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A Data Approach to Advanced Distribution Management Systems

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SUMMARY

The data that feeds your Advanced Distribution Management System (ADMS) can be the most intense piece of the implementation puzzle. It is also the most underrated as far as quality is concerned. You will not realize the emphasis put on quality of data until there are systems that depend on that quality to provide operationally critical information.

In an IT/OT project like an ADMS, we are requirements driven and need to break down the pieces of data for collection, calculation, and quality assurance into some semblance of order. Below is a simple phased approach breakdown. Yours may be more detailed and have more phases, but I do not suggest trying to bite off these 3 phases in a single success story. Or should I say, "lesson learned."

Outage Management Phase

- Network Topology
- Feeder Level SCADA
- Consumer Level Outage Reporting System

Load Flow and Advanced Applications Phase

- Equipment Nameplate Data
- Equipment Settings
- Additional SCADA Devices

Automation Phase

- Field Equipment (Outside the Substation Fence)
- Additional SCADA Points
- Trustworthy Software
- Change Management to Operational Procedures

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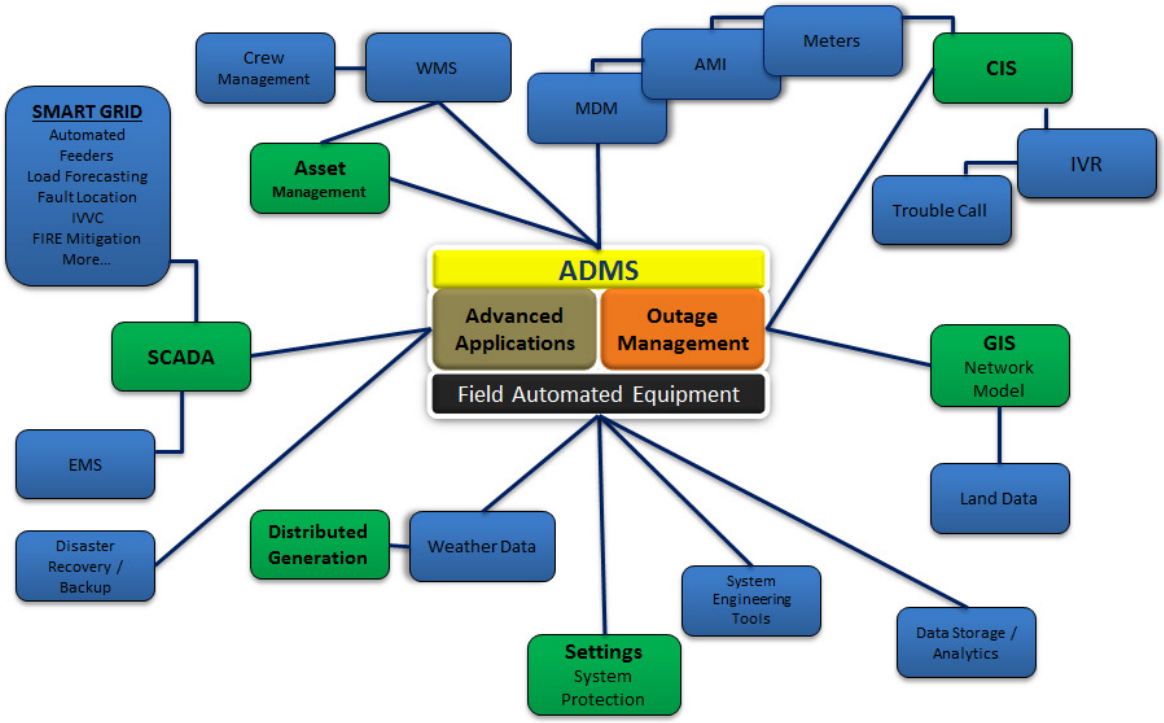
Systems of record will play a major battle in the interest of data validation. While it is always best to enter data a single time into its system of record and propagate that data to other systems, utility divisions can easily get a bad taste for errant data and start to maintain their own records to feed the systems they rely on. While Enterprise System Integration is the key, you may run into an integration point change or upgrade to one or more commonly utilized data repositories during the lifecycle of your ADMS implementation. Not only do these integrated systems need to have valid data, but now they all need to have their inserts (new assets), updates (changed assets), and deletes (removed assets) in a synchronized consumption pattern. Our Planners always had the ability to collect data from the past for loads and abnormal switch status to create a study and plan some changes to a portion of the system. In ADMS we are working in real-time operations with state estimation and current switch status that allows us to make the decisions necessary to operate safely and efficiently.

