

Best Practices for Creating Your Smart Grid Network Model

By John Dirkman, P.E.

Executive summary

A real-time model of their distribution network enables utilities to implement Smart Grid strategies such as managing demand and integrating renewable energy sources. They build this model in an Advanced Distribution Management System (ADMS) based on accurate and up-to-date information of the distribution network infrastructure. Yet, a recent survey shows that less than 5% of utilities are confident about the quality of the network data. This paper discusses best practices for ensuring complete, correct, and current data for a Smart Grid network model.

Introduction

Utilities worldwide are faced with numerous Smart Grid challenges—reducing peak demand, optimizing renewable energy resources, improving fault and outage management, minimizing network losses, enhancing asset management, and meeting regulatory requirements are just a few of the key drivers. Utilities require a system that can effectively overcome these challenges and allow them to provide reliable, safe, and efficient power.

A high-performance Advanced Distribution Management System (ADMS) unifies data from the Distribution Management System (DMS), SCADA system, and Outage Management System (OMS) to maintain a real-time distribution network model. Using this model, the ADMS performs advanced analytics and controls network devices to efficiently address Smart Grid challenges.

In order to maintain a real-time model, the ADMS must represent the as-built (static) state of the network along with the as-operated (dynamic) state. The more accurate the data is, the more accurate the model and analyses will be. Many utilities find that building and maintaining such a database is the most difficult aspect of implementing an ADMS. This paper discusses best practices for providing complete, correct, and current information for the Smart Grid network model.

Biggest challenge: the 3 C's

When Esri, an international geographic information system software company, surveyed 226 utility companies regarding the readiness of their network data for Smart Grid implementation, results showed the difficulty utilities face in maintaining data that is complete, correct, and current—the 3 C's.¹

- >20% of utilities had their oldest network asset work order open for 6–12 months
- >30% typically see 31–90 days for the database to be updated following completion of the work order
- only 2–5% were confident in the accuracy of their network data
- 60–70% reported their network databases were missing data

Enterprise GIS enables the 'three C's'

The more thoroughly utilities implement Smart Grid software solutions, the more data they require and generate. Different software systems drive different—and large—databases, some of which might even contain duplicate data. For instance, load data from metering systems can reside in head-end software, in meter data management software, and in a variety of business and analytical systems. Network asset (device) data can reside in Enterprise Asset Management (EAM) systems, fixed assets systems, GIS, CAD, and even paper files.

Utilities can minimize the number and size of databases by utilizing geospatial data—data about a utility's assets including geospatial location and network connectivity. This data can form the basis for nearly every aspect of asset management. An enterprise Geographic Information System (GIS) allows a single data foundation to be used across a utility's engineering, design, construction, maintenance and customer service departments. This 'single version of the truth' reduces data duplication, database maintenance, transposition errors, and security issues.

Because it models network connectivity, a geospatial database provides insight into the as-built state of the network, unlike the traditional hierarchical format of an EAM system. For example, normal switch position defines the network infrastructure and connectivity—data that the EAM system will not reflect. A GIS also is much more flexible and data-rich than CAD

Less than 5% of utility companies surveyed were confident in the accuracy of their distribution network data.

¹ Esri, "Is Your GIS Smart Grid Ready? A State-of-the-Industry Report," 2010.



White Paper

ADMS enables the monitoring, rapid diagnosis, and control to effectively implement Smart Grid strategies. The Schneider Electric white paper [Preparing for Distributed Energy Resources](#) discusses how ADMS capabilities can transform distributed generation into an efficient asset.

Additional data for ADMS

systems and paper files, and provides quality control capabilities far beyond what those methods offer.

