values are normally stored as value-timestamp combinations; the value and the timestamp when the value was recorded or calculated. A series of value-timestamp combinations is the history of that point. It's also common to store additional metadata with tags such as: path to field device and PLC register, design time comments, and even alarming information.

1.2 SCADA SYSTEMS

A SCADA system refer to a system consisting of a number of remote terminal units (or RTUs) collecting field data connected back to a master station via a communications system. The master station displays the acquired data and also allows the operator to perform remote control tasks. The accurate and timely data (normally real-time) allows for optimization of the operation of the plant and process. A further benefit is more efficient, reliable and most importantly, safer operations. This all results in a lower cost of operation compared to earlier non-automated systems.

A successful SCADA installation depends on utilizing proven and reliable technology, with adequate and comprehensive training of all personnel in the operation of the system. There is a history of

unsuccessful SCADA systems – contributing factors to these systems includes inadequate integration of the various components of the system, unnecessary complexity in the system, unreliable hardware and unproven software. Today hardware reliability is less of a problem, but the increasing software complexity is producing new challenges. It should be noted in passing that many operators judge a SCADA system not only by the smooth performance of the RTUs, communication links and the master station (all falling under the umbrella of SCADA system) but also the field devices (both transducers and control devices). The field devices however fall outside the scope of SCADA in this manual and will not be discussed further. A diagram of a typical SCADA system is given opposite.

The RTU provides an interface to the field analog and digital signals situated at each remote site. The communications system provides the pathway for communications between the master station and the remote sites. This communication system can be radio, telephone line, microwave and possibly even satellite. Specific protocols and error detection philosophies are used for efficient and optimum transfer of data. The master station (and sub-masters) gather data from the various RTUs and generally provide an operator interface for display of information and control of the remote sites. In large telemetry systems, sub-master sites gather information from remote sites and act as a relay back to the control master station.

SCADA technology has existed since the early sixties and there are now two other competing approaches possible – distributed control system (DCS) and programmable logic controller (PLC). In addition there has been a growing trend to use smart instruments as a key component in all these systems. Distributed control system (DCS), is another variant of SCADA where data acquisition and control functions are performed by a number of distributed microprocessor-based units situated near to the devices being controlled or the instrument from which data is being gathered. DCS systems have evolved into systems providing very sophisticated analog (e.g. loop) control capability. A closely integrated set of operator interfaces (or man machine interfaces) is provided to allow for easy system configurations and operator control. The data highway is normally capable of fairly high speeds. Another variant of SCADA components widely used is the Programmable Logic Controller (PLC). PLCs have replaced hardwired relays with a combination of ladder– logic software and solid state electronic input and output modules. They are often used in the implementation of a SCADA RTU as they offer a standard hardware solution, which is very economically priced.

1.3 Evolution of SCADA

- 1890's Remote Control and Remote Indication
- 1920's Tele command and control
- 1930's Check Before Operate (CEO) Systems
Based on Electro Mechanical Technology
- 1960's Supervisory Control Systems (Remote Control & Status Indication)
- 1960's Data Acquisitions gaining Popularity (DAS) SCADA came into being.
- 1980's Load Dispatch Centre and Control
- 1990's Energy Control Centre
- 2000's Energy Management Systems

1.4 Objectives of SCADA:

The important objectives of SCADA are to listed below:

1. Monitoring : Continuous monitoring of the parameters of voltage , current, etc..
2. Measurement: Measurement of variables for processing.
3. Data Acquisition: Frequent acquisition of data from RTUs and Data Loggers / Phasor data Concentrators (PDC)..

4. Data Communication: Transmission and receiving of large amounts of data from field to control centre's.
5. Control: Online real time control for closed loop and open loop processes.
6. Automation:: Automatic tasks of switching of transmission lines, CBs, etc.

1.5 Benefits of SCADA:

The important benefits of an EMS can be addresses as the following functions:

1. Continuous monitoring of process.
2. Real time control.
3. Automation and Protection.
4. Remote control and operation.