KEYWORDS

ADMS, Advanced Distribution Management, Advanced Grid Analytics, Data Quality

METHODS AND FINDINGS

This paper covers the trials and tribulations through the methods and findings that were encountered during the collection and validation of the various systems of record that provide data for an ADMS. Below is a logical diagram of system connections that make up the ADMS phases that were chosen at one utility. By no means are all these systems necessary or needed to be connected in this manner to achieve your operational goals.



For the sake of time, we have selected a few subject matters (in green) above to concentrate some methods and findings that may be beneficial to your ADMS implementation or future integrations.

Geographic Information System (GIS) for Network Topology. Network topology is simply defined as the way in which constituent parts are connected, interrelated or arranged.

Methods

- Determine if stitching or relationships need to be made between varying levels of the network to provide information from subtransmission, switching stations, distribution substations, feeders, secondary voltage level, and mesh systems.
- Apply upstream and downstream traces to expose connected vs non-connected.
- Verify connectivity rules at high voltage, switching, transformation, low voltage, and consumers.
- Determine if the secondary topology will be utilized for network connectivity to the meter or if a transformer to meter relationship table will be used.

Findings

- Substation information and distribution feeder maps sometimes have overlapping data and the source of reference or demarcation point needs to be managed.
- Some line segments are valid to be disconnected at given points of time in the design and energization process.
- Two phases of primary voltage can make up three phases of secondary when transformers are connected in Open Wye configuration. North American utilities will use a combination bank of transformers to supply both single phase and three phase service to their consumers.
- When moving from a transformer/consumer table to actual secondary topology, customer location validation places an extreme resource burden on your implementation.

Customer Information System (CIS) for contact and load information. We will also discuss meter data here as it may relate to a separate AMI or MDMS.

Methods

- Utilize last year's Meter Data Management System data to create load curves from meter reads. Utilize a source with a smaller data collection interval of 15 minutes to 1 hour if available.
- Reduce the number of load profile curves into logical categories such as residential, commercial, industrial, etc.
- Ascertain that new customers, inactive customers, and removed customers are accounted for in a timely manner.
- Expect errant relationships from CIS to be exposed at both the Outage Management phase as well as the Load Flow phase.

Findings

- Consumer remodels and added construction can lead to a change in the curves applied to individual consumers. It is nice when notification can be made between city planning departments and the electric utility.
- The number of load profile curves can get exhausting if you let it get out of hand. Examples include: Residential by sq. ft. becoming too many; adding external equipment to profiles like pools; tagging all electric homes; creating industrial by hours of operation; the list goes on…
- New loads need to be added to the system in a timely manner. Large loads should be loaded at design stage to an open switch so that state simulation can be analysed.
- Allow the ADMS to perform some quality assurance where it will expose overloaded or non-utilized distribution transformers that are in reality incorrect consumer to transformer relationships.

Asset Management to support the nameplate information and parameters of the equipment that makes up the network.

Methods

- Determine if the existing asset information repository has the ability to consume the data necessary to drive an ADMS.
- When an asset system of record is not available or is not ready to consume ADMS nameplate attributes, create catalog tables. This allows efficient storage of this data so that many of the same 25kVA transformers do not need to store duplicate information at every location they are installed.

- Find manufacturers data online where applicable to populate catalogs or asset repository.
- Apply change management early and often when new data is expected in the process flow.
- Keep settings of an asset in a separate repository or create different catalog entries for each setting available. Example is a dual voltage transformer that can be set to 7.2kV high side or 2.4kV to provide the same low side voltage.