An enterprise GIS further enables an accurate ADMS network model by

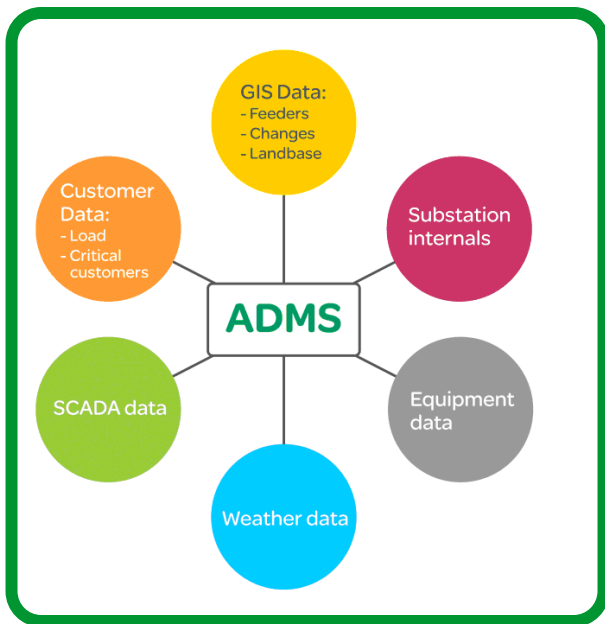
- Reducing the lag between work order and database update, even eliminating the lag when designs and as-built changes are done within the GIS
- Providing actionable information that can be used at any time for storm response and restoration, including fault location and isolation, dispatch, and service restoration and crew management within ADMS
- Hosting data that is readily accessible in the field and within the utility, from the designer's desk to the board room, for operations, analytics, planning, and training
- Facilitating the incorporation and tracking of new and intelligent devices and Distributed Energy Resources, including renewables, storage systems, electric vehicle locations, and microgrids
- Modeling connectivity for Demand Management, including switching; voltage reduction and volt-VAR optimization; load shedding; and customer energy efficiency programs for residential, commercial, and industrial customers

To build a fully functional network model, an ADMS needs more data than is typically available from the GIS. **Figure 1** identifies these other essential data sources. They include:

- Detailed equipment data typically not stored in a GIS, such as short circuit impedances, Thevenin resistance and reactance, susceptance, etc. Specific equipment data required depends on the ADMS applications the utility plans to use. Standard equipment data can be used in some cases when specific equipment data is not available.
- Load and critical customer data, typically imported from a Customer Information System (CIS), SCADA, or Advanced Metering Infrastructure/Meter Data Management (AMI/MDM) system
- SCADA monitoring and control points associated with the correct devices in ADMS
- Substation internals, typically in a one-line diagram or schematic format. Substation internals can be imported from GIS, Energy Management System (EMS), CAD, or paper sources, and then connected to feeders in ADMS.
- To-be-constructed/energized conductors or devices, which are typically imported from GIS and often managed by a graphic work design application. This data can be used within ADMS for planning and analysis, and energized in the ADMS as equipment is energized in the field.
- Weather forecast data, for accurate prediction of both expected load and contribution from renewable distributed energy sources such as solar and wind.

Figure 1

Automated analysis and control by ADMS requires data accessed from multiple databases.

