SCADA Overview

Presented By-
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Technical Services - Automation
Joint Venture of Tata Power Company and Govt. of NCT of Delhi (51: 49)

Licensed for distribution of power in North and North West Delhi

### TATA POWER DELHI DISTRIBUTION LIMITED

<table>
<thead>
<tr>
<th>Parameter</th>
<th>FY ‘16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnover</td>
<td>INR 6890 Cr</td>
</tr>
<tr>
<td>Peak Load</td>
<td>1783 MW</td>
</tr>
<tr>
<td>Annual energy requirement</td>
<td>7762 MUs</td>
</tr>
<tr>
<td>Total registered consumers</td>
<td>15.00 Lacs</td>
</tr>
<tr>
<td>Number of employees</td>
<td>3457</td>
</tr>
<tr>
<td>Area</td>
<td>510 Sq Kms</td>
</tr>
<tr>
<td>Population serviced in Network area (approx)</td>
<td>6 Million</td>
</tr>
<tr>
<td>Number of consumers per Sq.Km</td>
<td>2618</td>
</tr>
</tbody>
</table>

Certifications: ISO 9001, 14001, 27001; SA 8000; OHSAS 18001
WHAT IS AUTOMATION
What is Automation?

- The dictionary defines *automation* as “The technique of making an apparatus, a process, or a system operate automatically.”
- Automation federation define automation as “The creation and application of technology to monitor and control the production and delivery of products and services.”
- Automation means use of Available technologies to reduce the need of Human work.
- Automation is a step beyond mechanization.
  
  Mechanization provides human operators machinery to assist themselves with the muscular requirements of work......
  
  While
  
  Automation greatly decreases the need for human sensory and mental requirements as well.
• Safety - The plant or process must be safe to operate. The more complex or dangerous the plant or process, the greater is the need for automatic controls and safeguard protocol.

• Stability - The plant or processes should work steadily, predictably and repeatable, without fluctuations or unplanned shutdowns.

• Accuracy - This is a primary requirement in factories and buildings to prevent spoilage, increase quality and production rates, and maintain comfort. These are the fundamentals of economic efficiency.
  • Other desirable benefits such as economy, speed, and reliability are also important, but it is against the three major parameters of safety, stability and accuracy that each control application will be measured.
Different types of automation tools exist:

- **ANN** - Artificial neural network
- **DCS** - Distributed Control System
- **HMI** - Human Machine Interface
- **PLC** – Programmable Logic Controller
- **SCADA** - Supervisory Control and Data Acquisition
WHAT IS SCADA ???
Supervisory control & Data Acquisition

**SCADA**

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 focuses on gathering and circulating the right amount of system information to the right person or computer within the right amount of time.
Telemetry:

- It is a technique used in transmitting and receiving information or data over a medium.
- The information can be measurements, such as voltage, current, breaker status, transformer tap position etc.
- These data are transmitted from one location to another location through a medium such as cable, telephone line or radio wave.
- Information may come from multiple locations. A way of addressing these different sites is incorporated in the system.
Distribution Network…Monitoring & Control

Network Hierarchy

- 66 or 33KV
- 11KV
- 0.4KV

Network terminology

- Sub-Transmission
- 11KV DISTRIBUTION
- 0.4 KV

Technology

- SCADA
- OMS
- DMS/DA
- Geographic Information System

Communication Network
The Technology Journey so far ...

2002-04
- All grid substation Panels and relays old and non communicable.
- All grid substations manned. No data at Load dispatch center.

2005-07
- Sub Station Automation
- Fiber communication infrastructure
- Geographical Information System

2007-09
- SCADA System & BCC for Disaster Mitigation Plan
- Integration of GIS – DMS
- Integration of SAP ERP for Work management

2009-11
- DMS System & Distribution Automation
- SAP ISU Integration

2011-12
- OMS
- ISO 27001- Security citification
- Basic DMS Application, SPM JGC

2013-17
- Advance DMS application
- Integration with AMI, ADR
- Demand
- Response
- Field force Automation
Transition to Substation Automation - Approach

- Fully Scalable System
- DC system monitoring
- Metering data for Energy Audit
- C remote operation & monitoring