1.6 Functions of SCADA:

The important functions of an SCADA are listed below

1. Data Acquisition
2. Information Display
3. Supervisory Control
4. Alarm Processing
5. Information Storage and Reports
6. Sequence of Event Acquisition
7. Data Calculation
8. Special RTU Processing/Control

1.7 SCADA IN PROCESS CONTROL

There are two types of process-control systems in view i) distributed control systems (DCS) and ii) supervisory control and data acquisition (SCADA). DCS are typically used for single-point processing and are employed in a limited geographic area. On the other hand, SCADA systems are used for large-scale, distributed management of critical infrastructure systems and are often geographically dispersed. For example, in a power utility, DCS may be used for generation of power, while SCADA is used for the distribution and transmission of power. The basic SCADA configuration shown in Figure 1, consists of a supervisory control station and multiple controller stations, either local or remote. Through the use of the control station, operators can monitor status and issue commands to the appropriate devices. Control stations consist of devices that collect data or effect control of equipment. These devices are remote terminal units (RTU), intelligent electronic devices or programmable logic controllers (PLC).

1.8 SCADA APPLCIATIONS

SCADA is not a specific technology, but a type of application. SCADA stands for Supervisory Control and Data Acquisition— any application that gets data about a system in order to control that system is a SCADA application.

A SCADA application has two elements:

1. The process or system that needs to be monitored and controlled.

2. A network of intelligent devices that interfaces with the first system through sensors and control outputs. This network, which is the SCADA system, gives the ability to measure and control specific elements of the first system. One can a SCADA system using several different kinds of technologies and protocols. This white paper will help you evaluate your options and decide what kind of SCADA system is best for your needs.

1.9 Usage of SCADA

SCADA can be used to manage any kind of equipment. Typically, SCADA systems are used to automate complex industrial processes where human control is difficult. For example in systems where there are more control factors unable to be managed by operators in a control centre.

SCADA systems are widely used for control in the following domains

1. **Electric power generation, transmission and distribution:** Electric utilities use SCADA systems to detect current flow and line voltage, to monitor the operation of circuit breakers, and to take sections of the power grid online or offline.
2. **Water and sewage:** State and municipal water utilities use SCADA to monitor and regulate water flow, reservoir levels, pipe pressure and other factors.
3. **Buildings, facilities and environments:** Facility managers use SCADA to control HVAC, refrigeration units, lighting and entry systems.
4. **Manufacturing:** SCADA systems manage parts inventories for just-in-time manufacturing, regulate industrial automation and robots, and monitor process and quality control.
5. **Mass transit:** Transit authorities use SCADA to regulate electricity to subways, trams and trolley buses; to automate traffic signals for rail systems; to track and locate trains and buses; and to control railroad crossing gates.
6. **Traffic signals:** SCADA regulates traffic lights, controls traffic flow and detects out-of-order signals.

1.10 Real-Time Monitoring and Control using SCADA

The following are the important features of a SCADA from an control point of view. SCADA is capable of the following

1. Acquire quantitative measurements immediately and over time
2. Detect, Diagnose and correct problems as soon as they arise
3. Measure trends over time and prepare reports and charts
4. Discover and eliminate bottlenecks over time and improve efficiency
5. Ability to Control large and complex processes with a few specialized staff.

SCADA provides the facility to fine-tune the operators experiential knowledge in to the system. Sensors can be placed at every critical point in the process to be managed and controlled. As SCADA technology improves, more sensors can be placed to improve efficiency. SCADA has the ability to view the operation of large power process in real time through software. GIS (Geographical Information System) is one such software widely used in electric power applications. With such am=n ability it is possible to correct errors and diagnostics

So even for very complex manufacturing processes, large electrical plants, etc., you can have an eagle-eye view of every event while it's happening — and that means you have a knowledge base from which to correct errors and improve efficiency. With SCADA, you can do more, at less cost, providing a direct increase in profitability.