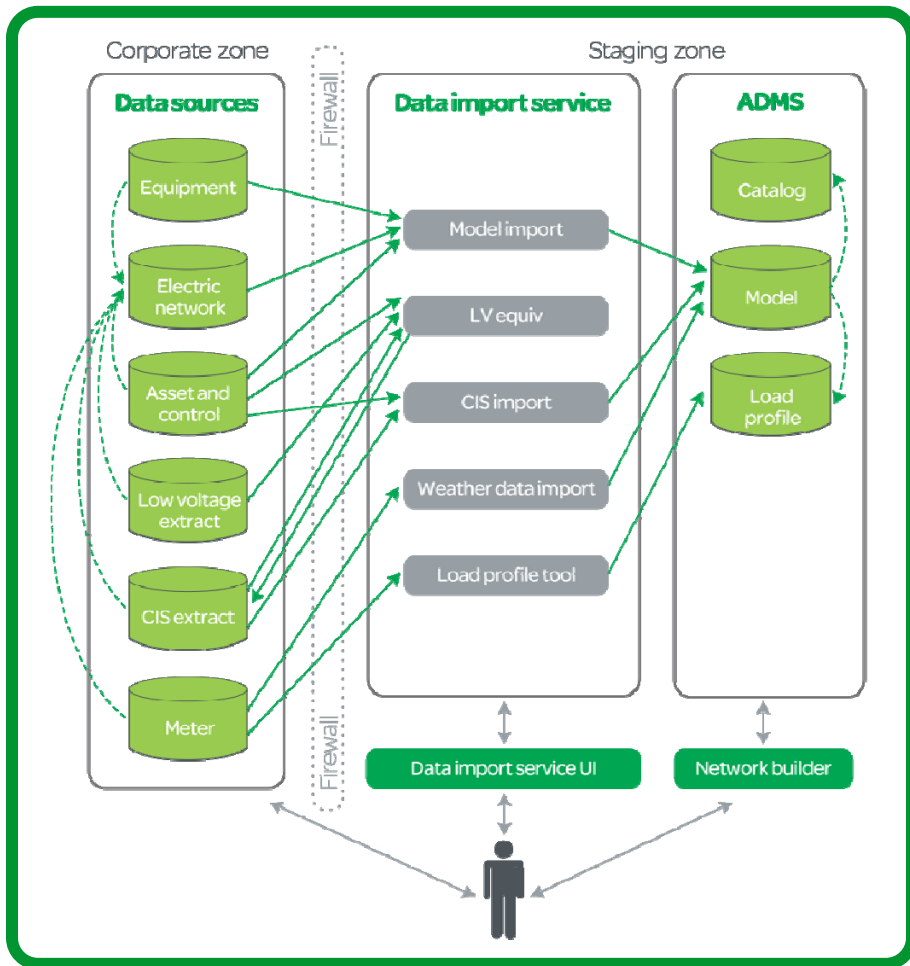


Using the data for a Smart Grid network model

After the utility identifies the enterprise databases and tables needed, configured tools are used to combine the data and validate data for use in ADMS (see **Figure 2**).

Figure 2

Staging enterprise data for network model creation/maintenance



Preparing GIS data

An ADMS database has rigorous requirements. Preparing the data might simply involve adding detail to existing asset and network data, or combining data from different sources. Converting geospatial data that has been maintained carefully in a GIS is fairly straightforward. But it is not uncommon for the quality and detail of GIS data to vary across the service territory, especially for large utility companies.

GIS data quality problems will significantly impact ADMS. Errors with connectivity, phase or voltage mismatches, and missing or out-of-date data will all negatively impact the quality of ADMS analysis and operations.

A combination of validation rules and automated tools can help keep GIS data up-to-date and accurate. Validation rules can flag missing data, help ensure electric connectivity, and check phase and voltage consistency along sections of conductor. However, because there is no simple way to automatically determine outdated data, manual inspection and editing, typically conducted via mobile devices and applications, is required.

Aligning ADMS data

The success of the ADMS model is highly contingent on the quality of the data used to build it. The success of the ADMS model is highly contingent on the quality of the data used to build it. ADMS can be used to provide quality control of imported data. Errors can be discovered during data import or by running ADMS applications to analyze the imported data.

Aligning ADMS model data with real field information is critical. For example, more thorough feeder surveys may need to be conducted to ensure that source feeder data is correct, current, and complete.

A recommended approach is to align data in three steps, or waves, based on business priorities:

1. Power conductors and devices must be in the model with associated detailed equipment data, load data, SCADA points, and substation internals.
2. Quality control and corrections to data need to be made, as necessary, for basic ADMS applications like load flow and state estimation.
3. Quality control and corrections to data need to be made, as necessary, for advanced ADMS applications like Fault Location, Isolation and Service Restoration (FLISR); Volt/VAR Optimization (VVO); Switch Order Management, Network Reconfiguration; and other operations, analysis, planning, and training functions. Wave 3 can be divided into sub-waves, depending on the business priorities of the utility.

