Big Data, Enterprise Data Management, and IT/OT Convergence

Presented by: John D. McDonald, P.E.
Smart Grid Business Development Leader
Grid Solutions, GE Power

Biography

John D. McDonald

Smart Grid Business Development Leader, GE Power
Atlanta, Georgia

- BSEE (1973), MSEE (1974) - Purdue University
- MBA (Finance) (1978) – University of California-Berkeley
- 43 years full-time work experience in electric power system automation (i.e., Smart Grid)
- Worked for 4 automation system suppliers and 2 international consultants (10 years at GE)
- Written 80+ papers and articles, co-authored five books
- Extensive industry thought leadership
- Active in IEEE PES for 46 years (IEEE Life Fellow)
- Teach Smart Grid courses for GE (Grid Solutions and Energy Consulting)
- Mentor young professionals; reverse mentored for 3 years
- Eagle Scout; Atlanta Area Council Boy Scouts of America (AAC BSA) Board Member
- AAC BSA Explorer Post at GE on STEM (high school boys and girls)

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Agenda

- Key Industry / Societal Trends
- Grid Operations: Types of Data
- IoT and New Software Analytics
- IT/OT Convergence and Enterprise Data Management
- Grid Modernization Standards: Development and Interoperability
- New Sources of Data – Unmanned Aerial Vehicles (UAVs) and Robotics

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KEY INDUSTRY / SOCIETAL TRENDS

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Key Industry / Societal Trends

- Transitioning from Devices / Systems to Holistic Solutions
- Success = Technology, Standards, Policy
- Culture => Closed Loop Control, Distributed Intelligence
- Grid Resiliency => Microgrids
- Big Data, the Cloud and Use of Social Media
- Convergence of IT and OT
- ADMS Project Costs => 30% ADMS Cost, 70% Integration Costs
- Strong Grid (Communications Infrastructure, IT Infrastructure) before Smart Grid

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GRID OPERATIONS: TYPES OF DATA

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Types of Data: "Operational" Data

- Data that represents the **real-time status, performance, and loading** of power system equipment
- This is the **fundamental information used by system operators** to monitor and control the power system

Examples:

- Circuit breaker open/closed status
- Line current (amperes)
- Bus voltages
- Transformer loading (real and reactive power)
- Substation alarms (high temperature, low pressure, intrusion)

Types of Data: "Non-Operational" Data

- Data items for which the **primary user is someone other than the system operators** (engineering, maintenance, etc.)
- Note that operators are usually interested in some data that is classified as non-operational

Examples of "Non-Operational" data:

- Digital fault recorder records (waveforms) (protection engineer)
- Circuit breaker contact wear indicator (maintenance)
- Dissolved gas/moisture content in oil (maintenance)

Characteristics of Operational & Non-Operational Data

Characteristic	Operational Data	Non-Operational Data
Data Format	Usually limited to **individual time-sequenced data items**	**Usually a data file** that consists of a collection of related data elements
Real Time vs Historical	Usually consists of **real-time or near real-time** quantities	Mostly **historical** data: trends over time
Data Integration	Easily transportable by conventional SCADA RTUs using **standard (non-proprietary) protocols**	Typically use **vendor specific (proprietary) formats** that are not easily transported by SCADA communication protocols

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IOT AND NEW SOFTWARE ANALYTICS

Internet of Things (IoT)

Drive the next productivity revolution by connecting intelligent machines with people at work

The "IoT" Connects…

1 Intelligent Machines + **2 Big Data & Analytics** + **3 People at Work**

Leverage technology & communication to cost-effectively connect machines

Combine the power of big data, big analytics, and industry physics

Connecting people any place, any way, and any time for intelligent operations

A world that works better, faster, safer, cleaner and cheaper

Energy Value: **Global Energy Capex $1.9T/year** → **The first 1% annual savings equals $300B over 15 years**

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New Software Analytics Development Areas

Meter Insight

- Revenue Protection
- Power Quality and Reliability
- Load Forecasting and Research

Outage Insight

- Automated KPI data validation
- Dynamic KPI dashboards
- Outage Event Recorder
- Planned outage optimization
- Predictive Outage Analytics
- Accurate ETR

Reliability Insight

- Predictive vegetation management
- Asset health analysis
- System health analysis
- Lifecycle analysis and portfolio optimization

Renewables Insight

- PV load (dis)aggregation/ hotspot analysis
- Wind load (dis)aggregation and hotspot analysis
- EV penetration/ impact analysis
- DER load orchestration

Consumer Insight

- Social media integration
- Customer Segmentation
- Customer Engagement
- Sentiment Analysis

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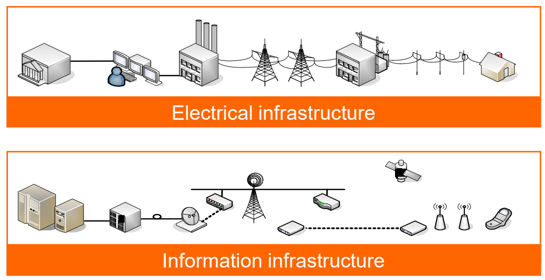
IT/OT CONVERGENCE & ENTERPRISE DATA MANAGEMENT