1.11 SCADA FUNCTIONS

A SCADA system performs four functions:

1. Data acquisition
2. Networked data communication
3. Data presentation
4. Control

These functions are performed by four kinds of SCADA components:

1. **Sensors** (either digital or analog) and **control relays** that directly interface with the managed system.
2. **Remote telemetry units (RTUs)**. These are small computerized units deployed in the field at specific sites and locations. RTUs serve as local collection points for gathering reports from sensors and delivering commands to control relays.
3. **SCADA master units**. These are larger computer consoles that serve as the central processor for the SCADA system. Master units provide a human interface to the system and automatically regulate the managed system in response to sensor inputs.
4. **Communications network** that connects the SCADA master unit to the RTUs in the field.

1.11.1 Data Acquisition

First, the systems you need to monitor are much more complex than just one machine with one output. So a real-life SCADA system needs to monitor hundreds or thousands of sensors. Some sensors measure inputs into the system (for example, water flowing into a reservoir), and some sensors measure outputs (like valve pressure as water is released from the reservoir). Some of those sensors measure simple events that can be detected by a straightforward on/off switch, called a discrete input (or digital input). For example, in our simple model of the widget fabricator, the switch that turns on the light would be a discrete input. In real life, discrete inputs are used to measure simple states, like whether equipment is on or off, or tripwire alarms, like a power failure at a critical facility. Some sensors measure more complex situations where exact measurement is important. These are analog sensors, which can detect continuous changes in a voltage or current input. Analog sensors are used to track fluid levels in tanks, voltage levels in batteries, temperature and other factors that can be measured in a continuous range of input. For most analog factors, there is a normal range defined by a bottom and top level. For example, you may want the temperature in a server room to stay between 60 and 85 degrees Fahrenheit. If the temperature goes above or below this range, it will trigger a threshold alarm. In more advanced systems, there are four threshold alarms for analog sensors, defining Major Under, Minor Under, Minor Over and Major Over alarms.

1.11.2 Data Communication

In our simple model of the widget fabricator, the “network” is just the wire leading from the switch to the panel light. In real life, you want to be able to monitor multiple systems from a central location, so you need a communications network to transport all the data collected from your sensors. Early SCADA networks communicated over radio, modem or dedicated serial lines. Today the trend is to put SCADA data on Ethernet and IP over SONET. For security reasons, SCADA data should be kept on closed LAN/WANs without exposing sensitive data to the open Internet. Real SCADA systems don’t communicate with just simple electrical signals, either. SCADA data is encoded in protocol format. Older SCADA systems depended on closed proprietary protocols, but today the trend is to open, standard protocols and protocol mediation. Sensors and control relays are very simple electric devices that can’t generate or interpret protocol communication on their own. Therefore the remote telemetry unit (RTU) is needed to provide an interface between the sensors and the SCADA network. The RTU encodes sensor inputs into protocol format and forwards them to the SCADA master; in turn, the RTU receives control commands in protocol format from the master and transmits electrical signals to the appropriate control relays.

1.11.3 Data Presentation

The only display element in our model SCADA system is the light that comes on when the switch is activated. This obviously won't do on a large scale — you can't track a lightboard of a thousand separate lights, and you don't want to pay someone simply to watch a lightboard, either. A real SCADA system reports to human operators over a specialized computer that is variously called a master station, an HMI (Human-Machine Interface) or an HCI (Human-Computer Interface). The SCADA master station has several different functions. The master continuously monitors all sensors and alerts the operator when there is an "alarm" — that is, when a control factor is operating outside what is defined as its normal operation. The master presents a comprehensive view of the entire managed system, and presents more detail in response to user requests. The master also performs data processing on information gathered from sensors — it maintains report logs and summarizes historical trends. An advanced SCADA master can add a great deal of intelligence and automation to your systems management, making your job much easier.

