Unmanned Substation—A Case Study

L. N. Mishra and Bharatkumar Soni

Abstract Just a few years ago it was extremely difficult to monitor and control the distributed substations. The reason for this was that the remote systems were either unable to communicate with a control center or communication involved a great deal of efforts and expense. The technological advancement in communication system and Information technology, the application of Remote Operation of all Substations can be adopted which in turn optimized the requirement of skilled manpower, virtual management of Substations and assets can be managed with better efficiency. Remote control technology describes the remote monitoring and control of physically separate system parts by means of data transmission. Measured values and control commands are transmitted over long distances and visualized, processed and stored in control center.

Keywords Remote control and monitoring · Substations · Data analytics

1 Introduction

Adani Transmission Limited (ATL) has established itself in Transmission Sector as India's largest Private Transmission Company in short span of time. ATL is operating various EHV Substations along with associated Transmission Lines with varied spectrum voltages in various region of India with best in class availability figures. ATL also owns and operates a 990 km long, ±500 kV HVDC Transmission system.

L. N. Mishra (✉) · B. Soni
Adani Transmission Limited, Ahmedabad, India
e-mail: ln.mishra@adani.com

B. Soni
e-mail: bharat.soni@adani.com

R. K. Pillai et al. (eds.), *ISUW 2019*, Lecture Notes in Electrical Engineering 764,
https://doi.org/10.1007/978-981-16-1299-2_10

2 Project Overview

Presently ATL is implementing 16 nos. Substations and 340 km of associated Transmission Lines in the state of Rajasthan. These 16 nos. Substations are as listed below:

1. 220/132/33 kV Ranpur SS
2. 132/33 kV Peeplu SS
3. 132/33 kV Chitri SS
4. 132/33 kV Bambora SS
5. 132/33 kV Khatoti SS
6. 132/33 kV Riyabari SS
7. 132/33 kV Baytu SS
8. 132/33 kV Ram Ji Gol SS
9. 132/33 kV Bar SS
10. 132/33 kV Ghumati SS
11. 132/33 kV Ahore SS
12. 132/33 kV Rajmatai SS
13. 132/33 kV Bengatikalan SS
14. 132/33 kV Shekhsar SS
15. 132/33 kV Ghamurwali SS
16. 132/33 kV Sorda SS.

SUBSTATION LOCATION:

The Substations and associated transmission lines are scattered and covers almost 85% of area geographically in Rajasthan. The average distance between two Substations is about 100 km. In the present configuration, it would require a large fleet of O&M staff and logistic supports to operate and maintain these substations, leading to high response time and operating cost. To overcome this challenge, a case was worked out to leverage the state of the art technology with respect to Remote Operation with minimal/no manpower.

3 Way Forward for Remote Operation

The transmission sector is currently facing multiple challenges like competitive bidding for transmission projects resulting in cost crunch and lean time schedules, scarcity of experienced manpower and stringent availability demands by regulators etc. In view of the latest developments in communication system and information technology, it is possible to create a remote control center for scattered Substations with an objective of better efficiency and optimization in skilled manpower. ATL decided to move towards the central operation of all 16 nos. Substations from Remote Control center at its existing Substation of Alwar and Deedwana in Rajasthan. Additionally, having information of entire assets at common location will help in better coordination and data analytics. Since complete set up of Operation is available at existing 400/220 kV Alwar and 400/220/132 kV Deedwana SS, ATL decided to build up the Alwar and Deedwana SS as Master Control Center. Further back up of Alwar Master Control Center can be built up at Deedwana SS and vice versa so that in case of any emergency, Operation of Substations can be managed through back up control Center.

4 Solution Overview

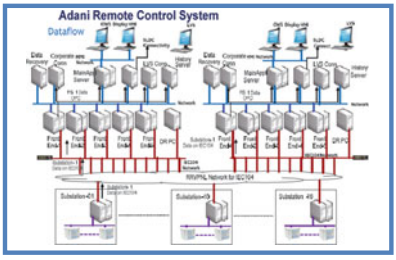
Entire Transmission lines under the projects are laid with OPGW for fiber optic telecommunication system, however all substations are not interconnected with each other; hence fiber network is not available among Substations under the projects. Since RRVPNL has planned the laying of OPGW in entire Transmission network of Rajasthan, ATL has tied up with RRVPNL for utilization of their network for connectivity of all Substations including Alwar and Deedwana also.

For remote SCADA system at each Master Control Center, ABB make 800xA and Micro SCADA system had been considered since all individual Substations have ABB make Micro SCADA system. This would result in better interfaces and compatibility. The remote SCADA system at each Control Center includes the following main functional equipment.

