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A Study Project on Online Monitoring and Controlling of Substation Using SCADA

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Abstract: **- Development of nation depends upon electric energy and at present scenario there is large gap between electric generation and load [1]. This gap can be filled with proper control, monitoring and coordinating the distribution components at power sector [2]. In this view, Automation of power transmission system has increasingly been adopted by power utilities worldwide in recent years. As part of its efforts to provide a more reliable supply to the customer and to enhance operational efficiency, the automation of the power system can be achieved by SCADA [3].**

Key Words**: SCADA –Supervisory Control and Data Acquisition, RTU-Remote Terminal Unit, MCC-Master Control Center, ALDC-Area Load Dispatch Centre.**

I. INTRODUCTION

Karnataka Power Transmission Corporation Limited is a registered company under the Companies Act, 1956 was incorporated on 28-7-1999 and is a company wholly owned by the Government of Karnataka with an authorized share capital of Rs. 1000 crores **[4].** KPTCL was formed on 01-08-1999 by carving out the Transmission and Distribution functions of the erstwhile Karnataka Electricity Board. Present day power systems have large interconnected networks **[5].** The success of the recently evolving electricity market structure will heavily depend on modern information systems and online decision tools. Maintaining system security, reliability, quality, stability and ensuring economic operation are the major operating concerns **[6].** Online monitoring, operation and control of the modern day power systems have become impossible without computer aided monitoring & dispatching systems. The basic requirement to fulfill these needs is SCADA **[7].**

The ability to perform operations at an unattended location from an attended station or operating centre and to have a definite indication that the operations have been successfully carried out can provide significant cost saving in the operation of a system **[8].** This is exactly what is achieved through the SCADA system. A formal definition of SCADA system, as recommended by IEEE, is "A collection of that will provide an operator at a remote location with sufficient information to determine the status of particular equipment or a process and cause actions to take place regarding that equipment or process without being physically present". **[9][10].**

II. ABOUT KPTCL

Karnataka Power Transmission Corporation Ltd. (KPTCL) has a very large network of high voltage transmission lines in whole Karnataka. Transmission lines transfer power from power houses to substations and from one substation to many other substations or vice versa. Power is generated at low voltage (of the order of 3.3KV to 25KV) and is stepped-up to high voltage (765KV, 400KV, 220KV and 132KV) for evacuating power into the grid network through transmission lines.

Distribution of power is a part of the KPTCL. 33/11KV substations of distribution companies (ESCOMs) draw power from transmission substations through 33KV lines and distribute that to consumers (at 0.04KV, 11KV or in few cases at 33KV). Distribution companies have industrial, rural and domestic load, which varies from time to time of the day and from season to season of the year. Sometimes, large variations in load cause over/under loading of lines, transformers or generators. Variations beyond limits and breakdowns cause fluctuations in voltages and grid frequency of the network. Control Centres, in hierarchical form, are set up for smooth functioning of the grid. Each generating unit or substation has its own Control Centre. These are also named as Unit Control Board (UCB)/Main Control Board (MCB)/Control Room. These Control Centres report to Area Load Dispatch Centre (ALDC).

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III. SUMMARY

a. Conventional Substation

Conventional substations are those where the readings are taken manually for hourly once such as current, voltage and KW etc. Since the readings are taken hourly once exact time of peak load is not available. Readings should be taken at exact time else readings will not be available (gives zero readings).All the parameters should be multiplied with their constants so it takes long time for calculations. Identification of faults and repair of faults takes long time.

Challenges faced in conventional substations are,
1. Load changes cannot be known at particular time
2. Peak load recordings are not exact.
3. Voltages and current curves with respect to time are not available
4. It takes long time to generate a report
5. Only 3 days data will be available etc.

To overcome these challenges online monitoring and control of substation is done using SCADA

b. SCADA

SCADA is neither hardware nor software. It is concept, where the system consists of hardware and software with coded singles over communication channels so as to provide control of remote equipment (using typically one communication channel per remote station). The control system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of the remote equipment for display or for recording functions.

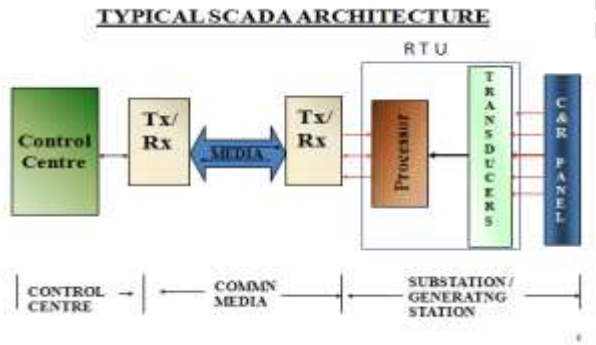

Fig 1.SCADA Architecture

c. MAIN COMPNENTS OF SCADA

1. RTU (Remote Terminal Unit)
2. COMMUNICATION MEDIA.
3. SCADA MASTER CONTROL CENTER

d. Remote Terminal Unit (RTU):

The RTU is small ruggedized computer provides intelligence in the field, allows the central SCADA master to communicate with the field instruments.

