Blackout 101

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An Electric Power System Tutorial - Part 2

Monitoring and Control of Power Systems

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Sponsored by IEEE PES and IEEE-USA

Friday, February 6, 2004
Overview

- What is a SCADA System?
- How are SCADA Systems Used?
- What is a Substation Integration and Automation System?
- What are the Different Sources of Information?
- SCADA Alarm Processing / Filtering Capabilities
- System Factory and Site Testing
- Power System Action Time Frames
What is a SCADA System?

- Supervisory Control and Data Acquisition (SCADA)
  - Supervisory Control => Remote Control of Field Devices
  - Data Acquisition => Monitoring of Field Conditions
- SCADA System Components
  - Master Station => System “Nerve Center” Located in Electric Utility Energy Control Center (ECC); Dispatchers Use to Monitor and Control Power System
  - Field Devices => Needed Wherever There is Data to be Sent to Master Station (Substations, Lines or Feeders)
  - Communications => Links Master Station with Field Devices; Continuous 24 by 7 Operation
Electric Utility Energy Control Center (ECC)
SCADA System
Master Station – Computer Servers and Communication Equipment
SCADA System Master Station – Dispatcher Console Equipment
One-Line (Single-Line) Diagram
# Alarm Summary Display

## Alarm Summary

<table>
<thead>
<tr>
<th>No.</th>
<th>Date/Time</th>
<th>Origin</th>
<th>Description</th>
<th>Event</th>
<th>Value</th>
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</tr>
</tbody>
</table>
World Coordinate Display Schematic Diagram
Electric Utility Substation
Remote Terminal Unit (RTU)
How are SCADA Systems Used?

Supervisory Control and Data Acquisition

SCADA

SCADA/Automatic Generation Control

Energy Management System

Distribution Automation System

DA

Distribution Management System

DMS

EMS
SCADA System
Primary Functions

- Data Acquisition
- Remote Control
- User Interface
- Areas of Responsibility
- Historical Data Analysis
- Report Writer
SCADA / AGC System
Primary Functions

- Automatic Generation Control (AGC)
- Economic Dispatch (ED) / Hydro Allocator
- Interchange Transaction Scheduling
Energy Management System (EMS) Primary Functions

- Network Configuration / Topology Processor
- State Estimation
- Contingency Analysis
- Three Phase Balanced Operator Power Flow
- Optimal Power Flow
- Dispatcher Training Simulator
Distribution Automation (DA) System Primary Functions

- Voltage Reduction
- Load Management
- Power Factor Control
- Two-Way Distribution Communications
- Short-Term Load Forecasting
- Fault Identification / Fault Isolation / Service Restoration
- Interface to Intelligent Electronic Devices (IEDs)
Distribution Management System (DMS) Primary Functions

- Three Phase Unbalanced Operator Power Flow
- Map Series Graphics
- Interface to Automated Mapping / Facilities Management (AM/FM) or Geographic Information System (GIS)
- Interface To Customer Information System (CIS)
- Interface to Outage Management
Intelligent Electronic Device (IED) – the Building Block of Substation Integration and Automation

- Any device incorporating one or more processors with the capability to receive or send data/control from or to an external source (e.g., electronic multifunction meters, digital relays, controllers)
What is a Substation Integration and Automation System?

- Utility Enterprise
- Substation Automation Applications
- IED Integration
- IED Implementation
- Power System Equipment (Transformers, Breakers)
Substation Integration and Automation Systems
What are the Different Sources of Information?

Web Pages with:
- Real-time values
- Relay settings
- Fault records
- Fault records, summaries and waveform data from relays (and settings)

Real-time SCADA data and controls (any IED’s data)
SCADA Alarm Processing / Filtering Capabilities

- Knowledge-Based Alarm Suppression
  - Direct Linkages (can use pseudo status points)
  - Indirect Linkages
- Area of Responsibility
  - Use for each alarm window and each printer
  - Use to route alarms to proper windows/dispatchers and/or printers
Priority

- Each point has a priority level
- Every alarm window has an assignable alarm priority level
- By increasing the alarm priority level of an alarm window, lower priority alarms are suppressed from the alarm window
SCADA Alarm Processing / Filtering Capabilities (continued)

- Timed Alarm Suppression
  - Each data point may be assigned a transient filter
  - Used to suppress an alarm until it has remained in the alarm state for the length of time specified with the transient filter
SCADA Alarm Processing / Filtering Capabilities (continued)

- Momentary Alarm Change Detect
  - Tracks rapid multiple state changes that are recorded by the RTU
  - Operations counter to track device operations for maintenance reporting
SCADA Alarm Processing / Filtering Capabilities (continued)

- Alarm Acknowledge / Delete
  - Separate acknowledge and delete actions
  - Alarm automatically deleted upon acknowledgment if alarm has returned to normal
  - On acknowledgment alarm will be deleted from alarm list
  - Alarm is deleted after a specified time delay following acknowledgment of alarm
SCADA Alarm Processing / Filtering Capabilities (continued)

- Historical Events File
  - All events, including alarms, stored in a daily file
  - Can be sorted and used to create reports
System Site Testing
Power System Action Time Frames

- **Transient Stability**
  - Generator/excitation dynamics
  - Mech.
  - Switched cap’s
  - SVC, DC
  - SVC, DC
  - Relaying, incl. under-frequency load shedding

- **Long-term Stability**
  - LTCs & dist. voltage reg.
  - Excitation limiting
  - Under-voltage load shedding
  - Line/transformer overload
  - System operator

Time - Seconds

0.1 1 10 100 1000 10000
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