Applying the Grid Model Data Management (GMDM) Information Architecture at the Distribution Utility

Technical Brief — *Information and Communication Technology*

Introduction

From the beginning, electric utilities have needed to understand and manage grid behavior. Starting as early as the 1930s, elaborate analog tools were used to simulate power systems with fixed (and limited) numbers of circuits and generators. Digital simulation programs began to be used in the 1960s to support transmission grid planning, and, in subsequent decades, the software systems used in transmission operations and markets incorporated the use of network analysis. Today network analysis products are employed universally and ubiquitously in transmission and the need for accurate, accessible, timely transmission grid modeling is clear and compelling.

In distribution, on the other hand, routine, widespread use of grid simulations is relatively new. While distribution planning products have been around for quite a while, much of distribution engineering did not require network analysis and, if it did, manual enhancement of a starting point model acquired from a (Geographical Information System) GIS was a reasonable, if time-consuming, approach. Over the past decade, however, increasing distribution complexity has driven growing use of analysis, both in distribution operations and (because real-time grid behavior needs to be studied ahead of real-time) in distribution planning. And distribution utilities are coming to the realization that they, too, have an urgent need for accurate, accessible, and timely grid modeling.

The most effective approach for meeting the need – enterprise scale grid model management - is quite well understood in transmission and is starting to become a familiar concept in distribution. The approach calls for consolidated management of grid model data, based on an overarching design, enabled by a grid model management tool, and supported with appropriate business processes. It is an approach that holds significant long-term promise for increasing a utility's ability to understand, manage and optimize the behavior of its grid while reducing the required resources. It is also an approach that works. There are real-world examples - the leading one being the Network Model Management System (NMMS) implementation at the Electric Reliability Council of Texas (ERCOT). But it is an approach that many utilities have found challenging to implement.

This technical brief explores the challenge of implementing consolidated enterprise-wide management of grid model data at the distribution utility. It examines existing grid model data management practice and how distribution system characteristics, typical distribution software tool usage, and historic software integration approaches have combined to create the expensive, brittle data sharing solutions often found at distribution utilities today. It identifies common obstacles that distribution utilities face in trying to move toward more comprehensive, efficient grid model data management. Finally, it proposes a strategy, based on EPRI's experience with utilities—both transmission and distribution—over the last decade, for moving forward toward effective grid model data management.

Cohesive Distribution Grid Model Data Management is Important, Urgent and Perplexing

Distribution is an area of tremendous innovation, especially but not exclusively focused around Distributed Energy Resources (DER), how DER are managed, and what the consequences of DER activity are to feeder design and operation. The distribution grid of the future is no longer passive. It consists of numerous semi-independent agents that the utility is responsible for knitting into a reliable overall operation. This creates challenges in active system management the likes of which have not been seen previously in distribution.

What will it take for distribution utilities to meet this challenge? A solid bet is that network analysis will increasingly be at the core of future solutions. It is expected that distribution operations will maintain a real-time steady-state solution of the present state. Operations will study switching prior to initiating switching. It will examine contingencies and study mitigation of alarm conditions. It will run analysis to determine optimum control settings. It will supply transmission with dynamic models of distribution. In addition, the assumption is made that distribution planning will require all the same data as distribution operations and will need to support all the same applications, plus more that deal with optimizing grid expansion and facilitating engagement of DER developers and end consumers. The time constraints will be somewhat less demanding in planning than in real-time operations, but the scope of studies will be greater.

Every one of the network analysis tools which enable distribution utility management of the future grid will rely on accurate, complete, and up-to-date grid models. And this will continue to incrementally "up the ante" in terms of required grid model quality, currency, and accessibility. Based on feedback from EPRI's members, distribution utilities are becoming acutely aware of the urgency of this situation and equally anxious about what course of action is appropriate to deal with it. There is a growing sense that a utility should frame its response to the grid model management challenge proactively, with the goal of supplying accurate and complete models to all its grid simulation tools. But visualizing what the solution looks like – what tool capabilities are necessary, when and where data should flow, what business processes or work group responsibilities must change – is daunting. And figuring out the steps to be taken to achieve the solution appears even more difficult.

EPRI's assessment is that a comprehensive revision of the management of network analysis data to establish a solid base architecture is the right move. It is a huge job that should be done once and done right. Such a program will admittedly rely on a vision of the future where the precise nature of every upcoming requirement is not known and on a path which will evolve as understanding is gained. But it is certain that the enterprise-level approach that has been demonstrated as effective in transmission is the best way to enable efficient, and inexpensive, deployment of new applications to meet new distribution requirements, whatever they turn out to be.

The Vision for Effective Distribution Utility Grid Model Management

In its "*Introduction to Grid Model Data Management: A Best Practice Approach to Managing Distribution Grid Model Data,*"[1] EPRI outlines a vision for enterprise-wide management of grid model data: grid model data is entered once and leveraged across the enterprise, supplying grid analytics and simulations in planning, operations, and markets with accurate, easily accessible grid models. Data management processes are streamlined, applications interoperate seamlessly, errors are caught and corrected early, simulation results are accurate and can be shared among applications, and the distribution utility is positioned to add new analytics with a minimum of effort and cost.

