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ROLE OF ICT IN POWER SYSTEM

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SUMMARY

With advances in ICT, the new millennium has leapfrogged into a revolution in networking and communication technologies to offer automation as a solution to improve distribution efficiencies.
Daily, we BSES Yamuna Power Ltd. try to meet new challenges to improve productivity and reduce operating and maintenance costs while providing customers with a reliable supply and a broad range of services. The company has identified the essentiality of effective use of ICT to achieve rapid success in power distribution.
This paper throws light on smart use of ICT in 66/33/11 KV receiving stations and 11/415V substation automation.

Keywords: SCADA (Supervisory Control and Data Acquisition System), MIDAS (Modular Integrated Distribution Automation System, Relay, Smart Grid, Renewable, DG set

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1. INTRODUCTION

BSES Yamuna Power Ltd. is one of the five power distribution utilities in Capital of India Delhi. It serves 1.2 million customers spread in 200 sq Km of area. The peak demand was around 1400 MW and power is received at 66/33/11KV in 50 receiving substations. It also has more than 2000 Km of conductor and 3250, 11/415 V distribution transformers.
This paper discusses the smart use of ICT in 66/33/11 kV receiving stations and 11/415 V substation automation. One has to appreciate the fact that these are not only being in large numbers but are unmanned and also spread in the area of 200 sq KM's. Further the consumer power availability and reliability is directly related with the functioning of these substation and equipments lies there in. The use of IT in aiding operations, specifically automation, is of paramount importance when it comes to distribution utilities. Thus BSES Yamuna power limited has always been in the forefront in innovating new products and used ICT to the hilt in making these substations automated.

2. SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA)

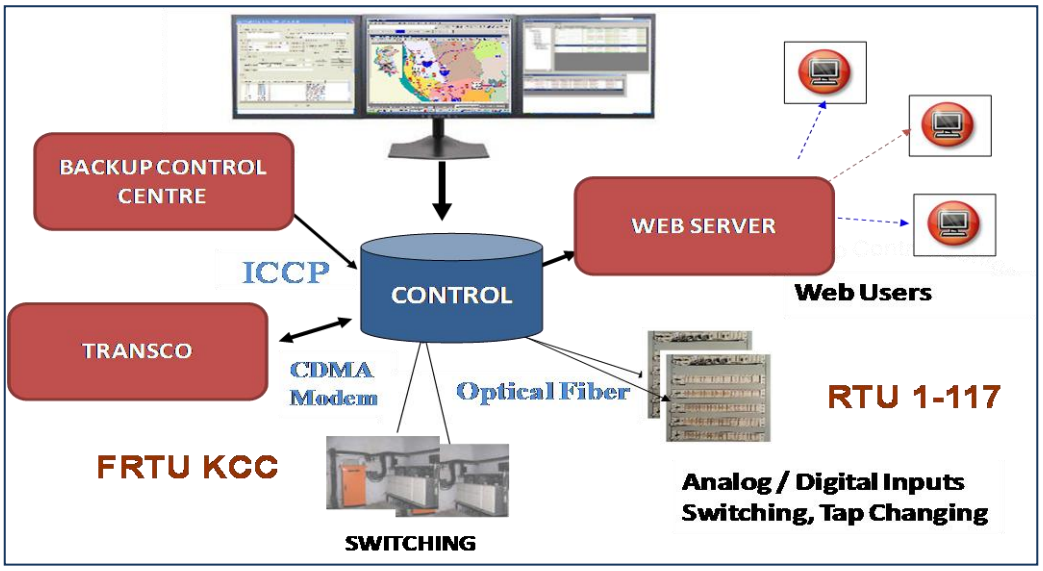
2.1 Overview

The state of art Supervisory Control and Data Acquisition system (SCADA) is commissioned in BSES Yamuna Power Ltd. to remotely monitor and control the various power system equipments in 50 numbers of 66/33/11 kV receiving stations from centralized master control centre (MCC).

SCADA enables visibility of the entire network from a single location. It is scalable for network expansion and integration with other business process. The optic fibre cable ensures that the network is fault tolerant, fast and scalable. All kind of numerical relays and digital remote tap changing controllers are integrated with the system, allowing for the efficient control of voltages. IT allows management and control of various components of a substation from a remote location. Therefore, it reduces the operational costs for the company by decreasing the manpower requirement at substations. It provides real time, enterprise wide information, which enables to secure appropriate information at the required time to enhance grid reliability.