Updating ADMS data

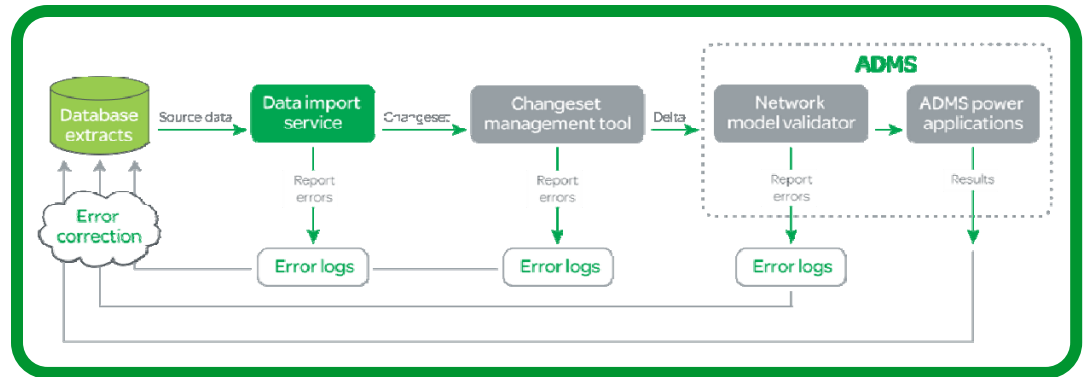
Once the data is loaded in ADMS, several tasks keep the network model data current:

- Make changes within GIS and import new data changes periodically into ADMS. The frequency of data import depends on how often and how significantly the network infrastructure changes. Changes that have an immediate and large effect on the network can be imported as soon as edits are completed in GIS.
- Make small corrections to the network model within ADMS where incremental GIS updates might not be necessary. However, it is important to note that it might be preferable to go back and update the GIS with the correction to ensure that source data is kept current.

'The success of the ADMS model is highly contingent on the quality of the data used to build it.'

Based on the quality of the source data, there might initially be a considerable amount of errors to correct. The ability to resolve these errors is essential for creating a usable ADMS model. **Figure 3** shows a quality control process for incrementally updating the network model.

Figure 3
Feedback loops for model correction



Committing to complete, correct, and current data

Creating and maintaining an accurate network model that supports Smart Grid performance requires a company-wide effort. Like any successful change management initiative, it begins with a strong business commitment at the top and cascades down with buy-in from all parties.

At the highest level, the utility needs to commit to developing the business processes that will sustain the integrity of data once the network model is built. How does one entity hand off information to another? It is to be expected that many business processes will change to ensure data integrity, and it is best if each individual involved in these business processes clearly understands how his or her part fits into, and impacts, the overall process.

Further down the organizational hierarchy, employees need dedicated time to researching, communicating with others, and troubleshooting data anomalies. Many different skill sets are required, including those of power engineers, power and IT technicians, IT programmers, and database experts. Because an ADMS relies on data as similar to the changing real-world conditions as possible, the utility should consider model maintenance as an essential, ongoing activity.

Conclusion

Developing a real-time network model enables a utility to implement Smart Grid demand management strategies and fulfill other Smart Grid business drivers. An Advanced Distribution Management System (ADMS) builds this model based on complete, correct, and current data defining network infrastructure and devices. Consequently, collecting and maintaining accurate data are crucial to a successful ADMS network model. A Geographic Information System (GIS) enables an accurate 'single source of the truth' for conductor and device data.

Here are six actions that utilities must take to ensure a successful Smart Grid network model:

- Adopt a highly focused evaluation of data requirements based on identified business drivers.
- Commit the resources and time to improve the quality and timeliness of GIS and other source data.
- Prepare the data sources needed for ADMS deployment, including performing adequate quality control and correcting errors.
- Define user roles and train operators, engineers, planners, field personnel, and support staff.
- Implement the business processes and change management necessary to create and validate the ADMS model.
- Dedicate resources to updating and maintaining the model.

Maintaining a real-time network model requires a significant commitment, but a properly and fully implemented distribution network model provides significant Smart Grid performance returns.

About the author

John Dirkman, P.E., is a Senior Product Manager, Smart Grid Global, with Schneider Electric's Smart Infrastructure division. He provides product and program management for advanced integrated Smart Grid systems, from concept through sales, design, development, implementation, and maintenance. John has served as product and program manager for a wide variety of Smart Grid implementations and currently is responsible for driving technical Smart Grid vision and strategy. He is an active member of the Institute of Electrical & Electronics Engineers (IEEE) and the IEEE Power & Energy Society.



[Preparing for Distributed Energy Resources](#)