The vision leverages the Grid Model Data Management (GMDM) information architecture, where a Grid Model Management function is introduced between suppliers and consumers of grid model data. (See Figure 1.) The Grid Model Management function gathers source data and maintains a master repository of behavioral grid modeling for the electric distribution system and hosts a variety of model transformation and assembly activities that create the modeling required by grid model consumers.

A utility solution which aligns with the GMDM information architecture would enable all users of distribution grid modeling, regardless of the utility function they support, to receive accurate, accessible, timely grid models supplied with data from the same single source of truth by fully automated processes.

Challenges to Realizing the Vision

As appealing as the argument is for enterprise management of grid model data, a combination of conditions often makes the vision seem out of reach. Some of the conditions are general to all industries, some are specific to the electric utility industry and yet others are due to characteristics prevalent uniquely within the distribution domain.

At a broad level, implementing enterprise-wide data management for any type of data in any sort of industry is difficult. An organization serious about doing so faces a serious set of challenges. It needs to be able to engage a variety of work groups to develop a shared understanding and a shared vision for data management at a enterprise level; it needs to

1 *Introduction to Grid Model Data Management: A Best Practice Approach to Managing Distribution Grid Model Data.* EPRI, Palo Alto, CA: 2022. 3002025384.

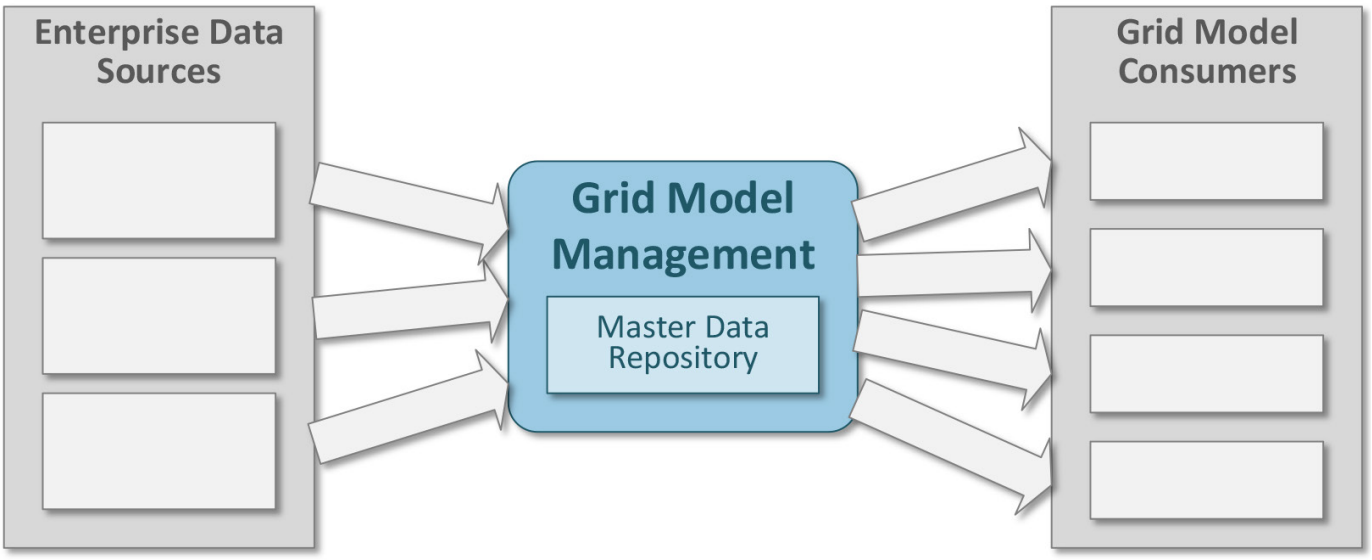

Figure 1 – Basic Grid Model Data Management (GMDM) architectural concept

develop an architecture that governs data flows among applications and to design and implement interfaces that align with it; it needs to implement data governance that enables local control of data in line with organizational goals; it needs to fund and support what is almost invariably a multi-year, incremental improvement effort; and it needs to do major change management as roles, responsibilities, business processes and applications evolve over time. In most industries, including the electric industry, meeting these challenges requires a set of skills and background experience not common within the organization.

At electric utilities another challenge emerges: Utilities in general approach the implementation of software technology from a 'buy not build' approach. Vendor capabilities are relied on heavily, not just for the development of software tools but also for the design and implementation of interfaces between tools. This leads, almost inevitably, to a view of interfaces as solutions that facilitate communication between two applications, not as solutions in service to the management of data across the enterprise. This is not a criticism of vendors – they are naturally limited to the view that their products afford them of the application landscape, and they serve multiple utility customers whose patterns of product choice and product usage can vary widely. There is very little opportunity for a vendor to develop the comprehensive view necessary to implement effective enterprise-level grid model data management at any given utility.