IT/OT Convergence: Grid Modernization

Integration of electrical and information infrastructures with automation and information technologies within our existing electrical network

Comprehensive solutions that:

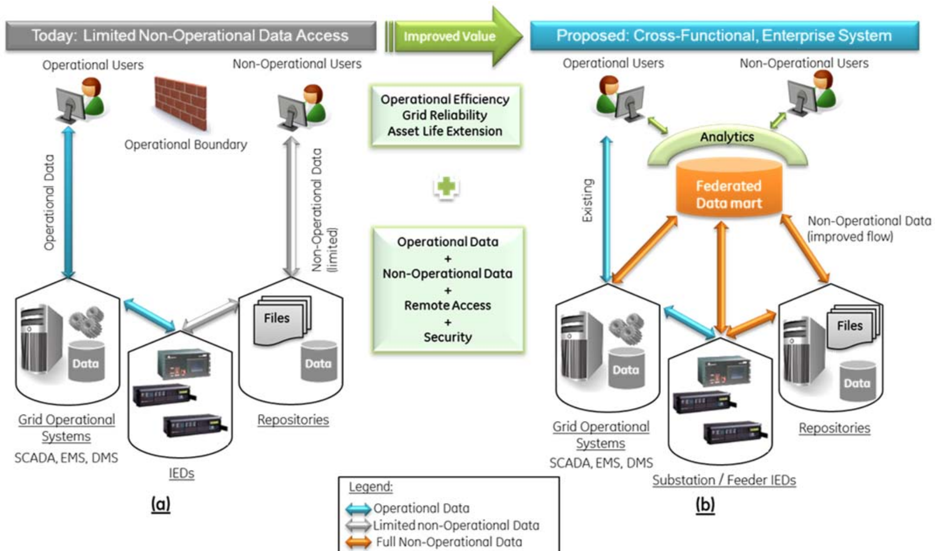
- Improve power reliability, operational performance and overall productivity
- Deliver increases in energy efficiencies and decreases in carbon emissions
- Empower consumers to manage their energy usage and save money without compromising their lifestyle
- Optimize renewable energy integration and enable broader penetration



That deliver meaningful, measurable and sustainable benefits to the utility, the consumer, the economy and the environment

More Focus on the Distribution System

IT/OT Convergence and Data Access



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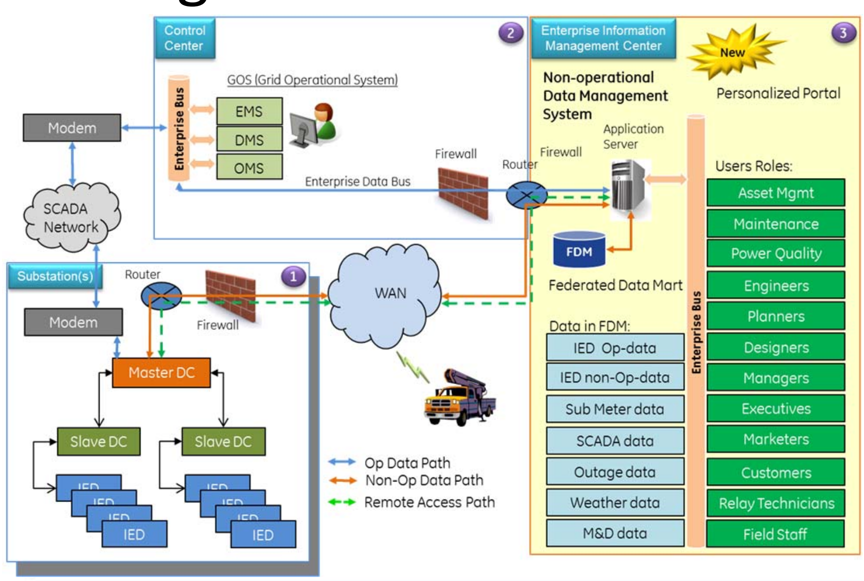
Realizing Greater Value from Data



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Project Steps

- Workshop to bring utility stakeholders to the same level in enterprise data management
- Review the data maps of all IEDs, systems and repositories and create standard data templates
- Develop enterprise data requirements matrix (map data points of value to stakeholder group(s) that will use the data)
- Review substation automation architectures to extract data points of value, concentrate the points, and send across firewall to enterprise data mart on corporate network