Seventy Four Grid Substations 66/11 KV, 33/11 KV, TPDDL Peak Demand 1783 MW
<table>
<thead>
<tr>
<th>Grid Station system</th>
<th>Two options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conventional Approach:</strong></td>
<td><strong>IED approach:</strong></td>
</tr>
<tr>
<td>• Additional transducers requirement</td>
<td>• Operation data for SCADA Centre for network monitoring and control</td>
</tr>
<tr>
<td>• Not substantial data for detail analysis</td>
<td>• Equipment condition monitoring data for maintenance planning</td>
</tr>
<tr>
<td>• Complicated wiring problems due to additional requirement of spare contacts</td>
<td>• Remote relay maintenance and FDR downloading for Protection</td>
</tr>
<tr>
<td></td>
<td>• Having capability of metering, control and protection</td>
</tr>
<tr>
<td></td>
<td>• Scalability</td>
</tr>
</tbody>
</table>

IED approach has been gear up in next level with building logical intelligence at GSAS by TPDDL.
Data Concentrator Instead Of Hardwired Conventional RTU

- Reduction of control wiring by 30%
- Data availability ten time more conventional RTU concept.
- Maintenance control Centre developed for protection dept for data downloading and relay parameterisation
- Transformer monitoring devices for paralleling of transformer and operation of OLTC, conventional RTCC panels removed.
Communication Protocol:

• **Definition:**

Communication protocol is a set of rules that govern data communication. It represents an agreement between the communicating devices. Without a protocol two devices can only be connected but not communicated, just as a person speaking French cannot be understood by a person who speaks only Japanese. So here Harry and Gary can communicate if they agree on the language English.
GSAS at TPDDL - Key Features

Multi Vendor System
- Data Concentrators from GE, ABB, Areva and Siemens
- Relays from ABB, Schneider, Areva and Easun

Multi Protocol System
- Modbus
- DNP 3.0
- LON
- SPA
- IEC 103
- IEC 104
- IEC 61850

23 Types of IEDs have been used which are integrated with SCADA system
General SCADA Architecture

Each line indicates one hardwire for one signal from Bay/Feeder to RTU panel.
Remote Terminal Unit

- Unmanned Substation Automation System
- Supervisory and Control for Large and Medium Scale Substations
- Fitted for Substation Integration Automation
To be harmonized with CIM
IEC 61970*

Vendor-independent device integration via IEC 61850 process bus

Digital instrument transformer
data via IEC61850-9-2

CT
VT

Merging unit

Circuit breaker controller

IEC61850 station bus

IEC61850 process bus

*in standardization work

CT
VT

Merging unit

Circuit breaker controller

Protective & Control

Firewall
Router

Communication to other substations*

IEC 61850
IEC 61850 (Ethernet)

IED
IED

Control center

IEC 61850
IEC 61850

IED
IED

CT
VT

Merging unit

Circuit breaker controller

*in standardization work

IEC 61850 (Ethernet)

Protective & Control

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For more information, please refer to:

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*in standardization work

For more information, please refer to:

IEC 61850
IEC 61850 (Ethernet)
SCADA as Foundation Technology……

Objective:
Unmanned monitoring and operations of all grid stations of TPDDL

Benefits:
- Chances of manual error has been minimized
- Data is available for analysis
- Restoration of supply takes less time.
- Better monitoring of load shedding feeders
- Application of Tagging
- Energy Audit available for Analysis of losses
- Operation Monitoring reports
- Limit Violation alarms for DC system
SCADA Applications at TPDDL

- Load Shedding
- Availability Based Tariff (ABT)
- Short Term Load Forecasting (STLF)
Load Shedding

Objective:
To avoid system overloading

Key Features:
- Manual Load Shedding
- Under frequency
- Transformer Overload
- Tie Line Overload

Benefits:
- Maintenance of Grid Stability
- Revenue optimization in theft prone areas
- Optimized system overloading
- Reduction in MU losses
Objective:
To optimize power purchase cost

Key Features:
- FTP scheduled drawl from NDPL machine
- Importing Scheduled drawl data into ABT application
- DUI – Daily Unscheduled Interchange Report
- WUI – Weekly Unscheduled Interchange Report
- MUI – Monthly Unscheduled Interchange Report
- YUI – Yearly Unscheduled Interchange Report

Benefits:
- Reduction in Power Purchase Costs
- Improving upon margins
- Optimum utilization of sanctioned power
Short Term Load Forecasting (STLF)

Objective:
To optimize load prediction for power procurement

Key Features:
- Short Term Load Forecast
- Very Short Term (Tracking) Load Forecast
- Manual Load Forecast
- Forecasts involve weather data as well

