International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 10, October- 2014

A Case Study: SCADA Implementation in KPTCL

Vinuta V Koluragi M.Tech(Power and Energy Systems)
Assisstant Professor
B.L.D.E.A's V P Dr P. G.
Halakatti College of Engg. & Tech.,
Bijapur.

Abstract: **Development of nation depends upon electricity energy and at present scenario there is large gap between electric generation and load. This gap can be filled with proper control, monitoring and coordinating the distribution components at power sector. In this view, Automation of power distribution 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 (Supervisory Control And Data Acquisition). It is a boon to the automation concept of dynamic technology. Karnataka Power Transmission Corporation Limited (KPTCL) has undertaken steps to automate existing substation and new substation by use of most advanced controlling and monitoring technology ABB SCADA. Karnataka Power Transmission Corporation Limited, presently with the help of 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 Load Despatch Center (LDC). Real time data acquisition from all interface points by SCADA, helps to perform energy billing, energy audit and Availability Based Tariff (ABT) functions, and Sub-system to perform Open Access operations.**

Keywords: **Real time monitoring and controlling, SCADA, RTU, ABT.**

NOMENCLATURE

SCADA	: Supervisory Control And Data Acquisition
RTU	: Remote Terminal Unit
ABT	: Availability Based Tariff

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. KPTCL was formed on 01-08-1999 by carving out the Transmission and Distribution functions of the erstwhile Karnataka Electricity Board [5].

Present day power systems have large interconnected networks. 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. 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.

The ability to perform operations at an unattended location from an attended station or operating center 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. This is exactly what is achieved through the SCADA system. A formal definition of SCADA system, as recommended by IEEE [1], is "A collection of equipment 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".

SCADA provides open architecture rather than a vendor controlled proprietary environment. It interfaces hardware and software, and it includes functionality such as trending, alarm handling, logging archiving, report generation, and facilitation of automation. Thus SCADA has been used has powerful tool for power system automation, that refers to automatic switching, regulating, controlling, logging, protection etc. of electric power flow without human intervention.

II. SCADA SYSTEM ARCHITECTURE

Figure 1 shows SCADA system architecture at KPTCL. It consists of 16 control centers, which includes the Main Control Centers (MCC), a Disaster Recovery Centre (DRMCC), Area Load Despatch Centers (ALDC) for the Transmission Zones and Distribution Control Centers (DCC) for the ESCOMs.

All the Transmission RTUs communicate to MCC-1 & Distribution RTUs communicate to MCC-2. The total system is configured with 72 servers and 115 operator workstations. Communication is on an owned VSAT HUB and Leased Lines for Inter control Centre Communication [3].

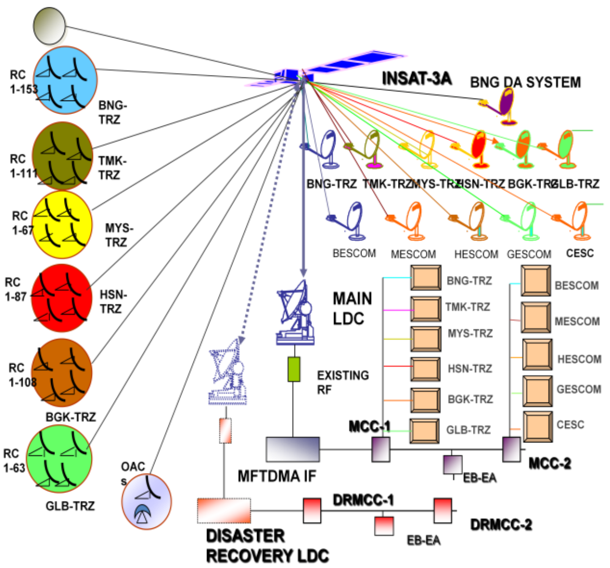

Fig 1: SCADA System Architecture at KPTCL [3].