The data we are obtaining from the station are being analogous in nature, but the instruments used in SCADA are electronic equipments and they can understand only the digital values. RTU consists of Transducer and Processor, The **transducers** used in RTU converts the analogous data obtained from the field into digital values and when RTU is gives control signals to station equipments, it converts digital signal into analogous value. **Processor** used in RTU processes the data and communicates with the MCC.

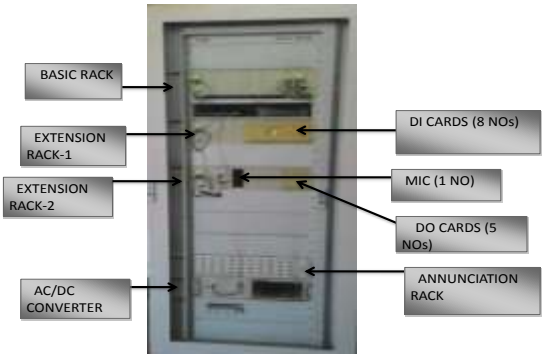

Fig 2. RTU560A

IV. COMMUNICATION SYSTEM

The communication media used in SCADA is satellite. The satellite has many advantages over other communication Medias like PLCC, optical fibers, GSM etc. VSAT is used in SCADA applications currently.

a. VAST (Very Small Aperture Terminal):

VAST is Very Small Aperture Terminal which refers to the small aperture antenna. VSAT consists of 2 parts, trans-receive unit that is placed Outdoor in direct line of sight to the satellite and a device that is placed Indoor trans-receive unit (IDU) used at remote locations to interface with the end users communication device such as pc.

The trans-receiver receives or sends a signal to a satellite transponder in the sky. The satellite sends or receives signals from a ground station computer that acts as hub for the system.

b. Master Control Centre (MCC):

Master Control Centre (MCC) in SCADA system is a control centre that collects the data from Remote Terminal Unit (RTUs) which are located at remote

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places, gathers the required data, stores the information, and process the information and display the information in the form of pictures, curves and tables to human interface and helps to take control decisions. This is the operation of the Master Control Centre (MCC) located in the control centre.

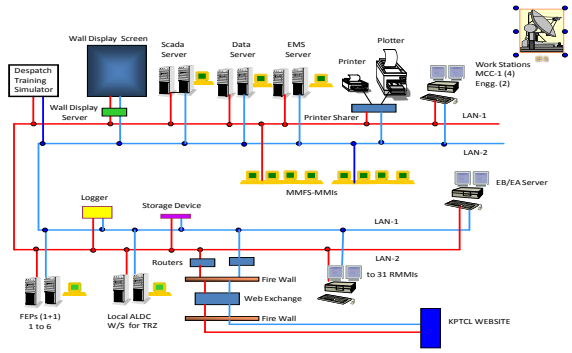

Fig 3. Master Control Centre

c. SCADA Operation

Operations carried out 66/11kV substation are,

- Real time data acquisition from RTUs**:** Area Load Despatch Centre (ALDC) requires data with respect to available transmission and load to be attended. As such real time data is required from receiving stations; real time data is required from Interface points from where power is delivered to Distribution companies or Consumers. RTU560A provides real time data such as Feeder ON OFF indication, Circuit Breaker status, tap change of transformer, etc. to ALDC. Operator at ALDC can observe single line diagram of substation shown in figure.

Fig 4. Operator at ALDC can observe single line diagram of 66/11kV substation at control centre

- Status monitoring and alarming**:** If operator at ALDC operates any of circuit breaker remotely, to indicate this information for local operator at substation SCADA Control Annunciator is provided in RTU 560A, which alarms operator. At present only few substation at Mysore is operated remotely.

Fig 5. Monitoring screen of 66/11kV substation at ALDC

- Sequence of event recording: RTU 560A also provides facility of recording events about fault occurred at substation.
- Information storage & Data retrieval for ABT functions**:** RTU 560A collects analog data like MW, MVAr, kWh import/export, frequency, voltage from metering core of CT, PT through MFTs and digital indications like CB open, close, auto trip, Isolator open.

Energy billing is one of the KPTCL SCADA applications, to achieve this customized Meter Interface card (MIC) is provided at the RTU to integrate the Interface (IF) points Special Energy meters. Connection diagram for IF point at substation is shown in figure below. The Energy Billing system downloads the data from the Energy meter at predefined time. Data acquired to carry out Energy Billing and UI (Unscheduled Interrupt charge) billing for ESCOMs and for Intra State ABT (Availability Based Tariff) billing.

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Fig.6.3.3. Connection of IF point at substation

Energy meters at substation are conventional meter and manufactured by different manufactures. There was no uniformity and accuracy was less in meter, no communication protocol to take data from meter. Thus KPTCL under gone to some Special Energy meters with 3-ph 4 wire and had a communication port of RS485.