Further, BYPL has done an innovative way of implementing SCADA in two of its receiving substations wherein the input output cards were fitted with numerical relay & communicating with RTU only on communication cable on IEC103 protocol thus avoid multiple copper cables. Similarly from battery charger or remote tap change controller only soft signals were taken on communication cable.

2.2 SCADA SYSTEM ARCHITECTURE



SCADA system is a combination of hardware and software, which is connected to the main control centre (MCC) and backup control centre (BCC). The MCC controls and monitors data from RTUs placed across substations and feeder remote terminal units (FRTUs) at ring main units (RMUs). SCADA servers are placed both at MCC and the BCC.

The grid stations are connected to the MCC and the BCC through 2Mbps optic fibre link. In case of failure in primary link between the MCC and the grid, the secondary link at the BCC is used for SCADA operations. The grid station also has very small aperture terminal (VSAT) backup link, which is used only during network congestion or failure.

SCADA and database servers at the two control centres are synchronised though a wide area network (WAN), with a speed of 10Mbps. The BCC and MCC control and supervise the entire power system, while RTUs report to the control centres. All the servers at the MCC can function in either online or standby mode, while one server at the BCC is kept on standby. In case of a malfunction, the BCC server is put into operation manually, following which the RTUs start reporting to the BCC.

IEDs are a key component of the substation integration and automation system. An IED is a device that incorporates one or more processors with the capability to receive or send data from or to an external source. IEDs contain both operational and non operational information about the substation.
SCADA system usually consist of subsystems which are the human machine interface (HMI), the supervisory system, the remote terminal unit (RTU), Programmable logic controllers (PLCs), and communication infrastructures. HMI is a device which provides process data to the human operator for monitoring and controlling the process. The supervisory (computer) system gathers data about the process and sends commands. RTUs connect to sensors in the process, convert sensor signals to digital data and send digital data to the supervisory system. PLCs are preferred as field devices because they are more economical, versatile and configurable than special purpose RTUs. Finally the communication infrastructure connects the supervisory system to the RTUs.
BSES Yamuna Power Limited has done an innovative way of implementing SCADA in two of its receiving substations wherein the input output cards were fitted with numerical relay & communicating with RTU only on communication cable on IEC103 protocol thus avoid

multiple copper cables as given in fig below. This saved not only on cost but also time in adaption too.

CABLE TRAY

It also result in lesser hardware requirement (no DI/DO/AI card required). SCADA panel is compact in size and require less floor space as no MFM and interconnector panel is required as sown in figure below.

SCADA PANEL

SCADA PANEL

Similarly from battery charger or remote tap change controller only soft signals were taken on communication cable. The RTU was housed in air conditioned avoiding heat and dust. Information from RTU is transferred to Master control centre primarily on optical fibre and as a backup on VSAT or long range radio.

There is a trend of setting up substations as per the IEC 61850 technology standard. It is the new international standard for communication within a substation, and enables the integration of all protection, control, measurement and monitoring functions within a substation, and provides the mean for high speed substation protection applications, interlocking and intertripping.

2.3 Benefits

The benefits of SCADA include the reduction of manpower, precise voltage control, effective monitoring of equipment overloading, better outage management due to centralised information, automatic load shedding schemes and provision of a historical database to aid future network planning and analysis.

3. MODULAR INTEGRATED DISTRIBUTION AUTOMATION SYSTEM (MIDAS)

3.1 Overview

MIDAS is an innovative design for automation of 11KV/415V distribution substation to remotely monitor health of equipments, sectionalize fault and prevent physical theft. It is an integral part of SMART GRID.

In BYPL distribution transformers are placed in approx 2200 substations. The Substations are of Outdoor, Indoor, Plinth mounted, Pole mounted as well as Package type. These transformers were prone to breakdown and physical theft as well as electricity theft. Also the associated switch gear had FPI and signal was local. Thus it was thought to develop a solution which not only helps in predicting a fault but does much more. We believe this is a breakthrough in the application of smart grid. We call it Modular Integrated Distribution Automation System (MIDAS).