Findings

- Most asset management systems have the ability to store the additional data required for an ADMS, but many consider this task as a project of its own.
- Some equipment types had so few assets that is was not worth the trouble of devising a model number system to apply a one-to-many relationship. A one-to-one relationship was used where more than 50% were unique or there were less than 100 assets.
- Where data could not be found on a particular piece of equipment due to it being very old or the manufacturer no longer being in existence, we applied a practice of gathering as much nameplate data in the field and then combining it with data from similar objects.
- It was difficult to find an actual utility division/department/resource that wanted to own and maintain the data. Executive sponsorship in the project is key to applying change for the overall good of the utility.
- There occasionally exists a fine line between asset information and settings. A couple of findings here;
    - Dual voltage transformers - where it was logical to put a separate set of catalog data into the system for each high side voltage. This item went to the asset side.
    - Distribution transformers with tap settings where we found the individual transformer unit needed to store what tap it was set to in the field, while the catalog accounted for the number of taps, the neutral tap and the tap percentage. This item went to the settings side.

Supervisory Controls and Data Acquisition (SCADA) points and locations as depicted in the network topology.

Methods

- Apply a SCADA tag to the equipment in the GIS model to associate the signal to the device in the graphical user interface.
- Install dual port RTU's to allow for a phased cutover from the existing system.
- Create a test system where you can generate imitation signals to verify that field RTUs are connected according to the location depicted in the network topology.

Findings

- Many SCADA points may need to be represented at a single GIS feature. Model changes had to be made in order to capture door open, temperature, and switch position at a single switching cabinet.
- There will be difficulty confirming that SCADA points have been applied to the correct network features.
- Thorough testing (100%) and setup of automated testing for future iterations.

Distributed Generation and the modelling applied for state estimation of load flows.

Methods

- Prepare the model for production metering, or net metering, or both to determine where actual metered load profiles may preside over time and temperature estimates.
- Determine if switch data is needed in the model to prevent distributed generation back feeds on a circuit outage.
- Size and date of install are a requirement to calculate the degradation of the photovoltaic system over time.

Findings

- Try to stick to one production estimation model if possible. Integrations aren't the toughest part. The timing and synchronizing of the different data sources becomes exponentially difficult as you add data source integrations.
- Do not include switching if it cannot be utilized in your ADMS switching order system. Safety rules are already in place to recognize the backfeed threat with your utility field crews.
- Some historical data collected on distributed generation did not include install date and assumptions had to be made. Many utilities collect data based on rules of install (<10kW or >10kW) where actual wattage is now needed.

Settings Data that may be applied to load tap changers, capacitor bank controllers, voltage regulators, fuse curves, breaker settings, etc.

Methods

- Determine what is actual settings data as opposed to asset data (catalog info) or location data (network and map attributes).
- Provide a source matrix for all users to understand where the single source of truth resides. Reduce duplicate data entry where possible.
- Examine the process flow to provide near real time information on changes to settings.

Findings

- Settings were held in many disparate databases and spreadsheets. Attacking this early may allow a consolidation project to precede the ADMS implementation.
- Users do not revisit documentation, remove redundant data entries and lock fields in data stores that are not the system of record.
- Settings are important to operators, allowing them to run the distribution system at 100% or elevated loads for periods of time. Inaccuracies may cause unnecessary switching and poor utilization of both human and facility resources.

CONCLUSION

The takeaway from this session will allow you to make decisions about the level of data quality needed to provide your operations with varying components of an ADMS as well as implementation methods to achieve that level of quality. While the data could be the most daunting task to implement the ADMS at the level that you are expecting, automated methods and default values can obtain a level of quality that will work. You may think your data is ready, but until it is tested by another application you really will not know. Do not discard the quality of your data and expect it to be perfect prior to the ADMS software installation. Instead, embrace your first pass and allow time for the ADMS to find issues to fix singularly or globally in your systems of record.

BIBLIOGRAPHY

No other works have been referenced in this paper or presentation.