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GRID MODERNIZATION STANDARDS: DEVELOPMENT & INTEROPERABILITY

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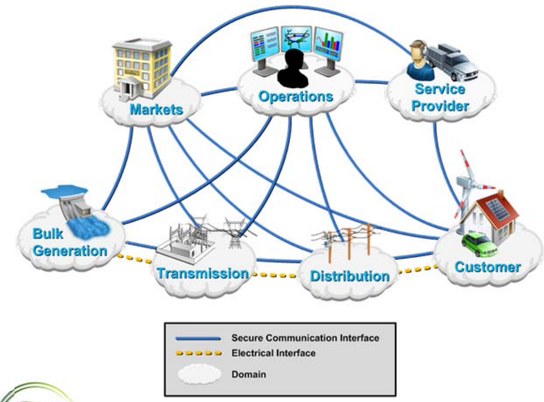
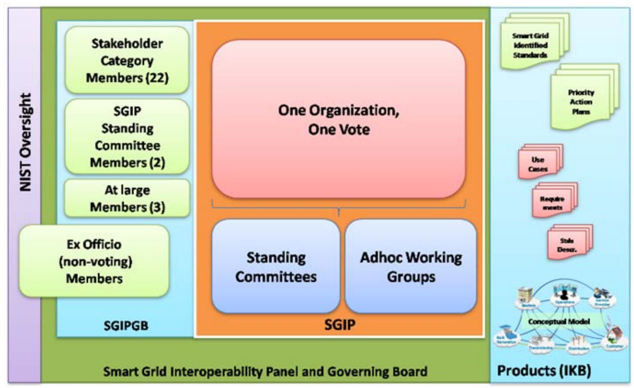
Example: Standards Framework

National Institute of Standards and Technology (NIST)

… Smart Grid Conceptual Reference Model

… Smart Grid Interoperability Panel Organizational Structure





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NIST: Smart Grid Interoperability Standards

Release 1.0 Standards Identified for NIST Interoperability Framework

Standard	Application
AMI-SEC System Security Requirements	Advanced metering infrastructure (AMI) and Smart Grid end-to-end security
ANSI C12.19/MC1219	Revenue metering information model
BACnet ANSI ASHRAE 135-2008/ ISO 16484-5	Building automation
DNP3	Substation and feeder device automation
IEC 60870-6 / TASE.2	Inter-control center communications
IEC 61850	Substation automation and protection
IEC 61968/61970	Application level energy management system interfaces
IEC 62351 Parts 1-8	Information security for power system control operations
IEEE C37.118	Phasor measurement unit (PMU) communications
IEEE 1547	Physical and electrical interconnections between utility and distributed generation (DG)
IEEE 1686-2007	Security for intelligent electronic devices (IEDs)
NERC CIP 002-009	Cyber security standards for the bulk power system
NIST Special Publication (SP) 800-53, NIST SP 800-82	Cyber security standards and guidelines for federal information systems, including those for the bulk power system
Open Automated Demand Response (Open ADR)	Price responsive and direct load control
OpenHAN	Home Area Network device communication, measurement, and control
ZigBee/HomePlug Smart Energy Profile	Home Area Network (HAN) Device Communications and Information Model

- IEEE had identified over 100 standards involved in Smart Grid.
- IEC had identified over 100 standards involved in Smart Grid.
- NIST and the Smart Grid Interoperability Panel (SGIP) reduced the list of Smart Grid standards to 16 "foundational standards" for Smart Grid.

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Communication Protocols

Control Center to Control Center

- IEC 60870-6/TASE.2 – Inter-control Center Communications Protocol (ICCP)

Control Center to Field Equipment

- IEEE 1815 (DNP3) – North American Suppliers
- IEC 60870-5 – European Suppliers
  - 101 – serial communications
  - 103 – protection devices
  - 104 – TCP/IP (network communications)

Field Equipment

- IEC 61850 – substation automation and protection
- IEEE 1815 (DNP3) – substation and feeder device automation

NEW SOURCES OF DATA - UNMANNED AERIAL VEHICLES (UAVS) AND ROBOTICS

Data Characteristics

Data from a variety of sources

- Photography
- LiDar and PhoDar imagery
- Infrared sensors

Data used to inform

- Asset management program
- Geographic Information Systems (GIS)
- Outage Management Systems (OMS)
- Storm damage assessments

Data analysis

- Pursue automated image analysis to create value (having humans watching hours of streaming video is not practical or a beneficial use of resources)

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Brief Ad Hoc Survey Conducted

Conducted brief ad hoc survey in late 2017

- Included utilities, consultants and power industry consortia
- Revealed how a coordinated industry response to the emergence of UAVs and robotics can speed time to value

Observations

- Power utility use of UAVs and robotics is in its infancy
- UAVs and robotics are an effective and efficient means to monitor infrastructure health and perform remedial work
- How raw and analyzed data is stored, routed or otherwise made available across a utility organization is <u>different</u> for each utility

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To Do Now

Recommendations

- “De-silo” the utility and its approach to data management to achieve the organization-wide value creation that creates a positive business case for new technologies and makes a power utility more nimble and competitive
- Now is the time to apply holistic data management thinking to how UAVs and robotics outputs are managed for value creation
- The power industry should determine and pursue common requirements for UAVs and robotics technologies and push UAV and robotic purveyors to comply with them
- Adopt standard data formats and data analytics based on open source architectures, and true enterprise-wide integration of the information
- Avoid proprietary solutions that limit the utility’s future options

THANK YOU