Smart Grid 101 – Understanding the System Operations

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Meet the Author:

An IEEE Fellow, electricity industry visionary, and leader, Dr. Mani Vadari delivers strategic services to a global set of utilities, vendors, and service providers seeking deep subject matter expertise in setting the business and technical direction to develop the next-generation electric/energy system. As a Business Architect, Dr. Vadari has been delivering solutions focusing on Transmission/ Distribution/ generation operations, Energy markets, and Smart Grid for over 35 years. In addition, he is an Adjunct Professor at Washington State University and an Affiliate Professor at the University of Washington. He has published two popular books, "Smart Grid Redefined: Transformation of the Electric Utility" and "Electric System Operations – Evolving to the Modern Grid, 2nd Edition", in addition to over a hundred industry papers, articles, and blogs. His books are serving as textbooks at several universities in the US and around the world

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"The systems operations function is crucial to electric power, yet it is frequently ignored or misunderstood. Given that our systems are increasingly interconnected, failing to grasp the role of systems operations can hamper success."

In a previous article about understanding the key players, we talked about the (sometimes bewildering) number of new roles that have arisen in recent decades, including Regional Transmission Operators (RTOs) and Independent System Operators (ISOs). As you will recall, RTOs and ISOs are responsible for "systems operations" -- coordinating, controlling, and monitoring the flow of power over large areas.

Starting in the 1970s, the U.S. electric power system went through a series of regulatory changes that remade systems operations. The objective expanded far beyond reliability to a plethora of activities needed to support the new market-style operations that had been mandated. Those activities can be represented in several functional areas, as explained below:

- *Grid Operations: Securing the grid, performing real-time operations, and supporting real-time operations. The main objective of this function remains network security and grid control. These functions are still performed mainly by an energy management system (EMS), used by both RTO/ISOs as well as transmission owners. The system is configured slightly differently for an RTO/ISO than for a utility. The changes include:*

- *SCADA Control: RTOs are generally not allowed SCADA control of devices in the field. That control still belongs to the transmission asset owner/operator.*

- *Calculate and Update Total Transmission Capability (TTC) and Available Transmission Capability (ATC). Power system conditions, system loading conditions, and the weather all have an impact on both the TTC and ATC. This calculation is posted to ensure that all market participants are made aware of the information at the same time.*

- *·Manage Congestion: Although the system operator has always needed to solve congestion problems, deregulation brought in new rules that govern which tools and mechanisms can be applied.*

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Market Operations: Facilitating the market, forecasting the market, scheduling energy/ancillary services, and monitoring the market. This new set of capabilities appeared after deregulation to manage the market. They typically apply just to the system operator (RTO or ISO). Where a market does not exist, the system operator is expected to run basic functions to create a balancing market.

- Electricity load fluctuates constantly. When it changes beyond what has been predicted (in essence, under- or over-scheduling), the balancing authority must meet the unexpected demand. It can buy electricity from generators (if it needs more). Or it can pay them to reduce output (if it needs less. This additional power (or reduction in power) is purchased in the "balancing" market. The balancing authority determines a "market-clearing price" every 5 minutes or more depending upon market rules.

A key job of the balancing authority is to send market signals to all participants:

- *Performing Forecast: Accurately predicting load and ancillary service is important because this forecast is used to set the market (how much will be purchased in actuals and how much in reserves). This has revenue implications for market participants.*
- *Facilitating the Market: Different jurisdictions run different markets based on different rules. (Some, such as Texas, also run a retail market at the same time.) Most of them run a combination of day-ahead, day-of, and real-time markets. They all take the cost of alleviating congestion into consideration as they clear the market. Where there is no market (such as the Pacific Northwest), most energy transactions are through bilateral trades. That process is facilitated through a balancing authority, who ensures that sufficient supply is available.*
- *Performing Scheduling: The market clearing process produces energy and ancillary services schedules that are fed to the system operator who uses them to manage the grid efficiently. As grid conditions change during the day, they are re-evaluated and re-adjusted.*

Other Key Terms:

Commercial Operations: Gathering and managing metered data and settling the market (including billing and dispute resolution). The metered data identified here is not to be confused with AMI/Smart Meter data from customers. This is wholesale metering for settling the market. These new functions depend on whether the operator functions as a normal transmission/distribution operator, as an RTO/ISO or as a balancing authority. However, they have little impact on the system operator.

Participant Operations: Managing the participants, their contracts and their communications. This is the last of the set of totally new capabilities that got introduced into the System Operator due to deregulation. Much of these capabilities will only be needed in a system operator if they are functioning as a RTO/ISO or a balancing authority. When the system is also performing those functions, the need to manage participants and contracts with them becomes an important part of the system operator.

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Managing the Assets: With a market in place, planning of transmission assets (both new and maintenance) which could span multiple utilities is generally performed at the RTO/ISO level. The jobs of building and maintaining those assets are usually left to transmission owners with some level of coordination at the RTO level.

System Administration, IT Management, and Corporate Services are similar to those functions at a regular utility and will not be discussed in any more detail.

The implications of the "new" systems operations

Deregulation brought dramatic changes to system operations. Those changes can be summarized as:

- Brought a commercial mindset into the control center with focus on settlements and the need to perform financial transactions that have a significant impact on a utility's bottom line.
- Brought a customer service mindset into the control center because of the need to deal with players who are not employees of the same utility, are not of a reliability mindset, and who, very often, have different corporate objectives.
- Brought strict accountability. Some of the new players (??) competitors so all interactions must be strictly process-driven, transparent, and auditable.
- Brought separation of powers. Making transmission tracking and availability transparent requires a "Chinese wall" separation between a) core control center functions, b) transmission functions, and c) generation and trading functions. This required utilities to redesign the control center or to buy more than one set of system operations solutions.
- Brought market-based operations. Core functions like generation dispatch and unit commitment used to be cost-based. Now they are market-based leading to very different patterns in how generation is dispatched, made available, and compensated.

As retail choice becomes more prevalent, it is possible that these changes will continue to extend from transmission into distribution operations also.