Benefits:
- Reduction in Power Purchase Costs
- Allows working within narrow margins
- Optimization of demand schedule
- Inputs for network planning
TPDDL SCADA CONTROL CENTER
Adaptation of Technology - Many firsts

Monitoring of total load through SCADA
Overview of TATA Power-DDL
Real-Time Load Monitoring

TATA POWER-DDL

TPDDL DEMAND WITH GENERATION: 783.04 MW
TPDDL DEMAND WITHOUT GENERATION: 738.77 MW
TPDDL SANCTIONED SCHEDULE: 1078 MW
TPDDL OD(+)/UD(-): -339 MW
RITHALA GEN.: 44.27 MW
GT-1: 12.98 MW, GT-2 + STG: 31.29 MW
GT-1 ISLAND: 12.82 MW, GT-2 ISLAND: 5.26 MW
Keshavpuram Solar Plant Generation: 292.00 MW
Real-Time Load Monitoring
Real-Time Load Monitoring
Distribution Management System

Objective:
- centralized monitoring and control for entire 11KV network to aid faster decision making and actions

Key features:
- Increase reliability of power through Central monitoring
- Reduction in the amount of Un served Energy
- Quick Isolation of Fault and restoration of supply
- Minimization of technical loss
- Improvement in Reactive power management
Benefits of SCADA/DMS

- Quick decision making on interruption as entire information is available at one location
- Reduction in Technical losses
- Precise voltage control/ Capacitor switching/Tap changing
- Monitoring of equipment overloading
- Automatic Load shedding schemes based on real time data
- Historical database for network planning and analysis
- Better assistance to field staff in localizing faulty section by using FPIs at DMS stations
- Reduction in time for fault identification and restoration
- Improvement on reliability & customer satisfaction.
- Increased safety standards
Revenue realization

Objective:
Commercial loss reduction through optimize Monitoring

Key feature
- Accurate Energy Audit data availability for L1, L2 and L3 Level.
- Prioritization of Load profile based on customer profile.
- Load shedding at 11KV Level to serve essential services.
Objective:
To maintain operational effectiveness

Key Features:
- Optimize loading through load balancing scheme.
- Voltage Regulation/ Capacitor switching/Tap changing
- Monitoring & controlling of Active & reactive power served
Distribution Applications

- Switching Procedure Management (SPM) : Generating Switching Records for Planned/unplanned Work

- Fault Isolation and Service Restoration (FISR) : Generating SPM for crew to execute accordingly for faulty section isolation & service restoration. Restoration of services is done based on losses minimization, customers affected, loading/voltage violation index

- Distribution power flow (DPF) : on line Estimated load flow & technical loss

- Volt/Var Control (VVC): voltage estimation on each node

Additional Applications:
Jumpers, Grounds and Temporary Connections (JGC)
Optimal feeder reconfiguration (OFR)
Fiber Ring in TPDDL:
Communication Topology:

- Six Rings covering all Grid Substations
- Core ring -2Gbps, Sub ring -566 Mbps
- Serve both Operational (SCADA) and Enterprise (SAP, Billing, GIS, Internet etc.) Networks
- Consists of
  - TTSL Laid Fiber: 70 kms
  - Buried Patch: 21 kms
  - OPGW: 80 kms
- Advantage of using TTSL Network
  - Available in the densely populated area
  - Covers 40% of total requirement
  - Covers 14 out of 42 grids
Remote control, data acquisition. Alarms, events, tags, trends
Accurate network model. Traditional power flow
Trouble calls, incident management,

Conventional Operation Technology deployed in TPDDL

SCADA
A remote control, data acquisition. Alarms, events, tags, trends

DMS
Accurate network model. Traditional power flow

OMS
Trouble calls, incident management,

Communication Infrastructure

SIEMENS..........Sinaut Spectrum
ICCP
GE... Power on restore
Challenges ... to strive Ahead

- Multiple network model creation in various systems i.e. GIS, SCADA-DMS and Network planning.
- Network updating through notification process thus involvement of human error or Mismatch prone.
- Non-functional of DMS application due to various inputs at multiple locations in Source Data Model.
- Multiple database, user interface lead to confusion to operators and affected operational efficiency.
- Insufficient information captured for report analysis & corrective measures due to multiple systems.
- Non-availability of standards for interfaces with different products.
- Preparation of real-time report as per user customization.
- Limitations on Load Shedding and ABT Modules based on recent regulation changes
Advance Distribution Management System- Block Diagram

