UNIT-V

COMPUTER CONTROL OF POWER SYSTEM

SCADA

SCADA 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.

➢The feedback control loop passes through the remote terminal unit(RTU) or Programmable logic controller (PLC), while the SCADA system monitors the overall performance.

For example:

A PLC may control the flow of cooling water through part of an industrial process, but the SCADA system may allow operators to change the set points for the flow, and enable alarm conditions, such as loss of flow and high temperature, to be displayed and recorded.

Most essentially the SCADA system consists of three fundamental components (i.e. Master station (MS) or Central Monitoring System (CMS), Communication link and RTU or PLC).

A Central Monitoring System (CMS), contained within the plant and one or more Remote Stations. The CMS houses the Control Server and the communications routers via a peer-to-peer network. The CMS collects and logs information gathered by the remote stations and generates necessary actions for events detected. A remote station consists of either a Remote Terminal Unit (RTU) or a Programmable Logic Controller (PLC) which controls actuators and monitors sensors.

Typically, remote stations have the added capability to be interfaced by field operators via hand held devices to perform diagnostic and repair operations. The communications network is the medium for transporting information between remote stations and the MS. This is performed using telephone line, cable, or radio frequency. If the remote site is too isolated to be reached via direct radio signal, a radio repeater is used to link the site.

Simulation tools used to aid the operator in preventing disturbances.
Simulation is used when the system which is to be analyse or design is complex to use analytical techniques (like aerodynamics).
Simulation models can be descriptive and physical.
Simulation models that are formulated called descriptive models.
Physical models mostly are time-discrete showing the act and interact of entities of a system. These models can be built after many steps involving computer programs.
The state of the system changes as a consequence of events in the system . These events are considered to occur at discrete times; models are called discrete event simulation models.

MAIN TASKS IN POWER SYSTEM OPERATION:

The main tasks of power system can be divided into the following categories:

1. Planning operations **2. Operation control**

3. Operating accounting and financial control

The above tasks are performed by the National control center, Regional control center, District control center and Major substation control rooms.

1) Planning of operations:

Planning means the formulating and preparing actions before put into the use. Planning is done for next hour, next day, next week, next month, and next year and for long range. Planning tasks includes:

➔ The ***national load center*** performs the following tasks:

First of all load prediction followed by generator scheduling, spinning reserves, planning of reserves, planning of maintenance schedules, planning of energy resource, selection of energy resource, hydro-thermal generation co-ordination, planning of power exchange b/w two regions and planning of installation of HVDC lines.

➔ The ***Regional load center*** performs the following tasks:

First of all load prediction followed by generator scheduling, planning of reserves, planning of maintenance schedules and selection of load scheduling.

➔ The ***District load center*** performs the following tasks:

First of all short term planning in terms of regional level planning and then followed by planning of generation and reserves, and planning of load shedding in district.

➔ The ***Power station and sub-station control room*** performs the following tasks:

Work planning for hourly, daily, weekly, monthly.

2) Operational control tasks:

An electric supply corporation basically must meet the following aims:

- -There must be continuity of the power supply for the consumer.
- -The network will be designed in such a manner so as to cover the --- maximum consumers.
- -Maximum security of supply
- -Less possibility of the fault
- -Maximum efficiency of the plant
- -Consistency of the frequency
- -Consistency of the voltage
- -Supply power at low cost

The ***national load center*** performs the following tasks:

-Accuracy of generation, and load and frequency

-Power exchange under emergency case

-System frequency control

The ***Regional load center*** performs the following tasks:

-Accuracy of generation, load and frequency and power exchange b/w districts under emergency.

The ***District load center*** performs the following tasks:

-Accuracy and control of generation in district

-Control of power station

-Control of T/L and tie-lines

The ***power station and sub-station control room*** performs the following tasks:
-Generation, start, stop function
-Automatic restoration function
-Control and protection functions
Maintenance
The ***transmission sub-station*** performs the following tasks:
-Switching operation
-Protective functions
-Voltage control and reactive power compensation
-Data collection
-Load shedding instructions.

3) Operating accounting and financial control:

The operating accounting deals with the data collection and evaluation and then preparation of the financial reports and billings. The task includes first of all the data collection regarding the power produced, and then billing on that power interchange for adjacent station, then estimate the performance of the power station, then estimate the price of the power available for the consumer.