1.11.4 Control

Unfortunately, our miniature SCADA system monitoring the widget fabricator doesn't include any control elements. So let's add one. Let's say the human operator also has a button on his control panel. When he presses the button, it activates a switch on the widget fabricator that brings more widget parts into the fabricator. Now let's add the full computerized control of a SCADA master unit that controls the entire factory. You now have a control system that responds to inputs elsewhere in the system. If the machines that make widget parts break down, you can slow down or stop the widget fabricator. If the part fabricators are running efficiently, you can speed up the widget fabricator. If you have a sufficiently sophisticated master unit, these controls can run completely automatically, without the need for human intervention. Of course, you can still manually override the automatic controls from the master station. In real life, SCADA systems automatically regulate all kinds of industrial processes. For example, if too much pressure is building up in a gas pipeline, the SCADA system can automatically open a release valve. Electricity production can be adjusted to meet demands on the power grid. Even these real-world examples are simplified; a full-scale SCADA system can adjust the managed system in response to multiple inputs.

Summary:

This section provides the introduction to SCADA, its evolution, features, benefits and applications. SCADA has many applications in various disciplines for monitoring and control in real time. Application of SCADA for real time control of power networks is a challenge and subsequent sections describe the design and development of SCADA system for computerized monitoring and control of a power system.

LECTURE 2: SCADA HARDWARE

2.1 Introduction:

A SCADA system consists of a number of remote terminal units (RTUs) collecting field data and sending that data back to a master station, via a communication system. The master station displays the acquired data and allows the operator to perform remote control tasks. The accurate and timely data allows for optimization of the plant operation and process. Other benefits include more efficient, reliable and most importantly, safer operations. This results in a lower cost of operation compared to earlier non-automated systems.

SCADA system essentially has five levels or hierarchies, as listed below

1. Field level instrumentation and control devices: These analog and digital sensors situated at each remote site
2. Marshalling terminals and RTUs: These provides an interface to the field devices
3. Communications system: Communications systems form the backbone of SCADA. The widely used systems are wire, fiber optic, radio, telephone line, microwave and possibly even satellite. Specific protocols and error detection techniques are used for efficient and optimum transfer of data pathway for communications between the master station and the remote sites
4. The master station(s): The master stations gather data from the various RTUs provide an operator interface for display of information and control of the remote sites
5. Information Technology (IT) Applications: The commercial information technology (IT) or data processing department computer system.

2.2 SCADA Hardware Functions

There are many functions of SCADA; some of them are listed below.

- a. Data Collection: collecting of the information via a RTU (remote terminal unit)
- b. Data Transfer: transferring it to the central site
- c. Data Processing: Carrying out any necessary analysis and control
- d. Information Display: Displaying that information on operator screens or displays
- e. Control Actions: Required control actions are then conveyed back to the process

2.3 Remote Terminal Units (RTU)

An RTU (sometimes referred to as a remote telemetry unit) as the title implies, is a standalone data acquisition and control unit, generally microprocessor based, which monitors and controls equipment at some remote location from the central station. Its primary task is to control and acquire data from process equipment at the remote location and to transfer this data back to a central station. It generally also has the facility for having its configuration and control programs dynamically downloaded from some central station.

There is also a facility to be configured locally by some RTU programming unit. Although traditionally the RTU communicates back to some central station, it is also possible to communicate on a peer-to-peer basis with other RTUs. The RTU can also act as a relay station (sometimes referred to as a store and forward station) to another RTU, which may not be accessible from the central station. The RTU

provides an interface to the field analog and digital sensors situated at each remote site. The communications system provides the pathway for communication between the master station and the remote sites. This communication system can be wire, fiber optic, radio, telephone line, microwave and possibly even satellite. Specific protocols and error detection philosophies are used for efficient and optimum transfer of data.

The master station (or sub-masters) gather data from the various RTUs and generally provide an operator interface for display of information and control of the remote sites. In large telemetry systems, sub-master sites gather information from remote sites and act as a relay back to the control master station. Small sized RTUs generally have less than 10 to 20 analog and digital signals, medium sized RTUs have 100 digital and 30 to 40 analog inputs. RTUs, having a capacity greater than this can be classified as large.

