21, rue d'Artois, F-75008 PARIS
http : //www.cigre.org

CIGRE US National Committee
2017 Grid of the Future Symposium

Effective Management of Distribution Grid Model Data

P. BROWN, J. SIMMINS, J. GREEN
EPRI
U.S.A.

SUMMARY

Effective management of geospatial and grid model data is one of the major challenges facing electric distribution utilities today. Siloed network analysis tools in multiple domains across the enterprise create fractured data storage, duplicated data entry, 'one off' point-to-point interfaces, and convoluted business processes. Utilities struggle with incorrect or missing GIS data, difficult-to-maintain grid models, and information that is out-of-sync with the field.

These problems will scale up as levels of DER penetration increase and distribution grids grow increasingly complex. Utilities will need a solid foundation of well-managed geospatial and grid model data on which to deploy the new software tools that effective grid planning and operation will depend on in a future that includes substantial DER.

The collaborative efforts of the industry – utilities, vendors, academia and research organizations is needed to develop an industry vision for effective GIS and grid model data management. Areas of investigation should include:

- Cost-effective strategies for achieving and maintaining accurate GIS data and consistent grid models for use across distribution planning, engineering, and operations
- Creation of industry consensus on the functionality of tools required for managing distribution grid models and the importance of effective grid model management
- Encouragement of field crew engagement in the maintenance of grid model data and the use of such data to improve field crew productivity and safety
- Creation of an industry architecture for distribution geospatial and grid model data management

The goal is effective management of grid information from its source in the field through its appearance as a geospatial model in the GIS, to its ultimate transformation into grid models consumed by multiple applications across the planning, protection and operations domains of the distribution utility.

Synthesizing knowledge developed collaboratively will contribute to interoperability standards and encourage product enhancements that enable effective GIS and grid model management strategies and deployments for utilities.

KEYWORDS
Grid model data management, Data management architecture, Standards-based integration, Common Information Model

pbrown@epri.com

Background
The increasing deployment of distributed energy resources (DER) into the distribution grid poses major challenges for distribution utilities. The potential benefits offered by DER have occasioned regulatory, technological, and societal changes the likes of which have not been seen in the distribution world in decades. Customer expectations, equipment capabilities, generation locations, ratemaking policies, energy market services, 3rd party players, and environmental concerns are in a state of flux. Utility practices in planning, operating and protecting the distribution grid are impacted: business approaches, data, and simulation models which have been effective for years are now proving to be insufficient to efficiently and reliably interconnect, integrate, and utilize DER in the electric grid.

The utility industry is devoting significant effort to integrating new customer technologies into the distribution system. However, the industry has yet to fully address either the simulation or data model challenges associated with this evolution. Research is starting to identify functions where improved simulation models are needed in both the operations and planning domains: DER screening, expansion and capacity planning, evaluation of non-wires alternatives, hosting capacity analysis, adaptive protection, energy efficient grid operation, and automated fault identification and restoration, to name a few. While the design and algorithmic approaches of those simulations are a topic of ongoing research activity, one thing is clear: all of them will require that utilities have accurate, accessible, sufficiently detailed grid model data. The current capability of utilities to provide such data varies widely across the US and abroad. Some utilities have full models of every distribution feeder. Other utilities, however, may have no models of their distribution system at all and use rules-of-thumb for planning and paper maps and field crew intelligence for operations. Regardless of location, size or ownership, most utilities reside somewhere in between—models are available, but have been created in certain areas only or on an as-need basis.

The Challenge
Many visionary distribution utilities, aware of the planning and operations challenges ahead of them, recognize that improvement of their network model data management practice is essential. However, efforts to improve distribution grid model data management today face several fundamental challenges:

- Such efforts, must, by necessity, take place in a shifting ecosystem of software solutions. Product market niches are being created and are evolving. Vendors are appearing, merging, and going out of business. Utilities trying to implement improvements must deal with enormous uncertainty related to the future functionality, support, and viability of products they choose to deploy.
- Undertaking data management improvement of any sort, along with its supporting application integration, is never trivial. In the case of grid model data, there are work groups from the operations, planning, protection, design engineering, field operations and IT areas that must be engaged and cross-work group understanding and collaboration must be fostered. Success is dependent on a set of essential data management strategies (semantic model-based application integration, business process design, and data governance) requiring skills which are often not mature at utilities.
- Building solid integration foundations is an investment whose cost is front-end loaded and benefit is back-end loaded. Like other areas of human endeavour (transportation systems, delivery systems or manufacturing processes) where initial frameworks must be built before productive activity can occur, the creation of underlying data management and integration solutions implies an initial outlay of effort and resources with payback occurring over time.

