Big Data in Smart Grid

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Sources of Big Data in Smart Grid

Creating New Opportunities to Improve Business Performance

Data Sources:
- DMS
- EMS
- Work Mgmt
- Asset Mgmt
- Meter/Device
- CIS/CRM
- ERP
- ETRM
- Weather
- GIS/Spatial
- Other

Expected Data Volume Growth of a Tier 1 IOU

- New Devices in the Home enabled by smart metering
- PCT’s Come On-line
- AMI Deployment
- RTU Upgrade
- OMS Upgrade
- Distribution Management Rollout
- GIS Upgrade
- Substation Automation System
- Mobile Workforce Project
- Advanced Distribution Automation

Source: Electric Power Research Institute

RTU: remote terminal unit
PCT - Programmable Communicating Thermostat
All data from multi-sources describe a whole picture for the smart grid, need smart grid unified data model.
Smart Grid Unified Data Model

Volume of Data

Operational Systems

Business Systems

Movement

Seconds
Minutes
Hours
Days
Months
Years

Real-Time Network Management
EMS
GMS
DMS
SCADA

Non-Real-Time Information Systems
ERP
AMS
BMS
CIS

Relational Analysis in the control room

Decision Support in the offices

Data with various resolutions maintained for on-line access for several years
Challenges of Smart Grid Big Data

• Availability of Data is Increasing
  – Example: From 1 Meter Read/mo to Hourly (720/mo)
    • =71,900% increase
• Data Sources Not Fully Utilized
• Data from Disparate Sources Not Integrated
• Combining Data into Information & Beneficial Applications?
• What Information is Actionable? (vs. just interesting)
• How to organize these data?

Management of the Grid = Management of Data
Outline

- Sources and Feature of Big Data in Smart Grid
- Use Scenarios of Big Data in Smart Grid
Impacts of Big Data on Smart Grid

Connected Customers, Connected Networks, Connected Assets

New Sensors / Distributed Computing on Transmission and Distribution Lines
alert operators, fix problems, integrate large-scale renewables generation

Smart Meters and Home Networks
help customers use energy wisely, mitigate peak demand, integrate local renewables
Use Scenarios of Smart Grid Big Data

ADN Situational Awareness
Active Control
Active Management
Active Planning

Active Service
Active Participation
Active Adaption
Use Case of Big Data in Smart Grid

• Situational Awareness
  – Geospatial and visual analytics that offer a centralized view of multiple technologies
  – Using AMI and Sensor Data for Distribution State Estimation (DSE)

• Active Management
  – Outage restoration analytics
  – Using AMI Data to Find Transformer Voltage Problems
  – Revenue protection (including theft and nontechnical loss analytics)

• Active Control
  – Grid optimization and power quality (including voltage control and conservation)
  – Renewable energy and storage analytics and optimal control
  – Home signature and thermostat control analytics

• Active Service
  – Peak load management (via demand-side management analytics) and energy portfolio management analytics
  – Consumer behavioral analytics (including comparison to neighbors/peers)
  – Time-of-use pricing analytics
  – Service quality analytics

• Active Planning
  – Customer planning: Voltage analysis
  – Long-term load and renewable energy forecast
Situational Awareness: Using AMI and Sensor Data for Distribution State Estimation (DSE)

Using AMI and Sensor Data for Distribution State Estimation (DSE)

Problem: Utilities don’t have a way to identify and correct “bad” data.

A Solution: Use data from AMI and distribution sensors to determine current electrical state of the distribution system.

DSE improves reliability of advanced distribution applications.
Active Management: Using AMI Data to Find Transformer Voltage Problems

Problem: Some customers have poor voltages. This limits voltage reduction.

Solution: AMI data analysis to find problems.

Voltage profile of the 99.9th percentile meter voltages.
Active Management: Using AMI Data to Auto-Generate Secondary Circuit Models

Problem: Utilities don’t have models of secondaries, or they are poor.

A Solution: Use voltage and current from AMI to auto-build secondary circuit models.

Secondary model based on AMI data was better than the utility model
Active Control: Fault Location

**Hydro Quebec: Using Feeder Monitors to Locate Faults and Estimate Cause**

A dangling phase conductor that caused multiple momentaries

Another case of a bad insulator causing repeat momentaries
Transformer load growth due to single customer, 40 apartments, converted from gas to electric space heaters - usage increased by 400%
Active Service: Demand response: Non-operational Peak Rewards (PR) device analysis

Non-operational PR device

No increase in consumption during 'payback' hour indicative of non-operational device
Active Planning: Customer planning: Voltage analysis

Detecting high-/low-voltage Issues

High voltage
Found several meters on the same transformer with similar voltage profile

Low voltage
Incorrect meter type installed
Conclusion

• The sources and features of big data in smart grid are discussed
• The impact big data on smart grid and the unified data model are given
• The common use scenarios of big data in smart grid are identified
• The application of big data in smart grid is just the beginning, but there is a great future
Thanks!