For the electric distribution utility, there are an additional set of challenges that make it difficult to figure out how to transform the existing landscape into a streamlined solution. Common factors, typical across distribution utilities, that contribute to this situation are:

- ***Widespread existing use of custom point-to-point automated interfaces.*** Existing interfaces are typically designed simply to move data from one application to another. Rarely will these interfaces be capable of contributing to enterprise data management. But because interfaces already exist at distribution utilities, it's easy to think in terms of interface reinforcement, when what is really needed is comprehensive redesign.
- ***Silo-bounded thinking that inhibits insight into enterprise-wide requirements, ideas, and solutions.*** Utility work groups are focused on doing their own work well and quickly and often have little opportunity to consider how processes work or information flows among work groups. Critical insights, like the important role construction projects play in managing the evolution of a utility's grid model, are easy to miss.
- ***Geospatial Information Systems (GISs) that are perceived as already doing grid model management.*** GISs are utility workhorses hosting a wide range of data and supporting increasingly sophisticated visualization and spatial analytics. But, in general, they fall short in providing the full range of grid model management functions, including support for substation or mesh network connectivity modeling, for projects described as standalone sets of changes, and for future model building and case assembly. Envisioning an effective model management future requires an understanding that new software capability needs to be added, either by significant augmentation of existing tools or by the addition of new applications.

It's not hard to see why distribution utilities, faced with the myriad challenges described above, have difficulty in envisioning and achieving enterprise-wide grid model data management. The unfortunate consequence is that the industry continues to implement one-off integrations with nearly every new system deployment – a situation that serves only to make the existing picture more and more complicated, fragile, and inefficient.

A Best-Practice Approach to Enterprise Data Management

Despite the current challenges faced by distribution utilities in moving toward better grid model data management, utilities are fortunate that a number of crucial components required for progress are in falling into place. The effort to manage grid model data using a single source of truth approach has parallels with similar efforts to manage various types of data effectively at an enterprise level at organizations in general. There is an enterprise architecture philosophy, called 'data centrism', which is gaining traction across a variety of industries, which speaks clearly to the benefits of managing data at an enterprise level. The data centric philosophy of automation puts data, not applications, at the core of the enterprise. It is an approach that views data as a valuable and versatile asset instead of an expensive afterthought. It advocates a view where applications collaborate to create, manage, and leverage an enterprise's data as effectively and seamlessly as possible.

Not surprisingly, many of the underlying precepts of EPRI's grid model management philosophy align very closely with various facets of the data centric approach. A recently published EPRI white paper, "*Exploring a Data Centric Approach for Digital Utilities: Why Getting Data 'Right' Matters*"[2] identified four main components of data centrism:

- ***An enterprise semantic model.*** An information model that defines the structure and meaning of a utility's shared data, which not only supports enterprise-wide understanding of the data of a utility but also provides the data structure which application interfaces must support.
- ***A data architecture for each data domain.*** A design for the management of a particular type of data across the enterprise, from the business functions involved in data creation and consumption, through the application functions and the application components that serve the business functions, down to the data exchanged between the applications and the underlying technology that stores and moves data.
- ***A data governance capability.*** The organization and processes that ensure ongoing data integrity, optimize data value and guide future data-related improvements.
- ***An enterprise data team.*** The unit of business responsible for maintenance of the enterprise semantic model and each data domain's data architecture and for the ongoing success of data governance.

2 *Exploring a Data Centric Approach for Digital Utilities: Why Getting Data 'Right' Matters.* EPRI, Palo Alto, CA: 2021. 3002021349.

The first two components are technical and represent a huge part of the 'lift' in achieving enterprise-wide management of any type of data. Here's where the news gets good in the distribution grid model management world:

- ***The Common Information Model (CIM) provides a mature, full-featured, industry-recognized information model.*** It is a model on which a utility could and should build the grid model portion of its enterprise semantic model. (The CIM's support for distribution grid model data management is explored in a companion EPRI report, "*Common Information Model (CIM) Support for Distribution Grid Model Data Management*."[3]) Not only is the CIM a solid model, built on decades of industry insight, the fact that it is an industry standard means that the interfaces on vendor tools are likely to come close to aligning with it 'out of the box'. (This is not just a pipe dream: see below for more information on EPRI's Grid Model Data Management (GMDM) Vendor Forum.)
- ***The EPRI-developed Grid Model Data Management (GMDM) information architecture provides a business function-based framework for understanding the complex picture of grid model data.*** It describes grid model data as it exists and is used across the utility enterprise and throughout its lifecycle. This industry-level framework is an invaluable reference for a utility in designing its grid model data architecture: it provides the comprehensive backdrop against which application requirements can be understood and specific data exchanges designed in service of broad enterprise data management. (The GMDM information architecture, describing grid model data management in business function terms, is available in an EPRI report, "*The Grid Model Data Management (GMDM) Information Architecture in ArchiMate*."[4])

The last two components are organizational. Their development, along with the development of the utility portions of the two technical components, will be discussed later in this report as part of the activities to be undertaken by a utility in the process of moving toward enterprise-wide grid model data management.