III. IMPLEMENTATION OF SCADA

According to features of Integrated Extended SCADA (IES) project, KPTCL covers all receiving substation ranging from 33 kV to 400 kV. 110/11kV Bijapur receiving station at City was one of old station to acquire data, monitor and to control remotely SCADA was implemented at this station under IES project first phase. This section briefly describes SCADA implementation, SCADA equipment, SCADA connection, and SCADA operation at 110/11kV substation.

Under Integrated Extended SCADA (IES) Project, adaptation works were basically carried out on the oldest substation as old as 50 years. Adaptation works for 600 substation was carried out and completed in a record time of one year. During this 110 kV City substation Bijapur was undergone, as it is old substation there was need to acquire data from existing equipment. Renewing all equipment or replacing old equipment by new equipment will increase cost, it is not economical also. Thus KPTCL took step to automate existing substation by installing RTU560A SCADA for automation and send all information to Master Control Center (MCC).

Figure 2 gives general block diagram of implementation of SCADA at all old substation in that 110/11kV substation Bijapur was one of substation.

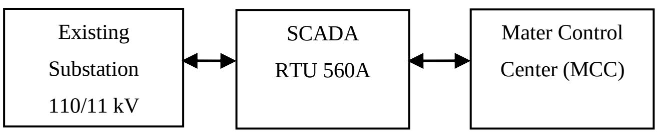

Fig 2: General Block diagram of Implementation SCADA at 110/11kV substation.

According to abbreviation of SCADA, Supervision, Control And Data acquisition are the main tasks to be carried out at every substation. Supervision - of the incoming line, Control and Relay Panels (C&R panel), Control - Switch gear and data acquisition - such as Voltage (phase), current (phase), active and reactive power, frequency etc. Table 1 gives information about parameters, input and output, relation of these with SCADA at 110/11 kV substations.

Table 1: SCADA, I/O and parameters used at 110/11 kV substation

SCADA	Supervision	Control	Data Acquisition
Input/ Output	Digital input	Digital output	Analog input
Observation	Status indication Control & relay panel	Switch Gears CT & PT	Measured value such as voltage current etc.

Supervision, Control and Data Acquisition at 110 kV City station Bijapur is done by installing ABB's RTU 560A which consists of all facilities that required for automation.

➢ About Remote Terminal unit (RTU)

The RTU connects to physical equipment. Typically, an RTU converts the electrical signals from the equipment to digital values such as the open/closed status from a switch or a value, or measurements such as pressure, flow, voltage or current. By converting and sending these electrical signals out to equipment the RTU can control equipment [1].

A. SCADA Equipments

At 110/11kV city substation Bijapur, consists of the following SCADA equipments. They are [4]:

i. RTU 560A along with IF panel.
ii. VSAT
   - Antenna,
   - IDU,
   - 8 port switch ,
   - telephone
iii. 2 kVA UPS (Power One make) along with
   - 8 No of 100Ah, 12V cells
   - Battery stand
   - ACDB

i. RTU 560A

Transmission and distribution networks are frequently being expanded, often resulting in more complex networks. The task of monitoring and controlling the energy transportation in order to achieve an economical operation, ABB's solution for transmission and distribution application requirement is Remote Terminal Unit system RTU560. Within the RTU560 family the communication unit and the I/O board family is a hardware system based on standard European format cards. To meet the requirements for typical medium stations with only some communication links on one side and large or modern stations with a higher number of IEDs on the other side, the RTU560, based on European format cards, is available in two versions [4]:

- RTU 560A for configurations with higher demands on communications links. The parallel wired process interface is still part of the configuration.
- RTU 560C for typical stations with a parallel wired process interface and some communication links only.

Features of RTU 560A [4]:

- 4 serial communication interfaces for host communication
- 32 MB Flash Memory
- 8 MB RAM
- Web Server
- PC104 module with CPU 486/66MHz
- PLC capable

The SCADA RTU560A as shown in figure 3 is small ruggedized computer, which provides intelligence in the field. It allows the central SCADA master to communicate with the field instruments. It is stand alone data acquisition and control unit. Its function is to control process equipment at the remote site such as to open or close the circuit breakers. It acquires data from the equipment and transfers the data back to the central SCADA system.