The Vision
The network model management foundation able to provide accurate, accessible, sufficiently detailed grid model data for the multitude of functions envision by the forward-looking utility will have the following hallmarks:

- Data whose value is recognized, acknowledged and accepted

- Clear roles for applications and well-defined automated data exchanges supported by effective business processes
- Well-architected, semantic model-based data integration with documented data flows
- Effective enterprise-wide data governance
- Successful tracking and managing of highest priority data (including history as appropriate)
- Single system of record for each piece of data (Master Data Repository)
- Easily accessible data
- Facilitation of accurate, natural data entry

A utility, and indeed our industry, can build a solid data management foundation possessing these characteristics only by following an intentional approach based on solid design principles and founded on a functional, process-driven architectural vision. By providing a high-level view of applications, the data they store, the functions they perform, and the data flows between them, a forward-looking data management architecture will allow vendors to create products that produce and consume grid model data in standard forms and will allow utilities to effectively implement the collections of integrated systems and tools necessary to support the distribution grid of the future.

The Plan

The definition of an industry architecture for the management of grid model data is the focus of a recently launched EPRI project. With participation from a growing number of utilities, the project proposes a multi-pronged approach to improving geospatial and grid model data management. Since geospatial data is the usual source of distribution grid models, the first area of focus for the project is GIS Data Cleanup. Because field crews are the ultimate holder of knowledge about the actual distribution grid, Field Crew Enablement is the second focus. The third is Distribution Grid Model Management, which leverages the results of first two areas and provides accurate, up-to-date grid models to existing and emerging grid simulation applications.

The work planned by the project includes:

<u>GIS Data Cleanup</u>

As more simulation models require detailed, accurate grid model data, the need for GIS systems to easily and efficiently source up-to-date equipment and connectivity information grows. There are numerous obstacles utilities face in their efforts to make GIS systems effective grid model data sources, including:

- The distance between the knowledge of a change in the field and the final update in the GIS makes maintaining timely data difficult.
- The historic role of GIS systems has been the tracking of asset and geo-location data – it hasn't been the maintenance of equipment connectivity and electrical behaviour information.

The project will address these issues with the following tasks

1. Exploration of technologies with potential for GIS data cleanup
   Many utilities are considering investments in multi-million dollar initiatives to deploy personnel to the field to capture accurate GIS information. Technology options using existing data and emerging data analytical techniques hold promise for significantly higher benefit-to-cost solutions for capturing accurate field data.
2. Documentation of geospatial model population best practices
   Geospatial modeling tools have a broad range of capabilities and a great deal of flexibility in how asset/geospatial data is organized, populated and displayed. The project will compile a set of best practice recommendations. It is envisioned that recommendations will be both industry general and product-specific, taking vendor product capabilities into consideration.

<u>Field Crew Enablement</u>

Field crews are both the ultimate producer and consumer of knowledge about the distribution grid as it exists in the real world. It seems unlikely that a truly successful grid model data management solution could be implemented without the participation of field crews in the provision of up-to-date information describing what equipment is installed where in the field. Enabling the operations functions that utilities envision (like Volt/VAr control, adaptive protection, FLISR, grid efficiency

improvements, real-time optimization of DER, etc.) will require accurate, timely updates that can be effectively sourced only from the field.

1. Alternate solution architectures report
   There are a multitude of mobile solutions currently on the market, some of which are host application-specific, some of which are app-based, and some which have interfaces to multiple systems. An evaluation will be done of representative technology approaches, their general architectural approaches and their strengths/weaknesses with respect to data management and application integration.
2. Demonstration project
   Utility-hosted demonstration projects are planned which will implement field enablement pilots which leverage data exchange standards and test the best practices described in the report.

<u>Distribution Grid Model Data Management</u>

A series of activities will design and articulate an industry vision for an architecture for effective, enterprise-wide management of geospatial and grid model data. Initial deep-dives at five utilities, patterned after work EPRI has done in the transmission domain, will provide a foundational understanding of requirements and the opportunity to vet and refine the architectural vision. To improve the 'deployability' of the architecture, the IEC Common Information Model standards will be enhanced with inputs from the project, the requirements for a distribution grid model management tool will be defined, and significant socialization of the results of the project will be undertaken.