Mention has been made previously in this Brief regarding the critical role that vendors play in utility enterprise data management. There are a couple important areas where vendor tooling support for the distribution grid model management vision is essential: 1) in the development of interoperable, product-based, CIM-standard interfaces that align with the GMDM information architecture and 2) in the creation (or enhancement) of vendor software products to fully implement the capabilities needed to meet the requirements of the grid model management business function.

In relation to the first area, EPRI recently organized and led a GMDM Vendor Forum, which vetted the GMDM information architecture and refined the CIM to better support unbalanced distribution grid modeling. Ultimately, in June of 2022, ten members of the Vendor Forum demonstrated the exchange of data using CIM-based building blocks aligned with the GMDM information architecture in the GMDM Interoperability Event, which was managed by the UCA International Users Group (UCAIug). The work of the GMDM Vendor Forum is a solid start on making standard, interoperable interfaces available on the tools distribution utilities use to create, manage, or analyze grid models. More information on the GMDM Vendor Forum is currently available on EPRI's Distribution GIS and Grid Model Data Management website[5] and Interoperability Event artifacts will be permanently housed on the CIM portion of the UCA® International Users Group website.[6]

Progress is also being made in the other area of need: the availability of tools which implement a comprehensive set of grid model management functions. There is a growing population of candidate distribution Grid Model Manager (GMM) tools: several vendors currently supply transmission-focused GMM tools, three vendors at the GMDM Vendor Forum participated in data exchanges in the GMM role, and several vendors of tools that either supply or consume grid model data are considering entry into the market. While no existing vendor tool fully implements all the capabilities required to fulfill the distribution grid model management functional requirements envisaged in the GMDM information architecture, the following vendors are positioning their tools as candidates to do distribution grid model data management:

- GE with its e-Terrasource tool
- Siemens with its ODMS and IMM tools
- Open Grid Systems with its CIMphony suite of tools
- IPS with its INMM tool
- OSI with its CIM Studio tool
- Digpro with its DpPower tool
- Bentley with its OpenUtilities Digital Twin Services

To encourage the development of GMM tools with the complete set of capabilities currently called for by the GMDM information architecture, EPRI has published a report titled, "*Distribution Grid Model Manager (GMM) Functional Requirements*"[7] which outlines the high-level functional and technical capabilities that a full-featured grid model management tool needs to implement.

All told, the future picture is promising for distribution utilities. A solid foundation comprised of a high-quality industry semantic model, the GMDM information architecture, and significant vendor engagement is emerging on which a utility could base its plan for effective grid model data management.

3 *Common Information Model (CIM) Support for Distribution Grid Model Data Management.* EPRI, Palo Alto, CA: 2022. 3002025386.

4 *The Grid Model Data Management (GMDM) Information Architecture in ArchiMate.* EPRI, Palo Alto, CA: 2022. 3002025385.

5 EPRI website page – The Integrated Grid Online Community: Distribution GIS and Grid Model Data Management, http://integratedgrid.com/distribution-gis-and-grid-model-data-management/

6 CIM portion of the UCA® International Users Group website, www.cimug.org

7 *Distribution Grid Model Manager (GMM) Functional Requirements,* EPRI, Palo Alto, CA: 2022. 3002025388.

Starting the Journey toward Effective Grid Model Data Management

EPRI has done grid model data management initiatives with more than 25 utilities over the course of the last decade, exploring existing practices, developing shared visions, and outlining strategic roadmaps for implementation. It has been gratifying work and a general sense of how a utility ought to approach the beginning of its journey toward improved grid model data management has emerged. The caveat, however, is that few distribution utilities have yet to traverse very far along the path. There are some that are on their way (Southern California Edison, Jacksonville Electric Authority, Snohomish Public Utility District, Ameren, Radius (Denmark), and the Provincial Electricity Authority (Thailand) are examples which provide inspiration), but an industry body of knowledge has yet to develop related to implementation experience.

Given that caveat, the following is offered as a possible strategy for getting started on the journey toward improved grid model data management.

Overall Approach

While each utility has ultimate responsibility for the shape of its solution and the process followed in achieving it, EPRI offers, as a general outline of the journey toward effective, enterprise-wide grid model data management, the steps pictured in Figure 2.

A set of initial launch activities (Launch 1) is undertaken by a small task force that focuses on understanding existing utility practice and the benefits that could be gained from grid model management improvement. After gaining approval to proceed, a second set of launch activities (Launch 2) builds team capabilities and knowledge about the industry state of grid model data management before moving on to define a utility-specific grid model data management vision and outline a phased deployment strategy for achieving it. Upon approval for continuation, a third set of activities (Launch 3) undertakes the detailed planning for Phase 1, including creation of a formal business case, which when approved, will initiate the first in a series of phases of implementation activities, each of which makes progress toward the utility's grid model management vision. At the end of each phase, the vision is refreshed, the phases adjusted as necessary, and the activities of the next phase planned.