A station consists many more meters then they are looped and connected to MIC of RTU through the RS485. MIC is firmware with buffer once polled it takes data from meter and transfers it to Energy Billing (EB) server. RTU 560A collects analog data like MW, MVAr, kWh import/export, frequency, voltage from metering core of CT, PT through MFTs and digital indications like CB open, close, auto trip, Isolator open. These data can be remotely accessed by operator at ABT wing for Energy Billing.

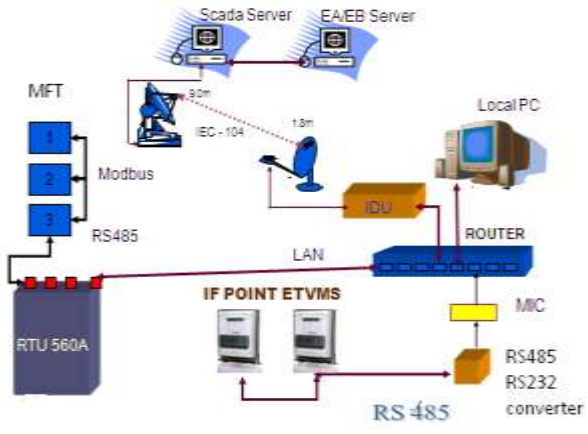

Fig.6.3.4. IF meter reading setup for energy billing

Figure above shows IF meter reading setup for Energy Billing at ABT through EB server. Every energy meter at substation is given a unique identification No. for accessing information at remote place. Operator at ABT wing has ABT drive software with MIC configuration through which he can MIC to get data. Data transfer is done on 96 block base for one day for every 15 min. For example IP address for polling a meter is 10.6.1.12, it defines as,

10	: Common No.
6	: Zonal No. for each district
1	: RTU No. at substation
12	: Energy meter No.

Thus data is received from substation at ABT wing and used for Energy Billing.

Benefits of scada:

- Open Access Monitoring
- ABT monitoring Screen
- Transmission Billing Efficiency
- Reactive power monitoring
- Automatic energy meter downloading by interfacing meters to RTU using MIC(meter interfacing cord).

V. COMPARITIVE STUDIES:

a. Convensional system

11 KV Bank 1			11 KV Bank 2			Total B (1+2)		Battery charger	
AMP	MW	KV	AMP	MW	KV	A	MWs	A	Volts
115	2.1	10.7	155	2.6	10.7	270	4.7	4	115
113	1.9	10.9	156	2.7	10.8	269	4.6	4	115
114	1.9	10.9	151	2.3	11.8	265	4.2	4	115
100	1.7	10.9	153	2.5	10.8	253	4.2	4	115
100	1.7	10.9	157	2.7	10.8	257	4.4	4	115
102	1.9	10.9	166	2.9	10.8	268	4.8	4	115
105	1.9	10.6	143	2.8	10.6	268	4.7	4	115

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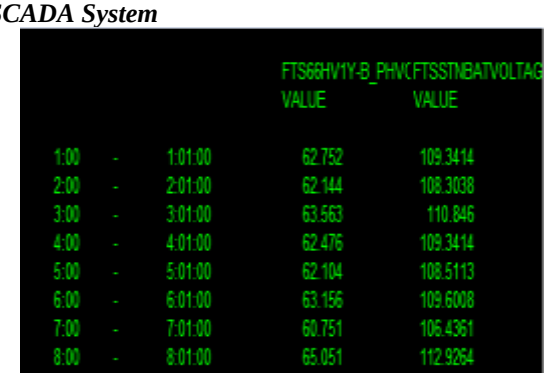
b. SCADA System



			FTS66HV1Y-B_PHV(VALUE	FTSSTNBATVOLTAG VALUE
1:00	-	1:01:00	62.752	109.3414
2:00	-	2:01:00	62.144	108.3038
3:00	-	3:01:00	63.563	110.846
4:00	-	4:01:00	62.476	109.3414
5:00	-	5:01:00	62.104	108.5113
6:00	-	6:01:00	63.156	109.6008
7:00	-	7:01:00	60.751	106.4361
8:00	-	8:01:00	65.051	112.9264

VI. CONCLUSION

Power Systems are large complex systems covering vast areas National grids and highly nonlinear, high order system. Many process operations need to be coordinated and millions of devices requiring harmonious interplay. The Energy flows from various Generating stations to various Receiving Sub stations via Transmission networks. For maintaining system security, reliability, quality, stability and ensuring economic operation, on line monitoring, operation and control of the modern day power systems is required. The basic requirement is of power system automation which is achieved by SCADA.

SCADA covers major generating stations and Independent Power Producers (IPP), receiving stations ranging from 33kV to 400kV, collects data from all feeders from 11 KV to 400 KV, upgrades information to Area Load Dispatch Centre (ALDC). SCADA has facilities to record data, event list, disturbance records, and trip values during fault etc., with help of these facilities operator at substation can analyze fault, if any mistakes in recording readings can be easily sorted out. Thus concluding that a full fledge SCADA system is very much necessary for monitoring, controlling, fault detection and prevention and to make restoration power supply activities easier and faster.

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