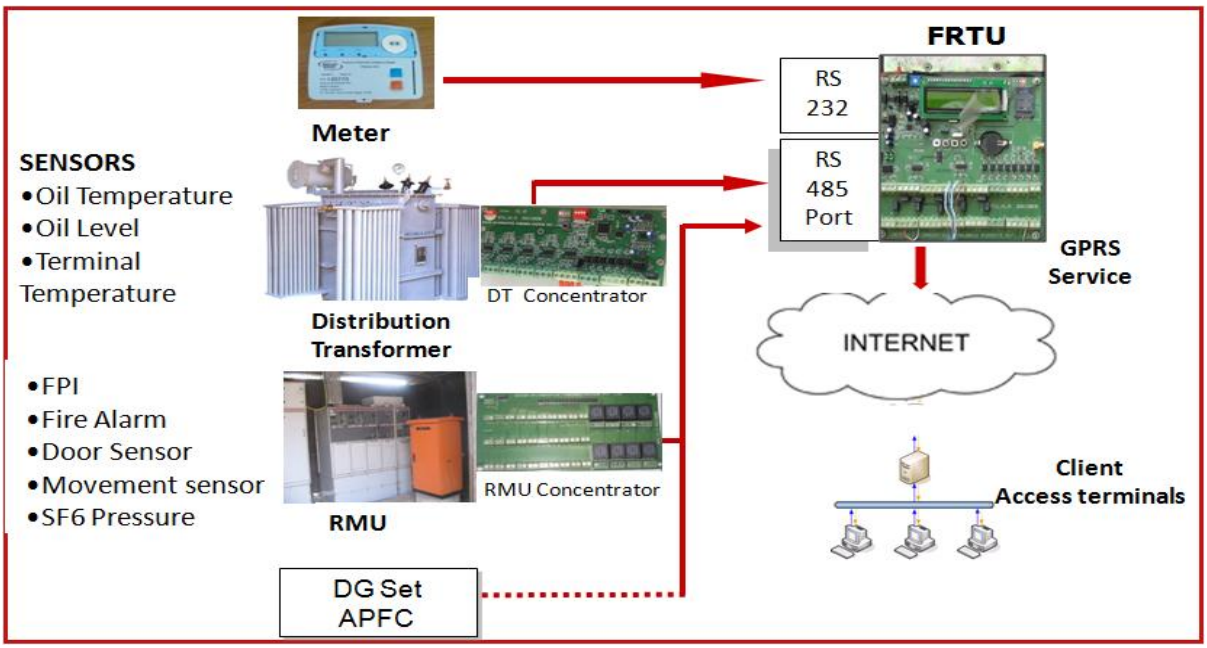
3.1.1 Objective of the MIDAS

- Predict the failure of the equipments
- Inform electronically via SMS and email to the concerned person
- Control Intrusion
- Sectionalize the fault in the underground cables
- Know the status of the switchgear
- Integrate Distribution transformer meter for AMR as well as load profiling
- Disaster management like Fire alarm

3.1.2 Status of substation prior to MIDAS

- Ageing Infrastructure
- High Preventive Maintenance Cost
- Theft
- No mechanism for Condition Monitoring
- DT meter data manually recorded
- Communication failure- DT Meter

3.2 System Description:



BLOCK DIAGRAM

- Various sensor like Door sensor, fire sensor, LT palm temperature sensor, Gas sensor, Oil level sensor, oil temperature sensor are mounted on transformer and switchgear
- These sensors send analog and digital signals through RS 232 and RS 485 to FRTU.
- FRTU has digital input and output to sense the status of NO/NC contacts.
- For getting metered parameter DT meter is integrated with FRTU.
- This information is send via GPRS modem to central server via TCP/IP protocol.
- Central server will send SMS and e-mail to concerned engineer for various alarms generated.
- It can be also integrated with DG set as well as renewable source of energy.
- MIDAS will be integrated with various applications such as SAP R3, GIS and AMR.

3.2.1 Field Remote Terminal Unit (FRTU)

An FRTU was designed, developed and tested along with DT data concentrator and RMU data concentrator as shown in Fig below.