RTU Hardware:

The RTU Hardware consists of a set on inputs, outputs, memory and communications. There are further classified as following

Inputs

- a. Analog inputs (AI)
- b. Counter inputs (CI)
- c. Digital inputs (DI)

Outputs

- a. Analog outputs (AO)
- b. Digital outputs (DO)

Memory

- a. Static and Dynamic Memory
- b. Control processor and associated memory

Communications and Other equipment

- c. Communication interface(s)
- d. Power supply
- e. RTU rack and enclosure

2.3 SCADA RTU

The SCADA RTU is a small rugged computer which provides intelligence in the field, and allows the central SCADA master to communicate with the field instruments. It is a stand alone data acquisition and control unit. Its function is to control process equipment at the remote site, acquire data from the equipment, and transfer the data back to the central SCADA system. There are two basic types of RTU - the "single board RTU" which is compact, and contains all I/O on a single board, and the "modular RTU" which has a separate CPU module, and can have other modules added, normally by plugging into a common "backplane" (a bit like a PC motherboard and plug in peripheral cards).

2.4 A typical single board RTU.

The single board RTU normally has fixed I/O eg 16 digital inputs, 8 digital outputs, 8 analogue inputs, and say 4 analogue outputs. It is normally not possible to expand its capability. The modular RTU is designed to be expanded by adding additional modules. Typical modules may be an 8 analog in

module, a 8 digital out module. Some specialised modules such as a GPS time stamp module may be available.

Hardware functionality in an RTU

The SCADA RTU is a small ruggedized computer. It has the following hardware features:

Memory

- CPU and volatile memory.
- Non volatile memory for storing programs and data.

Interface

- I/O interfaces to DI/DO/AI/AO's.
- Real time clock.

Communications

- Communications capability either through serial port(s) or sometimes with an on board modem.

Power Equipment

- Secure Power supply with battery backup.
- Watchdog timer to ensure the RTU restarts if something fails.

RTU Software functions

All RTU's require the following functionality. In many RTU's these may be intermingled and not necessarily identifiable as separate modules. Real time operating system, which can be a specific RTOS, or it may be code that started out life as one big loop scanning the inputs, and monitoring the communications ports. Driver for the communications system, which is the link to the SCADA Master. Device drivers for the I/O system connecting to the field devices. SCADA applications like scanning of inputs, processing and storing of data, responding to requests from the SCADA master over the communications network. Some method to allow the user applications to be configured in the RTU. This may be simple parameter setting, enabling or disabling specific I/O's or it may represent a complete user programming environment. Diagnostics. Some RTU's may have a file system with support for file downloads. This supports user programs, and configuration files.

2.5 Basic operation

The RTU will operate scanning its inputs, normally at a fairly fast rate. It may do some processing such as change of state processing, time stamping of changes, and storage of the data awaiting polling from the SCADA master. Some RTU's have the ability to initiate reporting to the SCADA master, although more common is the situation where the SCADA master polls the RTU's asking for changes. The RTU may do some alarm processing. When polled by the SCADA master, the RTU must respond to the request, which may be as simple as "give me all your data", to a complex control function to be executed. RTU's are specialty devices manufactured often by small suppliers in batches of as little as one hundred. They are made for niche markets, and at the smaller end can be subject to intense cost pressures. Therefore not all RTU's support all functionality. Larger RTU's may be capable of processing hundreds of inputs, and even controlling smaller "sub RTU's". These are obviously more expensive. The processing power of an RTU ranges from small 8 bit processors with minimal memory to larger sophisticated RTU's capable of time stamping data to millisecond accuracy.