- Front end servers: Front end servers communicate with substation gateways for data collection on IEC104 protocol. It has been so organized that each server shall handle data from 5 substations keeping in mind reliability and scalability.
- Main Application Servers: Main servers will process the analog and digital data from front end servers for monitoring and controlling from the Operator Workplace.
- Historian Server: History servers shall store system generated real time data for long period which will be essential for data analysis.
- Data Recovery Server: The Data Recovery Server stores the image backup of the systems in local HDD. In case of breakdown of the servers/workstation image back up data can be used for recovery.

- SLDC Gateway Server: SLDC Gateway Server communicates with SLDC for sending the 16 Substations data on IEC 104 protocol on a single link.
- Corporate Connection Server: Corporate server host the smart client for the corporate network.
- LVS Workstation: LVS workstation is used to display the graphics on Large Video Screen.
- Operator workstation with dual Monitor: The Operator workstation is intended for operators from where the monitoring and controlling of Substation are done.
- Engineering Workstation: The Engineering workstation is intended for engineering of Database, display modification etc.
- DR Workstation: For DR evaluation which collects and stores the DR from Substation.
- Printers: For printing Graphics, reports and alarm events.

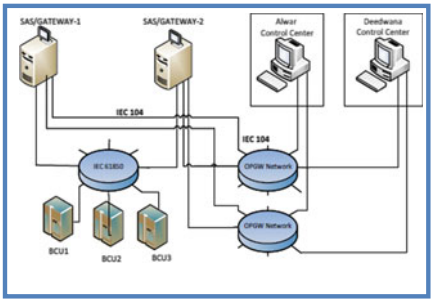
SYSTEM DIAGRAM



There are main two type of network forming the interconnection of various important SCADA devices;

1. Plant Network: This network interconnects all the Operator Workstations, Servers, printers through plant network switches of Remote SCADA System.
2. Control Network: This network interconnects all the IEC104 Gateways located at 16 Substations. This network shall be connected to IEC104 Front end servers. This network facilitates the transfer of status, commands and measurement data from 16 substations to remote SCADA system.

The SCADA servers and Front end servers with redundant configuration connected on dual LAN network along with Workstations, Engineering Workstations and printers. The Front end servers are communicating with Gateways available in Substations through OPGW network.



TYPICAL OVERALL COMMUNICATION N/W

5 Typical Overall Communication N/W

Remote SCADA system has been configured for redundancies at various levels of integration of the system like Main Servers, Front End servers, communication between Main servers and Front end servers, communication between Front end servers and Firewall and communication between Operator work station and servers.

ABB make 800xA system for Remote SCADA project is used for data acquisition and supervision of 220, 132 and 33 kV switchgear feeders. The system contains all information and means needed for the supervision of the process. It also includes tools for configuring the system and programming the process function.

The application creation involves the following function:

1. Graphic Displays
2. Event List
3. Alarm List
4. Status Monitoring
5. Trends
6. Reports
7. Time Synchronization with GPS
8. User Authorization.

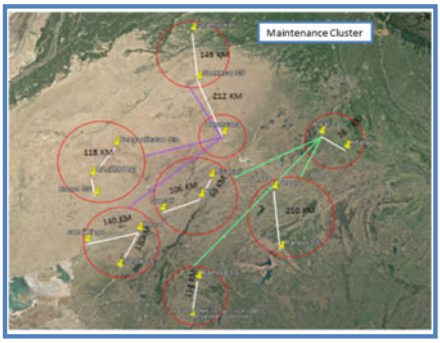
Control Authority: System has been designed in such a way that 8 nos. Substations shall be controlled from Alwar SS and remaining 8 nos. shall be controlled from Deedwana SS, however control of all 16 nos. can be exchanged to either of Master i.e. Alwar or Deedwana con∞trol station if required during contingency.

For equipment like Circuit Breaker, Isolators, a reset control to operate from the Control Center has been provided for. Accordingly, respective devices have to be set in remote mode at local station.

In addition to installation of Remote SCADA system, Security Camera and Operation Camera system is also envisaged at each location for safe and reliable operations.

6 Operation and Maintenance Philosophy

As per Remote Operation planning, two shift engineers and one shift assistant considered at Alwar and Deedwana stations. Each of shift engineers operates four substations at a time. Further, maintenance of these substations is planned in clusters of 2 or 3 substations each, based on the interstation distances. One maintenance team will look after the maintenance of substations in particular cluster.



7 Cost Benefit Analysis

The implementation of Remote Control Center offers the reduction in operational manpower of around 70 personnel and also produce additional benefits like

- Reduction in site visit,
- Ability for engineers to access the entire systems at one location for better analytics,
- Quicker data access,
- increased end to end operations efficiency,
- Faster decision etc.

The total Capex and Opex requirements has been estimated to be around Rs.18 crore which includes cost of Remote SCADA system, IT infrastructure, Cameras, charges for third party OPGW network, Lease line charges for time being (2 year) etc. Considering the net reduction of operational cost, payback period is estimated to be around 3 years.