Any enterprise-wide data management initiative needs to be viewed as an incremental process which gradually moves an organization toward its desired goal, not as a 'big bang' implementation which gets the organization to the destination all at once. This incremental philosophy underlies the strategy EPRI proposes.

More detail on each of the launch activities is provided in the following sections.

Launch 1 – Strategic Direction Setting

Launch 1 allows a utility to explore the concept of grid model management and its relevance to the utility situation without ramping up a full-scale project. It fosters development of a shared understanding of the potential value of enterprise-wide management of grid model data and positions the utility to undertake the larger design and planning activities of Launch 2 and 3. Five main activities are suggested for Launch 1:

- ***Assemble a task force to explore grid model data management.*** Pick a lead who understands both today's challenges and those likely to emerge in the future relative to power system modeling. Augment the team with interested/visionary individuals, with at least one representative from:
  - Operations
  - Planning and Protection
  - GIS
  - Facility Design (considering both substation and line design)
  - Work/Construction (again both substation and line work)
- ***Learn a bit about enterprise data management and the vision of EPRI's GMDM information architecture.*** Gain a high-level understanding of the concept and potential benefits of viewing and managing data from an enterprise perspective. The first seven chapters of Dave McComb' s "*The Data-Centric Revolution: Restoring Sanity to Enterprise Information Systems*"[8] provide a good general background. And EPRI's "*Why Does Distribution Grid Model Management Matter?*"[9] newsletter and "*Introduction to Grid Model Data Management: A Best Practice Approach to Managing Distribution Grid Model Data*"[1] Technical Brief examine the concept from the electric utility perspective.

8 The Data Centric Revolution: Restoring Sanity to Enterprise Information Systems, by Dave McComb ISBN 9781634625401 (ISBN10: 1634625404)

9 *Why Does Distribution Grid Model Management Matter?* EPRI, Palo Alto, CA: 2021. 3002022737)

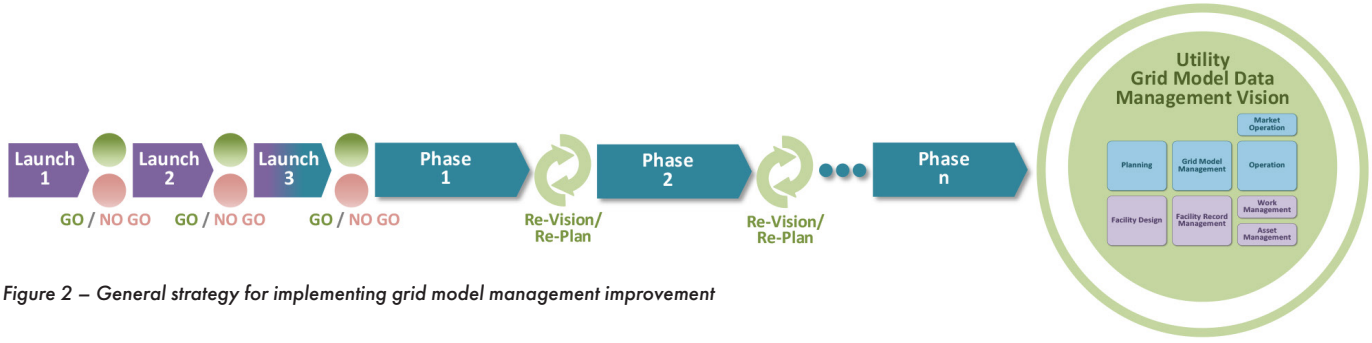

Figure 2 – General strategy for implementing grid model management improvement

- ***Understand the utility's drivers for grid model management improvement.*** Develop a general sense of the utility's business drivers, how they are changing, and their implications for grid data management. The GMDM information architecture can be used as a reference in identifying grid model data-related business areas where drivers are likely to have impact.
- ***Document the utility's as-is grid model management practice.*** Document where grid model data starts and where it flows across the utility. Identify the applications where data is created and used. Capture the 'type' of data that flows between applications and the work group responsible for transfer (as well as whether the transfer is manual or automated). Whatever technology (e.g., Visio, PowerPoint) or language (e.g., ArchiMate) the task force is comfortable with can be used for the documentation. It's important to note that this exercise is high-level and is focused on the type of data being shared and the supplying consuming applications, not the software/hardware infrastructure supporting either the exchanges or the applications. See Figure 3 for a simple example of as-is documentation. In EPRI's experience, this activity is most beneficial if multiple work groups are included in conversations – it is an opportunity for building shared understanding and cross-work group engagement.
- ***Develop a sense of the anticipated benefits of the vision.*** Every utility will have its own specific areas where the benefits of improved grid model management will be manifest. Explore typical benefits and identify those with the greatest relevance to the utility. Typical types of high-level benefits include:
  - Reduced Cost
    - Data maintenance and quality control labor is reduced
    - A well-designed application integration solution reduces the cost of application upgrades and future tool deployments
  - Improved Quality
    - Data quality, consistency and completeness are improved as updates are managed at the single source of truth
    - Likelihood of errors in network studies is reduced
  - Operational Efficiency
    - Regulatory compliance and security requirements are more easily addressed
    - Engineers can respond faster to both normal and ad hoc requirements for studies
    - Implementers can respond faster to new requirements for automation