IT Environment

- MDM/AMI
- SAP
- SAP- R3
- SAP- ISU
- SAP- BO/BW

OT Environment

- SCADA
- DMS
- OMS
- Web Service
- Reports
- GIS-CIM Adaptor
- ADMS -Power On Advantage
- ICCP
- CIM
- IEC 104
- ODBC
- Wsd

External Control Center

- SMS Gateway
- Mobility

- RTU
- FRTU
- RTCFI
- Power Portfolio Management

Geographical Information System (GIS) - GE's Electric Office
GIS- ADMS Integration approach

**EO**
- CIM Adaptor 435SP1 + CIM Metadata
- Test DS with ADMS changes applied

**ADMS**
- POA v6.2.2

CIM XML/GML
Status: Accept/Reject

Diagram:
- Electric Office
- Export circuit
- Circuit1 CIM XML, GML
- PowerOn Advantage
Patch Update from GIS to ADMS
Advance Distribution Management System

- One network model providing a single view of all work across distribution network operations in real-time
- Integrated and optimized operational workflows, streamlined across GIS, ADMS, AMI and mobile
- Giving visibility down to the consumer while reducing operational costs through IT/OT convergence

CIM standard based integration of GIS and ADMS helps…
11kV RMU Network of ADMS
Integrated Outage Management System…..
Initiatives: Outage Management System

TPDDL is the only utility in India to implement the INTEGRATED OUTAGE MANAGEMENT SYSTEM (OMS)

- Geo referenced network details along with trouble order to the field crew
- Prediction of the outage device thus curtaining diagnostic time
- Management of crews assisting in restoration
- Updation of CRM with status of on going and planned outages for intimation to customers
- Actionable intelligent reports.
Managing electricity outage complaints.
Delays that occur at each stage.

- Load shedding or breakdown?
- Extent of failure.
- Time of restoration.
- Consumer awareness.
- Information for restoring from adjacent network.
- Loading data.
- No information on cause of outage.
- No information on extent of outage.
- Difficulty in locating premises.
- Difficulty in locating fault.
- Correctly conveying address/location.
- Difficulty in locating premises.
- Difficulty in locating fault.
Defining Outage Management Systems

1. An Outage Management System (OMS) is a computer system used by operators of electric distribution systems to assist in restoration of power.

2. An Outage Management System facilitates efficient management of outages by utilizing user configurable logics supported by an geo referenced integrated environment of all systems and processes responsible for handling power supply in the utility.
Integrated Outage Management System

BCM of SAP

CRM of SAP

SCADA/DMS

WMS of SAP

Outage Management System

AMI / AMR

GIS

Integrated Outage Management System

BCM of SAP

CRM of SAP

SCADA/DMS

WMS of SAP

GIS

AMI / AMR
OMS..SYSTEM CONCEPT

Customer calls with service request

Call center generates call tickets in SAP-ISU

Outage Management System

PROPOSED IN FUTURE

MWM FSR Module

Call center generates call tickets in SAP-ISU

Enroute

Graphic

Worked
Traditional (Pre OMS) Complaint Handling.
OMS Environment Complaint Handling.

1. Prediction
2. Grouping
3. Prioritisation
4. ETR
5. Escalation
Post OMS – Prediction & Grouping of Multiple Customer Complaints.
Post OMS – Prediction of Estimated Time to Restore (ETR) Supply.
Challenges in Cyber Security…… For OT system

- Fast and constantly evolving nature of security risks
- Ever evolving standards, technologies, services, applications
- **OT Systems developed / normally on an older version**
- **Long shelf life of OT Systems – Avg 15 years**
- Increasing complexity of systems
  - Mobile & Wireless Everywhere
  - Heterogeneous Systems
  - Distributed & Complex Software
  - Multiple Interfaces &
  - Multiple stakeholders
- Lack of awareness about cyber security among operational team
Introducing Cyber Security Control Room  24 X 7

EMS and NMS will facilitate automated monitoring of
- Network availability, bandwidth utilization, network latency, traffic broadcasting etc.
- Systems
- Databases
- Applications performance
- Operations management

- EMS, NMS and SIEM generates huge logs.
- **Cyber Security Control Room required for real time monitoring and analysis** to decide and quickly take preventive and corrective actions in case of any event / incident and activating Emergency Response Team, if required
Technology implementation is a Journey, not a Destination

Thank You