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Smart Grid Basics

Turning Information into Power

Introduction

The Smart Grid is a vision of a better electricity delivery infrastructure. Smart Grid implementations dramatically increase the quantity, quality, and use of data available from advanced sensing, computing, and communications hardware and software. As a result, they help utilities address two of today's most important business drivers: environmental concerns and power delivery constraints and disturbances.

Effective use of Smart Grid technologies helps utilities:

- Optimize grid use.
- Improve grid efficiency and security.
- Better align demand with supply constraints and grid congestion.
- Enable distributed generation (especially from renewable sources).
- Empower customers to manage their consumption and take advantage of pricing and supply options.

Initial Focus

Smart Grids rely on information technology advancements across telecommunications and operations. Utilities apply these technologies both to grid operations—transmission and distribution wires and associated equipment—and to the customer site—meters, customer-owned energy technology equipment and appliances, and home area networks (HANs).

Wires

Wires-focused Smart Grid projects commonly involve:

- New telecommunications and operational (sense and control) technologies. These improve delivery performance and resilience.
- New sensor and control technologies. These, when combined with distributed intelligence, make it possible to report and resolve grid issues in real time (self-healing).
- Transmission and distribution intelligent electronic devices. These alert operators, automatically respond to problems, and integrate generation from renewables.

Utilities frequently view these advances as the next generation of distribution automation—“distribution automation on steroids.” Customers may see benefits like fewer power outages, faster repairs, and specific proactive information regarding their service issues.

Customers

Typically, initial customer-focused Smart Grid projects take the form of Smart Metering. In Smart Metering, an Advanced Metering Infrastructure (AMI) of interval meters and two-way communications systems serves as a gateway for utility/customer interaction. Smart appliances and near-real-time usage displays or messaging enable customers to participate in a variety of utility programs for conservation, peak demand reduction, load shifting, and carbon footprint reduction.

Smart Metering has the potential to reduce both customer and utility costs. It helps customers reduce overall use and better respond to price incentives. It reduces such utility costs as meter reading, turn-on/turn-offs, and contact center responses to bill estimations.

In a larger context, Smart Metering will enable deferral of new electricity generation plants. It will also help utilities avoid building new transmission and distribution infrastructure by reducing peak-demands and the related capacity constraints. That reduces not only the huge infrastructure costs but also such negative environmental effects of energy use as greenhouse gas emissions and landscape-damaging transmission

Need for a Broader Focus

While important, neither wires-focused nor customer-focused projects maximize the Smart Grid's potential. Even both are not enough. Smart Grid success depends on the successful handling of two major IT issues: integration and data handling.

Integration and data handling are components of what some refer to as enterprise information management (EIM). EIM is an integrative discipline for structuring, describing and governing information assets, regardless of organizational and technological boundaries. It improves operational efficiency, promotes transparency, and enables business insight.

Integration:

Smart Grids require integration among appropriate applications so that

- Meters act as grid nodes. This helps utilities identify outages and confirm power restoration.
- Customer-owned energy technology equipment and smart appliances respond individually to system disturbances and peak power conditions. This minimizes the potential negative effect of these conditions on customers.
- Transmission and distribution grids can use power from distributed generation and storage. Rooftop photovoltaics, advanced batteries, and plug-in hybrid electric vehicles (PHEVs) can contribute to supply. Related technologies like thermal storage for cooling or combined heat and power can also reduce peak and overall demand
- Utilities can reduce dependence on more generation or power supply contracts. Smart Grids limit the need for additional fossil-fuel generation
- Engineers involved in generation and transmission and distribution grid planning can leverage these technologies to improve utility planning through more detailed and accurate customer load models and behind-the-meter resources integrated into the planning process.
- Utilities leverage the advanced telecommunications infrastructure for Smart Grid field OT communications.

Data Handling

Smart Grid integration brings with it an exponential growth in the amount of data that must be gathered, verified, stored, and transformed in near real time for intelligent responses and decision support. Merely moving from monthly kilowatt-hour reads to hourly interval meter reads increases data-handling requirements more than 730 times. But there is also other rich information available in smart meters: amps, volts, watts, vars, total-harmonic distortion, momentary interruptions, and more.

An analogous situation lies in relays. Twenty years ago, most utilities used electro-mechanical protective relays in substations to protect their transmission and distribution lines and generation units. Electro-mechanical relays had only a few set points, did not require much maintenance, and lasted for the life the asset.

Today electro-mechanical relays are no longer available. They have been completely replaced by microprocessor-based protective relays. The reason is that relay manufacturers have found that modern computing technologies provide richer functionality at lower costs. In fact, these new relays have hundreds of set points and a broad-range of stored history.

Most utilities only use a fraction of the modern relay's functionality. The reason is that a decision to use more of the available data is only a first step. Modern relays are IP-addressable but require on-going operational technology governance to manage security, firm-ware changes, configuration changes, maintenance, health checks, version control, compatibility testing, etc.

Much as modern IT systems require on-going governance, smart grid technologies, too, will require on-going operations technology governance. Smart meters will evolve in the same way; they, too, will require on-going operations technology governance and enterprise information management.

Smart grid operational technologies and customer energy technologies will leverage additional processing power that will be needed to:

- Continually assess power delivery and available feeder capacity.
- Analyze sensor data to mitigate feeder problems before they occur.
- Prepare bills that reflect and explain to customers the complex pricing models that encourage them to shift optional electricity use to off-peak hours.
- Manage rebates and incentives processes for customers purchasing and installing energy efficient equipment or feeding customer-owned distributed generation into the grid through net metering.
- Size the network to optimize available capacity and limit line losses.
- Provide near-real-time views of usage and costs that empower customers to make the best usage decisions for their situation.
- Avoid data overload on downstream systems by managing information through distributed processing and report-by-exception messages to throttle events.
- Automate demand response programs—enrollment, event planning, notification, and analysis.

Many legacy applications simply cannot scale to handle the Smart Grid's required levels of data volume and complexity. Utilities need a complete set of Smart Grid systems to transform the exponential growth of data into information that drives utility performance.

Smart Grid Success

Achieving this broader view of the Smart Grid will require complex task prioritization and business process orchestration. Unfortunately, few utilities today are structured so that executives and staff can comfortably address those goals. Staff members and individual departments rarely grasp the demands and constraints on other departments' processes and goals. Metering, for instance, has traditionally been a customer service issue far removed from distribution operations. Traditionally, operations/engineering departments rarely interacted with IT for operational support. But for Smart Grids to succeed, all groups must unite in a common vision.

Ultimately, a commitment to that vision will maximize the benefits utilities and customers receive when an information-rich delivery network connects customers to electricity choices and thus turns information into power.



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