TECHNICAL FUNCTIONS OF SCADA:

The SCADA system provides the following functions:

Data acquisition:

The basic information of the power system collected is called the Data Acquisition. The data is collected by means of CTs, PTs and transducers. It provides the telemetry measurement and status indication to the operator.

Supervisory control:

It enables the operator to remotely control the devices. For example open and close of the circuit breaker.

Tagging:

It prevents the device from unauthorized operation. Means it authorizes the device to perform the specific operation.

Alarms:

It informs the operator about the unnecessary events and undesired conditions.

Logging (Recording):

It logs all the operating entry, all alarms and other information. In other words it keeps the record of all the events.

Load shading:

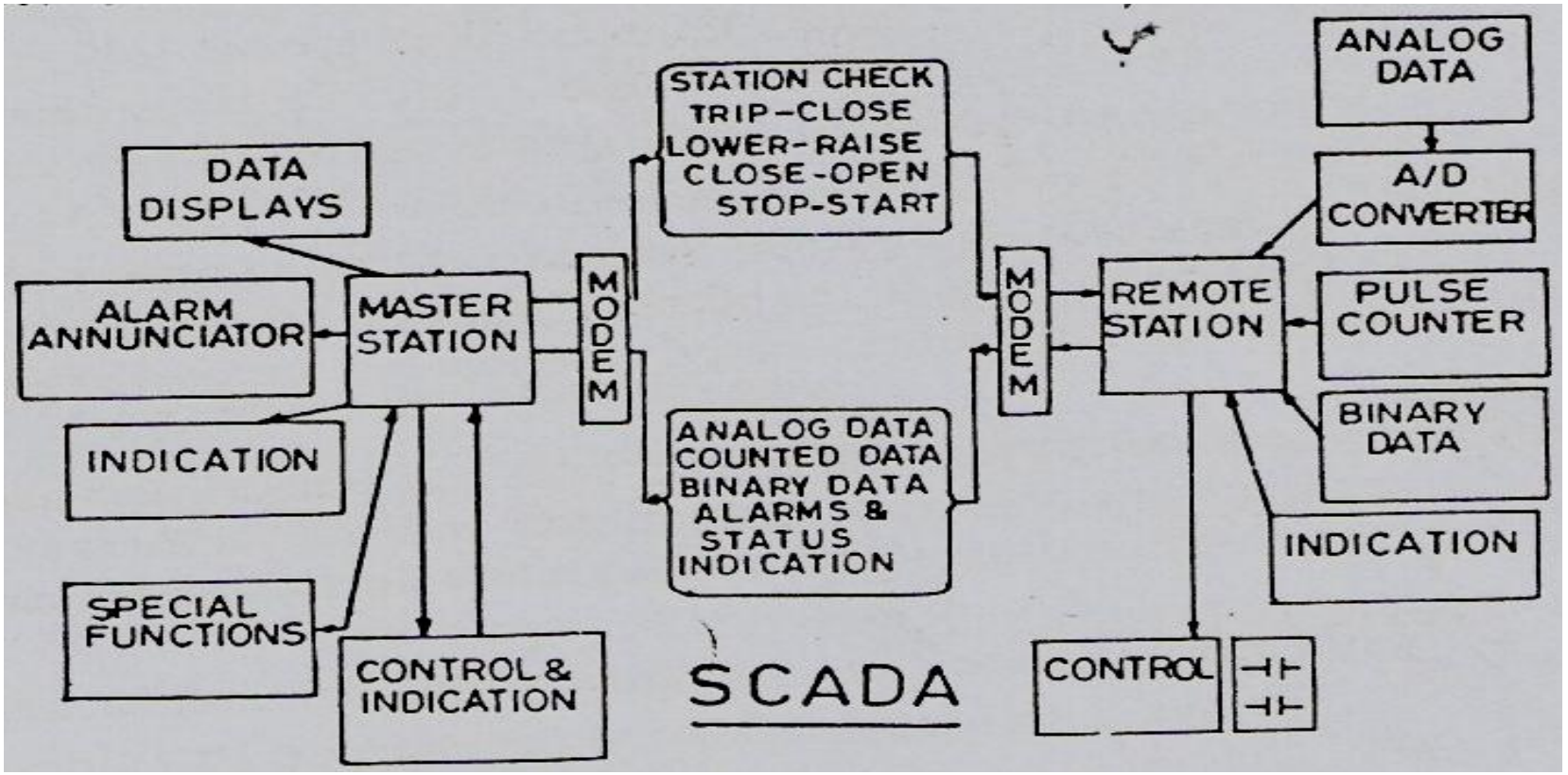
It provides both the automatic and manual control tripping of load during the emergency.