1. Geospatial and grid model data management utility deep-dive
   The project proposes to investigate typical practices in managing geospatial data (particularly detailed engineering design data) and grid model data and identify common requirements and data management problems. This work is patterned after the Integrated Network Model Management (INMM) project work EPRI has been doing in the transmission domain over the last 3 to 4 years. In that project, EPRI guided each participating utility through a series of steps intended to help the utility launch a major network model data management improvement initiative. Steps included documenting existing network model data flows, articulating a solution vision for effective network model data management, vetting the solution with utility SMEs, outlining likely benefits of such a solution, and describing a set of 'next steps' for the utility to consider in starting on the path toward improved network model management.
2. Design and articulation of industry vision for distribution grid model data management
   An industry vision for GIS and grid model data management is essential for creating an environment where vendor products can meet the needs of utilities. A GIS and grid model data management architecture for distribution, expressed in terms of application functions and information exchanges among those functions, will allow vendors to create products that produce and consume data in standard forms and it will allow utilities to effectively implement collections of integrated products.
   From the work done in the utility deep-dives, an industry distribution GIS and grid model data management architecture will be designed and subsequently vetted by project participants. The architecture will be illustrated in a publicly available report.
3. CIM standards development work
   Advancing and clarifying the CIM standards which provide information exchange models for asset data, geospatial configuration (or engineering design) data and network analysis data is the purpose of this task. The intent is to improve the salient CIM standards (currently all parts of 61970, plus 61968-13 Distribution Network Models and 61968-4 Assets) to encourage vendor development of compliant products and interfaces. Proposed activities include:
   - Revision of the CIM Interface Reference Model (IRM) to represent the functional actors that participate in creating the asset, geospatial /engineering design, and grid model data management foundation
   - Documentation of use cases describing asset, geospatial/engineering design and grid model data management, which are based on the updated CIM Interface Reference Model and outline the data exchanges the revised CIM standards need to support
   - Evaluation of the need for standardized geospatial/engineering design data models, investigation of available standards for expressing such standardized models, and

initial development of a geospatial /engineering design model for inclusion in the CIM standard if that appears to be the best path based on participant consensus
    - Enhancement of the CIM asset and distribution network analysis data models as necessary to support effective management of geospatial/engineering design and grid model data in the distribution domain
    - Documentation of findings and submission to the IEC for revision of existing IEC standards or the creation of new standards
4. GIS Grid Model Manager Technical Market Requirements report
   Definition of the functions a GIS (or related system) must implement to support the creation of distribution grid models from geospatial/engineering design data is the purpose of this task. This activity will use the distribution grid model data management architecture and the use cases developed during the utility deep-dives to help identify an initial set of functional requirements for a distribution grid model management tool which will be refined with input from all project participants.
   Tasks are planned to include:
    - Defining grid model data requirements for DMS, OMS, planning tools, and visualization platforms
    - Analyzing how grid model data needs to be managed to meet those requirements in areas like:
        - planned projects and model history (aka temporal modeling)
        - as-built vs as-operated vs future
        - substation/overhead/underground models
        - boundaries between distribution and transmission
        - case assumptions like loads/generation/voltage regulation/switch state
        - the assembly of data into models for export to consuming applications
    - Identifying grid model data sources, including asset and geospatial/engineering design data from GISs, and evaluating how they support effective, efficient, robust creation of grid model information
    - Consideration of the various work groups from which source data comes

5. Socialization of industry distribution grid model data management architecture
   EPRI and project participants will socialize the industry GIS and grid model data management architecture in magazine articles and social media and at conferences and industry group meetings.

The project is officially launching in September of 2017 and is slated to run for 30 months.

BIBLIOGRAPHY

[1] *Distribution Modeling Guidelines: Recommendation for System and Asset Modeling for Distributed Energy Resource Assessments (Executive Summary)*. EPRI, Palo Alto, CA: 2016. 3002008894

[2] *Launching a Distribution Data Management Improvement Initiative: Utility Case Study*. EPRI, Palo Alto, CA: 2017. 3002009504

[3] *Distribution Geographic Information System and Grid Model Data Management*. EPRI, Palo Alto, CA: 2017. 3002009807

[4] *Using the Common Information Model for Network Analysis Data Management: A CIM Primer Series Guide*. EPRI, Palo Alto, CA: 2017. 3002002587