RTU Standards

As indicated RTU's are specialty devices. There has been a lack of standards, especially in the communications area, and generally RTU's from one supplier cannot be mixed with RTU's from another supplier. An industry has grown up developing protocol converters and emulators. Recently

some standards have begun to emerge for RTU's. Some standards are i) DNP's and IEC870 for communications and ii) IEC1131-3 for programming RTU's.

Difference between PLC and RTU

A PLC (programmable logic controller) is a small industrial computer which originally replaced relay logic. It had inputs and outputs similar to those an RTU has. It contained a program which executed a loop, scanning the inputs and taking actions based on these inputs. Originally the PLC had no communications capability, but they began to be used in situations where communications was a desirable feature. Communications modules were developed for PLC's, supporting ethernet (for use in distributed control systems) and the Modbus communications protocol for use over dedicated (wire) links. As time goes on we will see PLC's support more sophisticated communications protocols.

RTU's have always been used in situations where the communications are more difficult, and the RTU's strength was its ability to handle difficult communications. RTU's originally had poor programmability in comparison to PLC's. As time has gone on, the programmability of the RTU has increased.

2.6 Features of SCADA

The important features of SCADA are the following:

1. Alarm Handling
2. Trend Curves Patterns
3. Data Access and Retrieval
4. Computer Networking and Processing

Alarms Handling

Alarm handling consists essentially of time stamped alarms to 1 millisecond precision. Single network acknowledgment and control of alarms with Sharing and Displaying of Alarms to all clients in chronological order. It performs Dynamic allocation of alarm pages and keeps track of deviation and rate of change monitoring for analog alarms. It has the option of Historical alarm and event logging. It is capable of performing On-line alarm disable and threshold modification with the option of preparing Event-triggered alarms and Alarm-triggered reports

Trends curves

Trend curves and patterns consists of Trend zooming and display of data. It performs Export and Archiving of historical trend data with Event based trends for Short and long term trend display. It has the option of On-line change of time-base and retrieval of archived historical trend data.

Real Time access and archiving and database Management.

Real time access and data retrieval consists of Direct, real-time access to data by any network user as well as Third-party access to real-time data. It has Network DDE compatibility for read, write and exec with DDE to all I/O device points. ODBC driver support and Direct SQL commands or high level reporting

Computer Networking and processing

Computer Networking and processing aspect of supports all compatible networks and protocols. It has Centralized alarm, trend and report processing – data available from anywhere in the network and Dual networks for full LAN redundancy. Open architecture design with Real-time multitasking are important features with Client/server fully supported with Distributed project updates and Concurrent support of multiple display nodes

LECTURE 4: APPLICATIONS of SCADA

1.1 Introduction:

SCADA is widely used in different areas from chemical, gas, water, communications and power systems. The list of applications of SCADA can be listed as follows.

1. **Electric power generation, transmission and distribution:** Electric utilities use SCADA systems to detect current flow and line voltage, to monitor the operation of circuit breakers, and to take sections of the power grid online or offline.
2. **Water, Waste Water Utilities and Sewage:** State and municipal water utilities use SCADA to monitor and regulate water flow, reservoir levels, pipe pressure and other factors.
3. **Buildings, facilities and environments:** Facility managers use SCADA to control HVAC, refrigeration units, lighting and entry systems.
4. **Oil and Gas Trans & Distributions:**
5. **Wind Power Generation**
6. **Communication Networks:**
7. **Industrial Plants and Process Control:**
8. **Manufacturing:** SCADA systems manage parts inventories for just-in-time manufacturing, regulate industrial automation and robots, and monitor process and quality control.
9. **Mass transit and Railway Traction:** Transit authorities use SCADA to regulate electricity to subways, trams and trolley buses; to automate traffic signals for rail systems; to track and locate trains and buses; and to control railroad crossing gates.
10. **Traffic signals:** SCADA regulates traffic lights, controls traffic flow and detects out-of-order signals.