Fig 3: ABB RTU560A Panel at 110/11 kV substation [5].

Components of RTU 560A

Figure 4 shows components of RTU 560A [3], it consists of Basic rack (top rack) with CPU and communication ports, Extension rack 1 (2nd rack) with Digital Input card (DI) Analog Input card (AI) and Analog Output card (AO). Digital Output card (DO) at Extension rack 2 (3rd rack) and each rack is supported by separate power supply cards. For load alarm annunciation, there is rack called SCADA annunciation panel. Table 2 gives details of components and their function.

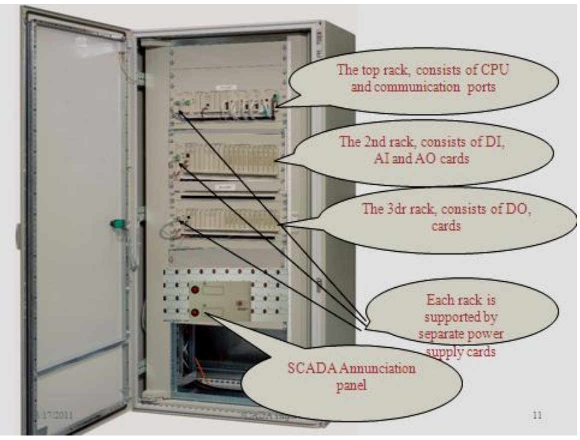

Fig 4: Components of RTU 560A [3].

Table 2 : Details of RTU 560A components [3]

Sl No.	Components	Quantity	Function
1	Multifunction Transducer (MFT)	30	30 no. of bays data can be collected.
2	Digital Input Card (DI card)	8	Each card supports 16 digital inputs.
3	Digital output Card (DO card)	5	Each card supports 16 digital outputs.
4	Analog Input Card (AI card)	3	Each card supports 8 inputs. (DC Voltage, Tap position…)
5	Analog Output Card (AO card)	1	2 linear control
6	Digital Output Relays	80	40 breakers can be controlled. (One relay for trip, one for close)
7	Meter Interface card	1	For acquiring ABT Energy meters located at IF points
8	Communication Card	2	Each having 4 ports for communication.
9	AC-DC Converter	2	For providing DC power supply to rack (48 V).
10	SCADA Control Annunciator	1	Provides alarm for operator.
11	Optocoupler	3	To isolate voltages (110V dc & 48V).

ii. VSAT

VSAT technology represents a cost effective solution for users seeking an independent communications network connecting a large number of geographically dispersed sites. This is the first system of its type and scope to be installed anywhere in the world, and helps KPTCL monitor, control and deliver electricity to roughly 14.6 million customers, across a coverage area of 192,000 sq. km.

The entire data acquisition is done over VSAT from the RTUs to the main control centers on IEC 104 protocol, a unique communication media deployed in the country by an electricity utility. Components of VSAT are antenna, Indoor unit (IDU) and Outdoor Unit (ODU). To avoid communication problem separate SCADA phones (VOIP) are provided at each substation. 8 port switch is provided for separate connection for MIC, IDU, Voice Over Internet Protocol (VOIP), CMU etc.

iii. UPS

2 kVA UPS with 8 No of 100Ah, 12V cells is provided for RTU 560A for back power supply.

B. SCADA operation [3]

Operations carried out 110/11kV substation are

- Real time data acquisition from RTUs.
- Status monitoring and alarming.
- Sequence of event recording.
- Information storage.
- Data retrieval for ABT functions.

Real time data acquisition from RTUs: Load Despatch Center (LDC) requires data with respect to available generation and load to be attended. As such real time data is required from all Generating stations; 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 LDC. Operator at LDC can observe single line diagram of substation shown in figure 5.