Trending:

It plots the measurement on the selected time scale.

Simple Layout of the SCADA :

The simple layout of the SCADA system with its essential features is shown below in the fig:



The SCADA system enables the operator to attain the complete knowledge of the system in a single room by means of display.

Almost all the SCADA systems are computer based (Digital computer). This computer is located in the master unit. The master unit is the heart of the SCADA system, it comprises many of the i/p and o/p equipments to receive and send the control message from and to the RTU.

All the data of operations of RTU are transmitted to the master control unit and after collecting the information the data are feed back to the RTU.
Also master unit consists of several modems which are used to convert the digital into analog or analog into digital message depending upon the requirement. The received information of the master unit is displayed on VDU and then is printed for permanent record.

In addition the SCADA system also comprises some more peripheral equipment such as control console, VDU, Alarms, Printers, D/A converter and Recording instruments.
Visual Display Unit (VDU) replaces mimic board to represent one line diagram, tabular display, bar charts, curves and event lists and used for entering commands to system.
Modern system includes the color display which is used to distinguish b/w the different voltage levels. Also different colors differentiate the operator to understand the open and close of CB, also the flashing indication can be made which determines the change of the state of any device.
The audible alarms can be used to alert the operator from the fault or condition. The printers are used to have the permanent records of the events. The D/A converter are used to convert the digital information into the analog information, and then the information is supplied to the indicating or the recording instruments. The recording instruments are used to store the data of each remote station unit.

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 andreceiving 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.

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.

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

Features of SCADA

- Dynamic representation
- Database connectivity
- Device connectivity
- Alarms
- Trends
- Scripts
- Security
- Recipe Management
- Networking

. **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.

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.

Features of SCADA

- Dynamic representation
- Database connectivity
- Device connectivity
- Alarms Trends
- Sports
- Trends
- Scripts
- Security
- Recipe Management
- Networking

SCADA- Importance

The main task of the load dispatcher is to ensure quality and reliable power at an economical rate. To fulfill this commitment. LD must have up to date and reliable information of power stations and important EHV sub-stations under control.

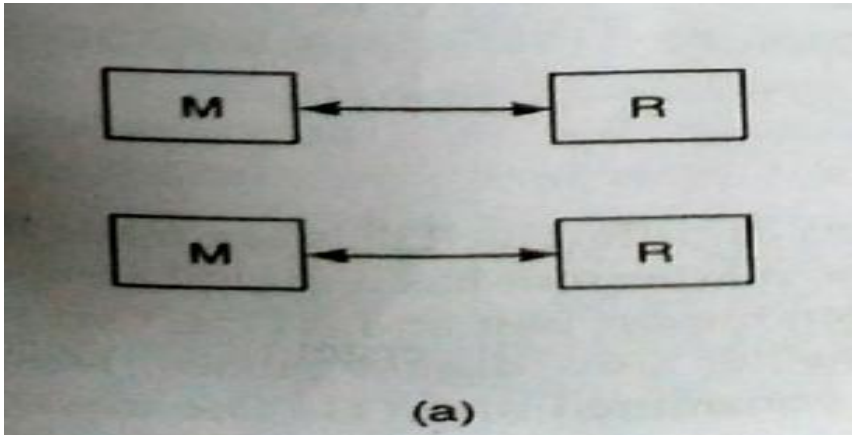
Where is SCADA used?

Main SCADA applications:

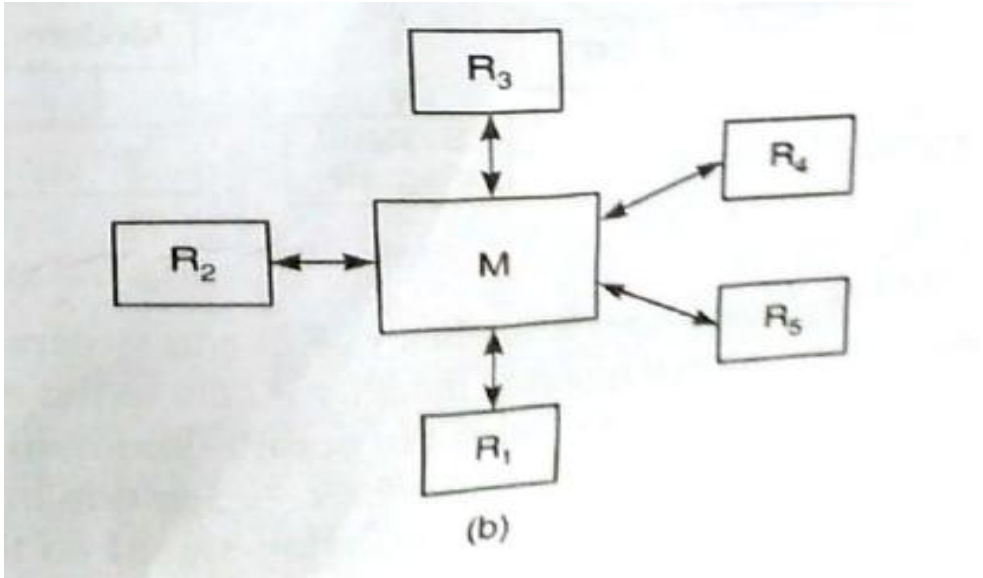
- Water and Waste water
- Power
- Oil and Gas
- Research facilities
- Transportation
- Security systems
- Siren Systems
- Irrigation
- Communication control

SCADA Configurations

One to One SCADA configuration



Star configuration with master unit at a central location and remote unit branched out