4.2 SCADA in Power Systems:

SCADA is widely used in power systems. The applications for SCADA keep increasing day after day. Some of the applications are

- Comprehensive operational planning and control
- Fuel resource scheduling
- Optimum power flow
- Network security
- Economic dispatch
- Generation dispatch control

4.3 Expected Benefits of SCADA for Power Systems

- Improved quality of service
- Improved reliability
- Reduced operating costs
- Maintenance /Expansion of customer base
- Ability to defer capacity addition projects
- High value service providers
- Improved information for engineering decision value added services
- Flexible billing option
- Improved customer information access
- Reduced system implementation costs
- Reduced manpower requirements

4.4 Typical features of a substation SCADA system are as under

- Substation parameter monitoring
- Controlling electrical network components remotely
- Safety tagging
- High resolution time stamping
- Sequence of event reporting for post event analysis

Additional features of substation control system

- Demand side management
- Volt/VAR control
- Preventive maintenance
- Fault detection isolation and restoration

4.5 SCADA for Power Utility Network:

The aim of power network utilities(PNU) software is to provide the electrical utility with tools which will enhance the operation of the system in a very cost effective way.in the present scenario of low budgets for power utilities to produce and distribute quality power at the minimum cost.This goal can be achieved by proper operation of the electrical network and at the same time having real time data about state of the network.This real time data can then be used for supervisory controlled changes of the network parameters with effective guidance from distribution automation tools.The PNU software utilizes the real time SCADA data.the real time network topology network component details & user defined strategies to achieve the above mentioned goals.PNU uses a combination of mathematical and logical techniques to provide the user with a host of applications for the purpose of distribution automation.

4.6 Features of Power Network Utilities

- Component Modeling
- State Estimation
- Bad data suppression
- Contingency analysis
- Fault isolation/islanding
- Load shedding
- Volt/Var scheduling
- Dispatcher power flow
- Short circuit analysis
- Network topology processor

4.7 Objectives:

There are many objectives of SCADA System.

1. Improved overall System efficiency (capital & energy)
2. Increased penetration energy sources including renewable energy sources.
3. Reduced Energy Requirements in both the Transmission and Generation
4. Increased Relativity of sequence to essential loads.

4.8 Components of SCADA

There are many parts or components of a SCADA system, which include hardware (input and output), controllers, networks, user interface, communications equipment and software. All together, the term SCADA refers to the entire central system. The central system usually monitors data from various sensors that are either in close proximity or off site (sometimes miles away).

An industrial SCADA consisting of the following

- 1) a central host or master station unit or, master terminal unit (MTU);
- 2) one or more field data gathering and control units or remotes (usually called remote stations, remote terminal units, or RTU's);
- 3) a collection of standard and/or custom software used to monitor and control remotely located field data elements.

Contemporary SCADA systems exhibit predominantly open-loop control characteristics and utilize predominantly long distance communications, although some elements of closed-loop control and/or short distance communications may also be present.

Major components of SCADA:

- 1) A collection of equipments that is provide the operator at remote location with enough information to determine the status of particular piece of equipment or entire substation or a plant or a dynamic network and cause actions to take place regarding that equipment or network without being physically present.
- 2) An arrangement for operator control and separation of remotely located apparatus using multiplexing techniques once a relatively small number of interconnecting channels.
- 3) Collecting Data from remote electrical equipment and controlling then through suitable communication medium.

Functions of SCADA

A SCADA system performs four functions:

1. Data acquisition
2. Networked data communication
3. Data presentation
4. Control

These functions are performed by four kinds of SCADA components:

1. **Sensors** (either digital or analog) and **control relays** that directly interface with the managed system.
2. **Remote telemetry units (RTUs)**. These are small computerized units deployed in the field at specific sites and locations. RTUs serve as local collection points for gathering reports from sensors and delivering commands to control relays.
3. **SCADA master units**. These are larger computer consoles that serve as the central processor for the SCADA system. Master units provide a human interface to the system and automatically regulate the managed system in response to sensor inputs.
4. The **communications network** that connects the SCADA master unit to the RTUs in the field.