Smart Grid 101 - The Smart Grid's New Systems

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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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"Author, trainer and smart grid pioneer Mani Vadari has previously explained how the smart grid is changing the traditional roles played by system operators. But he says the biggest changes of all are from the new systems that a smart grid makes possible, as he explains below." -- Jesse Berst

Of all the changes brought forth by the smart grid, the biggest impact comes from the introduction of new systems into distribution operations.

Previously, distribution was either the domain of customer operations or field operations. The main focus was trouble-call management. Introduction of new sensors and controls, AMI and its associated head-end systems, more SCADA into the distribution end of the system, new programs like demand response and time-of-use rates have required utilities to make distribution operations into a more formal set of operational functions – and these have all been supported by new sets of systems which will be introduced here.

Meter data management system (MDMS)?

Meter data management performs long-term data storage and management for the vast quantities of data that are delivered by smart metering systems. This data consists primarily of usage data and events that are imported from the head-end servers that manage the data collection in Advanced Metering Infrastructure (AMI) or Automatic meter reading (AMR) systems.

An MDMS will typically import the data, then validate, cleanse, and process it before making it available for billing and analysis. They integrate with existing enterprise applications and help to streamline utility business processes. Benefits are seen in billing, customer service, outage management, and analysis of utility operations.

With the anticipated increase in the number of meters in service supported by better communications, it can be expected that these meters could end up sending their data to the head-end system more often. As these changes occur, system operators are anticipating that this could be an opportunity for meter data to be routed to the distribution management system (DMS) as well to provide the better and more complete ability to observe the system in more detail.

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Outage management system (OMS):

A significant portion of North America's distribution networks are still not telemetered. As a result, utilities depend on customers to report outages. An OMS collects, analyzes calls, and determines probable device failures and/or probable outage locations. Using this information, utilities are able to reduce the time to identify, prioritize and resolve network incidents, and effectively communicate with their customers and regulators.

From a value perspective, an OMS allows the utility to reduce the duration of outages, improve customer communication before, during, and after outages, and improve operational efficiency by reducing overtime, dispatch centers, and storm staffing.

Outage management had its humble beginnings in Trouble-Call Management Systems (TCMS) – a system created to process the inbound avalanche of calls that follow a power outage and to manage the outbound communication of that same information to field crews, customers, stakeholders, and others who require it. As more and more telemetry was available from systems like SCADA, trouble call systems became more complex and developed into Outage Management Systems.

In several implementations, MDM systems are being integrated with outage management systems so that outages can be more automatically identified instead of solely relying on customers to call and report their outages.

Geographic information system (GIS)

Geographic information systems capture, store, manipulate, analyze, manage, and present all types of geographically referenced data. In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology.

Fundamental to a GIS is its ability to store and correlate disparate types of data like type of device, ID, location (GPS coordinates), and connectivity with their geospatial rendering. While this type of information was not that important when trying to model and support transmission systems (due to fewer components), they are tremendously important to support distribution systems.

From a system operations perspective, the GIS is a fundamental system which is designed (among other things) to deliver as –built data to OMS, DMS and other similar systems which depend on an accurate representation of various power system components in the field and their connectivity.

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Distribution management system (DMS)

A distribution management system (DMS) comprises a base SCADA system that is equipped with additional planning and operations functions for the utility's sub-transmission and distribution feeder systems. DMS applications are highly data intensive. This is due to the greater number of power system elements and spatial information to be included in displays, analysis functions, and databases.

The distribution management system enables the distribution system operators to manage their responsibilities of monitoring and operating the grid, coordinating clearances, creating switching orders, and supporting emergency and storm management. As a system, the DMS for the most part is the distribution equivalent of the energy management system (EMS) which was developed for transmission. The advent of the smart grid has made the DMS the cornerstone of the system operator's response to everything that the smart grid can throw at the utility.

Distributed energy management system (DEMS)

As DMSs are getting more and more acceptable in the industry an important gap has been identified by utilities and vendors. This is the gap between the distribution tap-end transformer and the customer. For lack of an industry-accepted name for this system, we have called it a distributed energy management system or DEMS. A typical DEMS system does not need to perform the full suite of power systems applications but has a combination of SCADA interfaces supported by one or more optimization mechanisms to support specific applications. We also believe that this system could be a path for those (generally) smaller utilities that either don't need the sophistication of a full-fledged DMS or cannot afford one.

Two major application suites stand out from a DEMS perspective. It is important to note that they could either reside independently, be a part of the DMS, or be integrated into the DMS.

- *Demand response management. There is a need to track various DR programs and the customers signed-up for them.The system would enable communication of the various DR triggers to the participating customers and track their responses, all in one place. This system will perform all actions required by the demand response programs. The data collection and the associated analytics tend to be an added bonus in these systems with a possible outcome being reports that can track compliance to the program requirements and their effectiveness.*

- *Distributed renewables management. As energy storage mechanisms, electric vehicles charging, renewables, other forms of distributed generation proliferate, distribution operators see a need to track and manage them. Key to this application suite is the ability to track their generation/consumption, the different controls that can be sent to them and the forecasting that would assist the system operator to manage the loading on the system appropriately.*