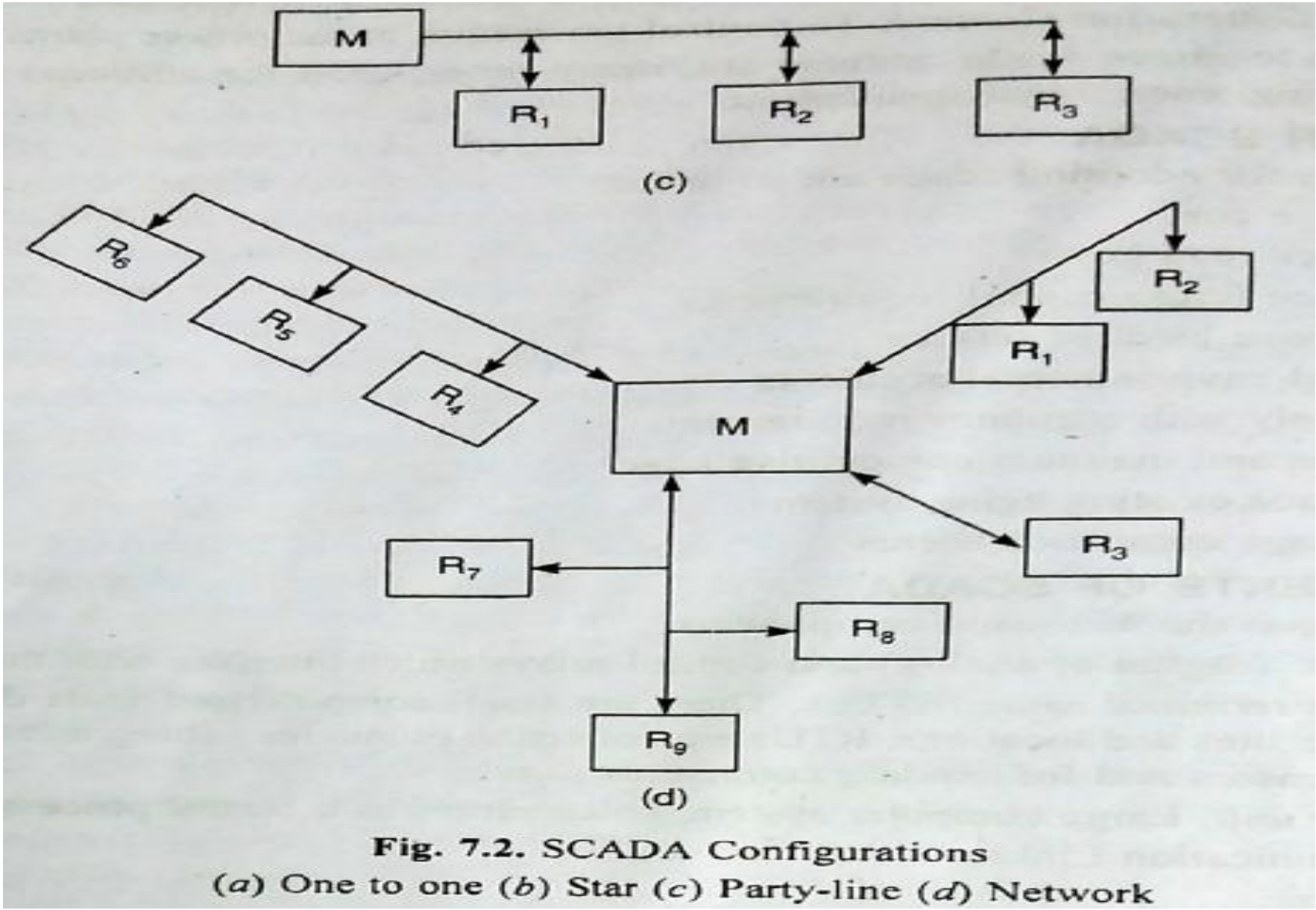


Fig. 7.2. SCADA Configurations
(*a*) One to one (*b*) Star (*c*) Party-line (*d*) Network

7.12.1. Energy Management System for Utilities. EMS for generation, transmission and distribution systems uses Scada (and some other softwares) for monitoring the system, state estimation, security analysis and contingency analysis. It affempts at one or more of the followiong.

1. Economic dispatch.
2. Unit commitment.
3. Network improvement solutions.
4. Asset management.
5. Loss identification and reduction.
6. Automatic remote meter reading, installation of new meters, retrofitting of existing meters, on line checking of utility meters.
7. Remote monitoring of important distribution parameters.
8. Improvement of data accuracy.
9. Analysis of maintenance schedules.
10. Record of daily sequence of events
11. Analysis of capacity utilisation
12. Analysis of power quality problems like voltage sags, THD etc.
13. Accurate demand prediction.
14. Load shifting to reduce peak time power shortage.
15. Better utilisation of manpower and cost reduction.
16. Meter data analysis through energy management software, energy accounting software, distribution network analysis software, feeder analysis software, capacitor optimisation software etc. etc.

7.12.2. Energy Management System for Users. Energy management systems for large users envisages demand side management, energy conservation, energy auditing etc. Development of cogeneration, captive power generation also form part of energy management systems.

The aims are:

1. Purchase of energy at lowest cost.
2. Maintain high efficiency of equipment
3. Reusing and Recycling of energy by cascading (e.g. waste heat recovery)
4. Use of more appropriate technology.
5. Demand control.
6. Accurate energy accounting.
7. Increased productivity.
8. Loss identification and management.
9. Better utilisation of manpower.
10. Monitoring and improving power factor.
11. Monitoring specific energy consumption.
12. Analyse maintenance and repair schedules.

Supervisory control and data acquisition (**SCADA**) is a control system architecture that uses computers, networked data communications and graphical user interfaces for high-level process supervisory management, but uses other peripheral devices such as programmable logic controllers and discrete PID controllers to interface to the process plant or machinery.

The operator interfaces which enable monitoring and the issuing of process commands, such as controller set point changes, are handled through the SCADA supervisory computer system. However, the real-time control logic or controller calculations are performed by networked modules which connect to the field sensors and actuators.

The SCADA concept was developed as a universal means of remote access to a variety of local control modules, which could be from different manufacturers allowing access through standard automation protocols.

In practice, large SCADA systems have grown to become very similar to distributed control systems in function, but using multiple means of interfacing with the plant. They can control large-scale processes that can include multiple sites, and work over large distances.[1] It is one of the most commonly-used types of industrial control systems, however there are concerns about SCADA systems being vulnerable to cyberwarfare/cyberterrorism attacks.[2]

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.

SCADA FUNCTIONS

- Supervisory Control
- Data Acquisition
- Real Time Database
- Graphical Operator Interface
- Alarm Processing
- Data Historian/Strip Chart Trending
- Mapboard Interface

Energy Management Overview (EMS operating states)

High performance, distributed, mission critical, control
Capability to monitor, control, and optimize the operation of geographically dispersed transmission and generation assets real-time

- Real-time SCADA Applications

in time.

- Generation Dispatch and Control
- Energy Scheduling and Accounting
- Transmission Security Management