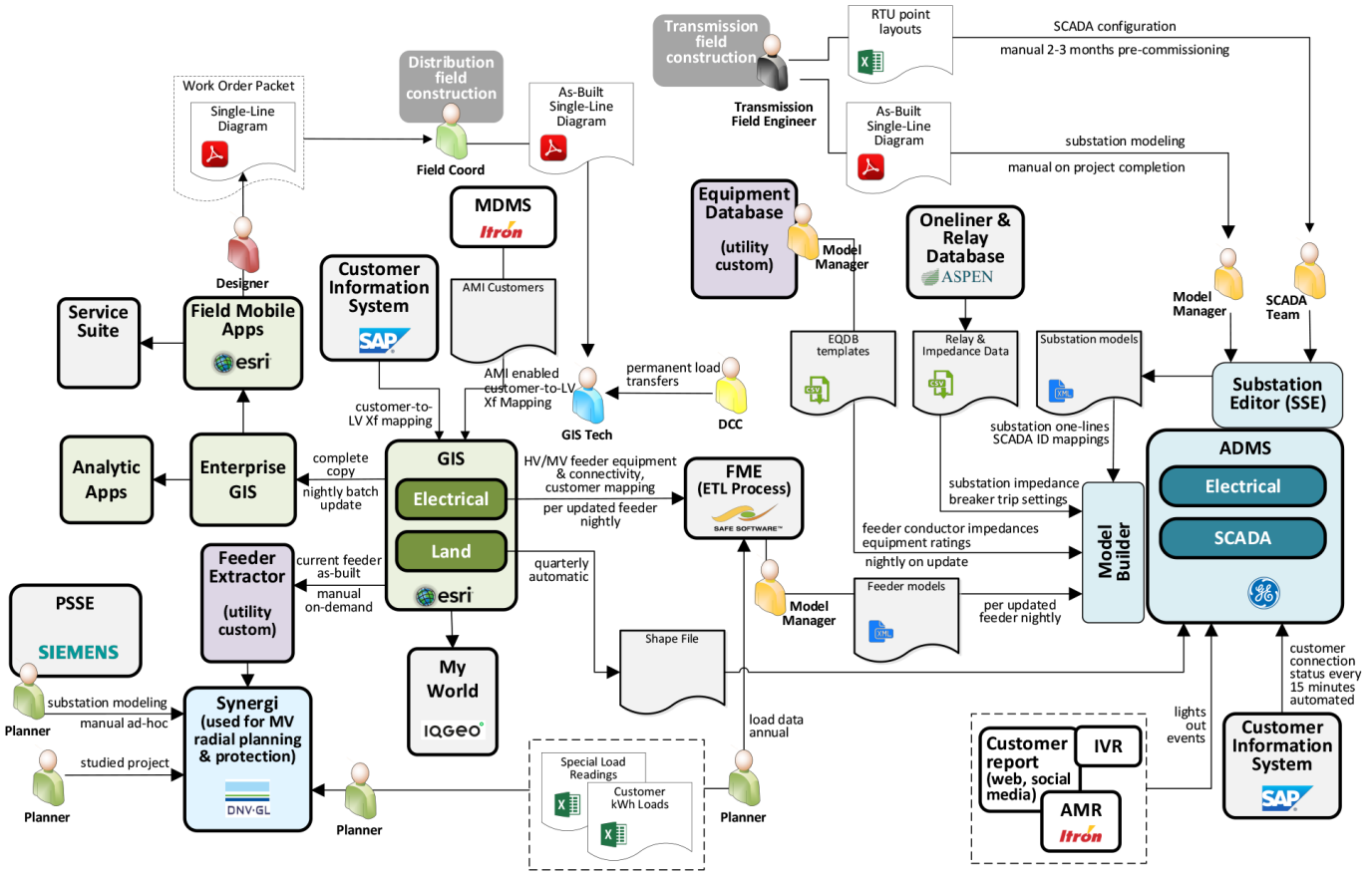

Figure 3 – Simple example of as-is distribution grid model data flow diagram

At the completion of Launch 1, the task force will have developed a general understanding of enterprise-wide grid model data management and the value it could bring to the utility. The task force will be in the position to create a business case for proceeding with a project to execute Launch 2 which can be taken to utility leadership. A note on 'utility leadership': any enterprise-wide grid data management initiative will ultimately require support from the executive ranks of every department or division whose work teams are impacted by the initiative. Engaging every stakeholder executive as early as possible will improve the chances of having the widespread, long-term leadership support a grid model data management initiative will inevitably require.