FEATURES

- Power Requirement: Unregulated 220V±10% AC.
- Case:

  IP54/IP55 enclosure protection for Indoor Substation

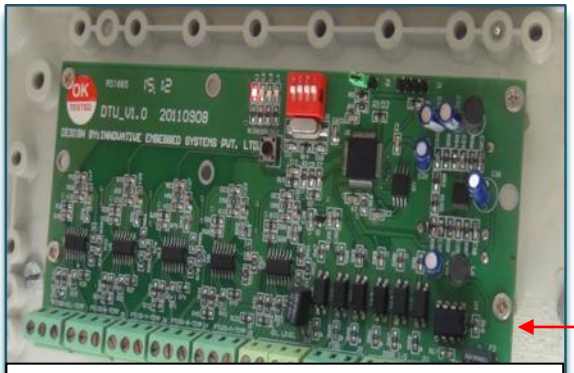
  IP 56 enclosure protection for Out Door Substation.
- FRTU: Embedded hardware with 32-bit microcontroller
- FRTU has internal EPROM
- Communicates with server on GPRS.
- RS-232/485 Interface
- Flash memory of size 4 MB

FRTU

The data was collated at FRTU and transmitted to the central server on GPRS. The application on central server is web based on internet cloud integrated with GIS and ERP. The meter data is read on cyclic mode every 30 minutes and any other event when it crosses the threshold value is transmitted immediately to the server which instantaneously sends an SMS and Email to the concerned person. The application also has many reports for analysis purpose. The provision exists for pulling the data on demand from the central server and also operates any equipment in the substation from remote. There will be only one FRTU for every substation.

3.2.2 Distribution Transformer (DT) Card:

DT Card is used to capture Oil Temperature, Oil level, LT palm Temperature Data. it has 5 Analog Input and 4 Digital Input.

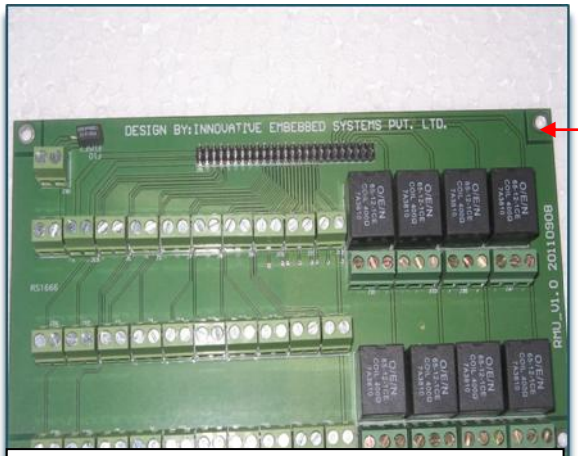


DT CARD

DT CARD at SITE

3.2.3 Ring Main Unit (RMU) Card:

RMU card is used to captures SF6 gas pressure, FPI, CBCT, isolator, breaker, Door Sensor, Fire Sensor status. It has 4 Analog Input, 24 Digital Input and 8 Digital Output.



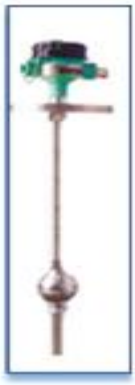
RMU CARD

RMU CARD at SITE

3.2.4 Sensors

It is a device that measures a physical quantity and converts it into a signal which can be read by an instrument.

a) **Top mounted oil level sensor**: This sensor is used to measure level of oil in the Transformer as shown in fig. In case the level of oil Decrease below the limit it will sense and generate the alarm indicating requirement for the maintenance.

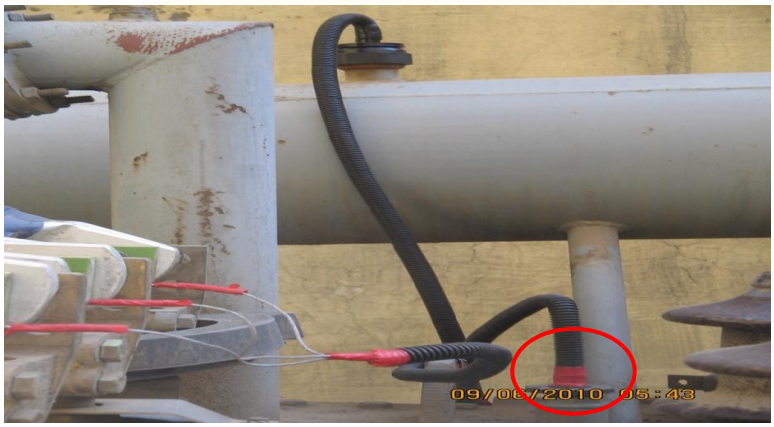


OIL LEVEL SENSOR

OIL LEVEL SENSOR at SITE

b) **Top mounted oil temperature sensor**: This sensor is used to sense the temperature of oil. It offer excellent accuracy over wide range of transformer from (-200°C to 850°C).