Status monitoring and alarming: If operator at LDC 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 Bangalore is operated remotely.

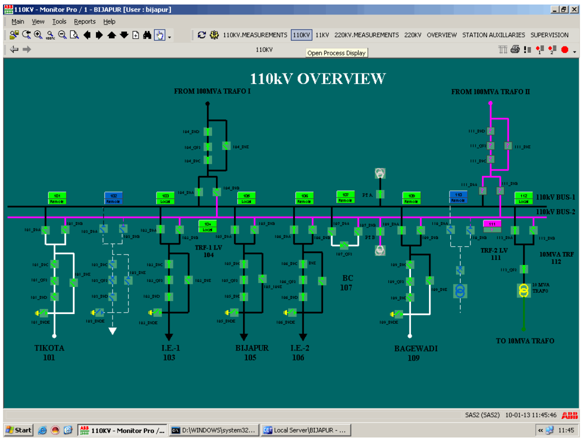

Fig 5: Monitoring screen of 110/11kV substation at control center

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 6.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.
- 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.
- Banks of substation consists of Electronic Trivector Meter (ETV) manufactured by either L&T or SEMs. If a bank consists two or more meter 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 and also same data can be downloaded to laptop at substation.

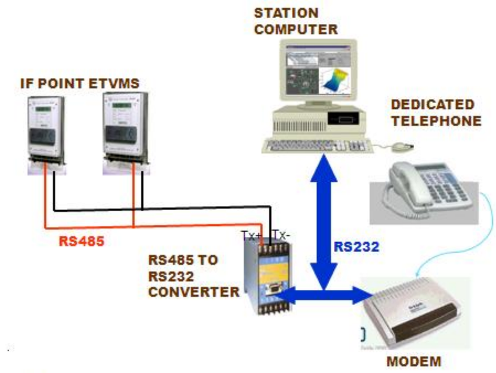

Fig 6: Connection of IF point at substation [3]

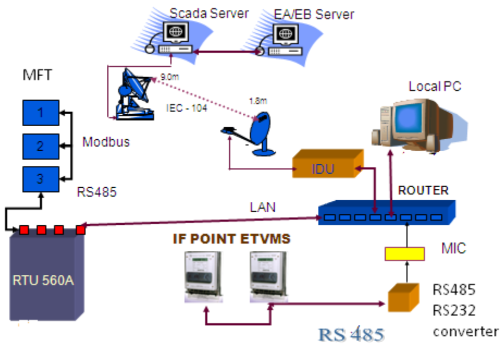

Fig 7: IF meter reading setup for energy billing [3]

Figure 7 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 ping MIC to get data. Phase 1 MIC is using Kalki software and phase 2 MIC is using Cushy link software. L&T meter can store data for 30 days and SEMs meter for 20 days. 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. (L&T -12 and SEMs-13)

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

IV. 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 Load Despatch Center (LDC).

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.

REFERENCES:

Technical report referred

[1] KPTCL training report “Remote Substation Monitoring And Control through SCADA”, 05-09 October 2009.

Paper presented

[2] Martin Chartrand, “Dual Redundant Controller Systems”, Control Microsystems White Paper, October 2004.

[3] Chandrashekar, Mallakkappa S “Integrated Extended SCADA project KPTCL” IES Summary, October 31 2007.

Manuals and website

[4] ABB RTU 560A Manual.

[5] www.kptcl.com and www.abb.com

X. BIOGRAPHY

Ms. Vinuta V Koluragi was born in Bijapur, Karnataka, India. on 13th July 1987. She obtained B.E degree in Electrical & Electronics from B.L.D.E.A’s Bijapur under VTU, Belgaum. She obtained M.Tech degree in Power & Energy System from BEC Bagalkot under VTU, Belgaum.

She is currently working as Assistant Professor at B.L.D.E.A’s V P Dr P. G. Halakatti College of Engg. & Tech., Bijapur. Her areas of interest are Renewable Energy Systems, PLC and SCADA,Control Systems, Power systems.