Launch 2 – Visioning and Planning

Education and Investigation

Once approval has been received to continue work, a set of activities intended to build utility capability are suggested:

- ***Investigate relevant external grid model data management activities.*** A number of utilities, especially in transmission, are already working on grid model data management solutions. Contact them for advice and read articles and conference materials related to their work. The EPRI team is currently aware of activities at a number of utilities:
  - In Transmission
    - American Electric Power (AEP)
    - California Independent System Operator (CAISO)
    - Electric Reliability Council of Texas (ERCOT)
    - Midwest System Operator
    - Oncor
    - TenneT [the Netherlands]
  - In Distribution
    - Alliander [the Netherlands]
    - Ameren
    - DIGIN [Norwegian TSO/DSO organization]
    - Hydro-Québec [Canada]
    - Jacksonville Electric Authority
    - Konstant [Denmark]
    - Provincial Electricity Authority [Thailand]
    - Radius [Denmark]
    - Snohomish Public Utility District (SnoPUD)
    - Southern California Edison (SCE)

It may also be productive to have conversations with entities with whom sharing of power system models is, or is likely to, occur. These could include adjoining transmission utilities, relevant market operators, or other 3rd party entities.

- ***Acquire CIM knowledge.*** Identify staff members who are best positioned to be trained on CIM grid modeling principles and have them:
  - Read EPRI reports, like "*Using the Common Information Model for Network Analysis Data Management*"[10] and "*Common Information Model (CIM) Support for Distribution Grid Model Data Management.*"[1]
  - Attend "CIM University" (preceding annual CIM Users' Group Meetings)[11]
  - Consider on-site CIM training from seasoned CIM implementation experts
  - Develop relationships with CIM experts in the area of grid model data management
- ***Gain a more in-depth understanding of distribution GMM tool functional capabilities.*** Sophisticated grid model data management is at the heart of the GMDM information architecture and is central to a utility's ability to implement effective, forward-looking grid model data management. Utility understanding of the functions a full-featured GMM should implement is important both as a utility evaluates GMM products and as it designs its grid model management solution. EPRI's "*Distribution Grid Model Manager (GMM) Functional Requirements*"[7] report is a good resource for learning about GMM tool requirements.
- ***Survey GMM products.*** At this stage, the utility will have a general idea of its future grid model management requirements and the 'distance' between its existing solution and future needs. It is not time (yet) to decide on software solutions, but acquiring an understanding of capabilities in the market will be valuable background for the next step in Launch 2 (Vision Creation and Strategic Planning). Read about, get demos of, or experiment with relevant products:
  - Model management tools (GE's e-Terrasource, IPS' INMM, Open Grid Systems' CIMphony, Siemens' ODMS or IMM, OSI's CIM Studio, Digpro's DpPower and Bentley's OpenUtilities Digital Twin Services)
  - Integration tools (IQGeo's Network Manager, SafeSoftware's FME)

10 *Using the CIM for Network Analysis Data Management.* EPRI, Palo Alto, CA: 2014. 3002002587.

11 CIM Users' Group – information on meetings available at www.cimug.org

The distribution tool landscape is 'wide open' at the moment. No vendor offers anywhere near a comprehensive distribution grid model management solution today. Dialog with potential vendors is critical and useful questions ask could include:

- What vendors offer what parts of the capability required by the utility?
- What are the stated future product development plans of various vendors and how do they align with the utility's vision?
- Can capabilities be combined to create a complete solution? Are vendor partnerships emerging?
- Which vendors seem open to future standards-based integration opportunities? Are vendors are participating in standards development processes or interoperability tests?

Vision Creation and Strategic Planning

The planning of a grid model management improvement initiative begins in earnest with the following suggested activities:

- ***Identify expertise (both internal and external).*** A core of team of utility personnel will likely have guided the project up until this point. Diversity of perspective and a passion for improvement will have been key factors in enabling project success through the preceding work activities. Moving forward, activities become more complex and require more specialized expertise. The goal is to have a level of expertise on hand that matches the focus and complexity of each work activity. A mix of integration/software engineering skills and network analysis experience will be required, along with experience in a variety of areas:
  - Strategic planning
  - Tactical planning
  - Implementation
  - Operation

  Different tasks will require different skills and experience, but, through the course of the project, there will be multiple tasks which will call for each type of skill and experience mentioned above. It may be wise to consider if outside vendors or contractors should be used. In particular the remaining activities in Launch 2 require a specialized combination of expertise in enterprise data management and application integration design, knowledge of CIM data structures, understanding of the GMDM information architecture, and familiarity with the distribution utility tools that produce and consume grid model data. Consultants with such expertise can be found among the members of International Electrotechnical Commission (IEC) Technical Committee (TC) 57 Working Group 13[12] or on the CIM – Common Information Model for Utilities LinkedIn group.[13]

- ***Flesh out the vision.*** Using the knowledge gained to-date, articulate the utility's long-term vision. The GMDM information architecture, which provides a framework for understanding and organizing electric utility grid model data, is an excellent starting point for this activity. EPRI suggests that it be used as a basis for developing the utility's own grid model information architecture. The business functions of the GMDM information architecture reflect are those that supply, manage, and use grid model data at the typical distribution utility. Those business functions can be augmented, tailored, or detailed to reflect the local business environment as the utility grid model information architecture is built. Explore and document significant business use cases against the utility grid model information architecture. This is an excellent way both to explore future business function requirements/business object flows and to refine the utility grid model information architecture.