OIL TEMPERATURE



OIL TEMPERATURE SENSOR at SITE

c) Door sensor: Normally Open Contact Switch (N/O) For Closed Loop System (N/C)

DOOR SENSOR

DOOR SENSOR at SITE

d) **Fire and smoke sensor**: It is a plug in fire detector combining optical smoke Detection, heat detection and microprocessor control with Analog Addressable Communications.

FIRE SENSOR

e) **LT palm temperature sensor**: It is used to measure the interface temperature at output 3-Ph RYB feeders from the transformer. Sensor is sandwiched between the cable and the transformer terminal. It is thermocouple based and measure temperature up to 200°C with an accuracy of 0.5°C.

LT PALM TEMPERATURE

LT PALM TEMPERATURE SENSOR at SITE

f) **Gas Sensor**: This sensor is used to sense pressure in circuit breaker.

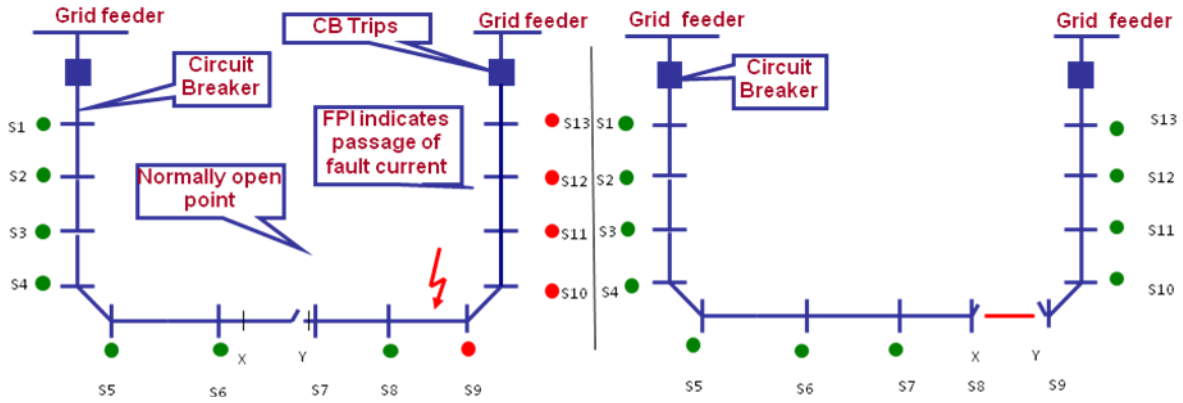
g**) Isolator and Circuit Breaker Status Sensor**: This sensor is used to sense open or close position of isolator and circuit breaker.

3.2.5 Fault Passage Indicator

When a fault occurs between section x & y (as shown in fig) it is detected with the help of core balance CT installed at substation S13, S12, S11, S10 and S9 which operates alarm contacts for remote indication and illuminates an integral LED at substation S13, S12, S11, S10 and S9 while indicator at Substation S8 will not glow red thus indicating faulty section of the network.

FPI indicator will help in pin pointing faulty section between two substations thus eliminating the need to check every section between two substation starting from grid.

FPI status will also be shown in software application of MIDAS.



3.3 SYSTEM FUNCTION:

3.3.1 Predictive Maintenance

The equipments were retro fitted with various sensing devices. Sensing temperature of transformer oil and terminal, level of transformer oil helps in finding out real-time condition of transformer and making out which substation requires maintenance.SF6 Gas level and switch position contact existed. For others Door position, Movement sensor and Fire alarm. DT Meter existed with serial RS 485 port

3.3.2 Metered Data

Metered Data comprising of line current, voltage and power factor will be sent in cyclic mode to central server in time interval of 30 minutes. Metered data will be analyzed as per validation rules in case of abnormality SMS and e-mail on lotus note will be sent to DT maintenance engineer to check the DT meter within 48 hours. It helps in improving time involved in DT metering.

It can store three months live data and rest will be archived in the data disc.

METER

METER AT SITE

3.3.3 Disaster management

MIDAS will be a helpful tool for disaster management (In case of fire).

3.3.4 Transformer Loading

Transformers having high terminal temperature are checked for overloading and loose connections prior to any mis happening thus will address safety issues.