  When the utility grid model architecture adequately expresses the long-term business function vision of the utility, use it as a backdrop for organizing a future vision at the application level. Where the use of a given tool is expected to persist well into the future, the application itself can be identified in the vision. Where there is no incumbent tool for a required capability, use an application function 'placeholder'. Define the future flow of data objects (sets of digital data) among the applications (or application functions) in a way that respects the business function architecture. The utility grid model data management vision which results from these activities should accurately describe the utility's aspirational future state. But it should be understood that it is an artifact that will be continually revised as new understanding is gained.

- ***Plan the high-level deployment phases.*** Articulate a series of deployment phases to move incrementally toward the vision. Each phase should:
  - Take between 6 and 18 months to accomplish
  - Deliver a finite set of outcomes that makes progress toward the utility's grid model management vision
  - Result in a stable state where time can be taken to re-examine and revise the grid model management vision and re-adjust the remaining deployment phases.

  The following considerations should be taken into account in planning/sequencing deployment phases:

  - Dependencies between activities
  - Technology availability
  - Most urgent needs
  - Easiest 'wins'
  - Visibility of results
  - Level of risk
  - Resource availability
  - Intersection with related projects

12 List of Working Group 13 Convenor & Members - https://www.iec.ch/dyn/www/f?p=103:14:0::::FSP_ORG_ID:2392

13 CIM – Common Information Model for Utilities LinkedIn group, https://www.linkedin.com/groups/1548657/

For every phase, document:

- The business objectives targeted by the phase
- The conceptual design achieved at the end of the phase, expressed in the same format as the utility grid model data management vision
- The major activities required to accomplish the phase
- Any business organization and process changes required by the phase
- The high-level estimated costs and expected benefits for the phase

Launch 3 – Phase I Deployment Planning

With the sequence of phases outlined, focus can turn to detailed planning of the first implementation phase, where suggested activities include:

- ***Documenting the Phase I end-state.*** Identify and explore alternate tool solutions within the scope of Phase I (note these could be tools supplying data, managing data, consuming data)
  - What tools (or combinations of tools) are able to implement the required application functions?
  - What are their current or near-future capabilities?
  - Does it make sense to implement local solutions fill in gaps?

  Determine potential solution alternatives and identify vendor tools in the market for each alternative. Select the combination of tools to be used and the data exchanges to be implemented. Document the planned end state as a refined version of what was articulated in in Launch 2 as the conceptual design state achieved by Phase I.

- ***Create a project plan for Phase I.*** The project plan will reflect both the utility's IT/OT project management practice and considerations unique to integration projects. The plan should address tasks, schedule, required resources and project management approach. Typical tasks might include:
  - Shared data requirements analysis
  - Shared data model definition
  - Shared data integration strategy, for example:
    - Integration with sources of data may involve conversion of source information into CIM fragments
    - Integration with consumers of data will typically be done using (nearly) CIM standard data exchanges
  - Data rationalization (aligning information from existing data sources) or cleanup
  - Data population
  - Interface design and coding
  - Business organization design and business process definition
  - Cyber security solution design
  - Tool procurement and installation
  - Hardware/software infrastructure procurement and installation
  - Establishing an ongoing data governance practice
  - Testing
  - Training
- ***Create a business case plan for Phase I.*** Create a business case outlining the expected costs and benefits of Phase I. The creation of the business case will be guided by the utility's usual project justification process, though special note should be made of the fact that, because of the cumulative effect of ongoing integration activities, many of the Phase I benefits will manifest in later Phases.

Summary

The urgency of the need for improved grid model data management is clear. So are the benefits that could sensibly be presumed to result from achieving it. However, the path a utility should take to optimize its success in making the transformation from today's silo'd, duplicative, sluggish solutions to a more integrated, streamlined, and flexible environment is much less certain. And the dearth of industry experience in traversing the path leaves many utilities wondering where and how to start.

In this technical brief, EPRI has suggested that the transformation should be accomplished incrementally and that the GMDM information architecture be used as a framework to guide utility solution design and decision-making. And a series of activities a utility could undertake in ramping up a grid model management improvement effort has been proposed. It is hoped that this will encourage more utilities to begin their journey toward effective, enterprise-wide grid model data management.

Acknowledgments

EPRI would like to recognize the following people and organizations for their contributions:

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3002025387 November 2022

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