Consolidating Operations, Planning, and Protection Model Management Using a Network Model Manager Approach[1]

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1 SUMMARY

Multiple applications within a utility rely on electrical system network models. In today's utility, these models are typically maintained independently for each application, with data manually supplied for each application's database. Engineers often spend significant amounts of time entering, synchronizing, validating, and correcting duplicate information. The current maintenance approach leads to process inefficiencies and data inconsistencies that can have adverse effects both in terms of reliability and cost.

The Common Information Model (CIM) provides a basis on which a coordinated network model maintenance strategy can be built. The CIM is mature and field-tested in the areas of network equipment, connectivity, topology, and power flow solution exchange. However, its use to-date in supporting network model exchange has been primarily for sharing information between utilities and/or regional authorities, not for the exchange of model information between applications inside a utility. The growing reliance on network analysis, the advent of new regulatory requirements related to model validation and the need for network model sharing between Transmission and Distribution, has made better management of Transmission and Distribution network models a topic of growing interest.

1.1. Network Model Information Management Today

The network model management practices typical at today's utilities have evolved 'ad-hoc' over many decades. They are a consequence of a continually increasing deployment of more sophisticated, more specialized and more critical network analysis functions (power flow, state estimator, contingency analysis, short circuit, dynamics, transients, etc.) in more domains (operations, operations planning, long-term planning, protection).

As more and more network applications came into use at utilities, silos developed: each application had its independent users, its independent model maintenance group and its individual modeling processes and assumptions. The resulting silos were, and continue to be, both technical and organizational, with the resulting lack of coordination reflected in a typical network model data management picture where network model information flows come from a variety of sources in a variety of forms, go to a number of target systems and are inconsistently triggered by a variety of events. Lacking an overarching or unifying data management architecture, the creation of accurate models relies on the experience, thoroughness and energy of modeling engineers.

2 Network Model Manager Vision

As articulated in the work of a recent project, led by EPRI with active participation by multiple utilities and vendors, the technical vision for improved model management is based around the architectural concept illustrated in Figure 1.

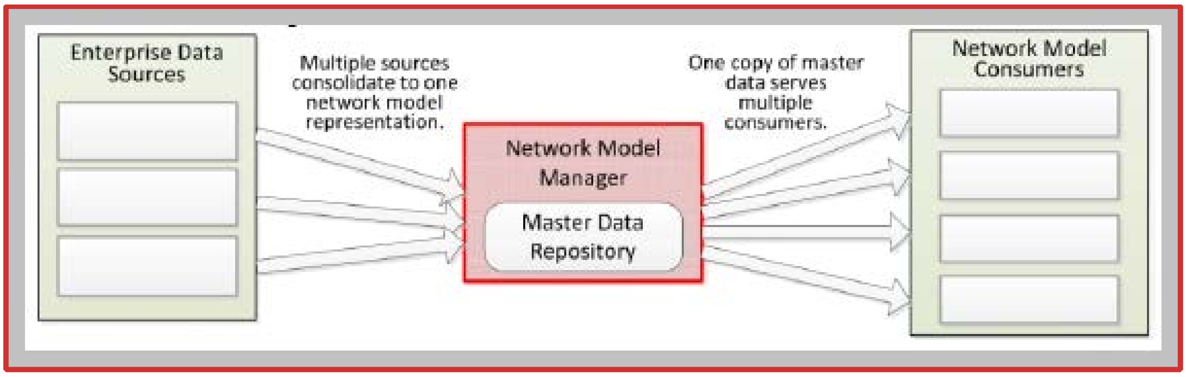

Figure 1. Network Model Manager Vision

Enterprise data sources (like station engineering drawings, asset databases and load forecasting systems for example) from which network model data is drawn are represented on the left side. On the right side are consumers of network models, such as an Energy Management System, a suite of planning applications or protection software. Between the sources and consumers, a Network Model Manager (NMM) function is introduced. The role of the NMM is to maintain a master repository of network model data that is shared by different network model consumers.

The NMM provides an environment for maintaining master source information in a form that enables efficient maintenance, sound quality control procedures and construction of the network base cases needed by the various analytical processes. Master data is created once but used many times.

The NMM furthermore is designed as a vehicle for integrating systems and taking advantage of IEC CIM interoperability standards (IEC 61970, 61968, 62325) and more precisely of 61970-301 [2], 61968-11 [3], 62325-301 [4].

2.1 Potential Benefits

The benefits of fully-realized consolidated network model management can be substantial and far-reaching. The use cases explored in the project highlighted a number of main benefits, including:

- Existence of a generally-accessible, single source of model data. Modeling time can be cut substantially as changes are entered only once and all consumer applications receive the information they need.
- Model accuracy is improved for all applications. Quality of study results is improved, and labor spent identifying/correcting problems is reduced.
- Accuracy can be validated quantitatively. Confidence in study results is improved.
- Model maintenance work flow processes are supported. Data completeness and quality are improved, and labor spent correcting errors or oversights is reduced.
- Model and case information produced in CIM standard form. Implementation of a forward-looking solution positions utility to effectively deal with future process or application changes (both internal and external).

- History is maintained. Ability to support post-event analysis greatly increased. Labor to effectively manage model changes over time is significantly decreased.
- Documentation is improved. Labor spent communicating and managing changes is reduced.

2.2 Network Model Manager Functional Overview

As envisioned by the project, the NMM plays a central role in network model management. Its purpose is to maintain the master data components that are shared by network analysis analytical applications and other utility software requiring grid equipment and connectivity information. An NMM is the central vehicle for consolidating model data and automating network model management. A nominal 3 functional overview of the NMM is shown in Figure 2. (Note: this drawing is not intended as a design; it is simply a way to illustrate functionality visually.

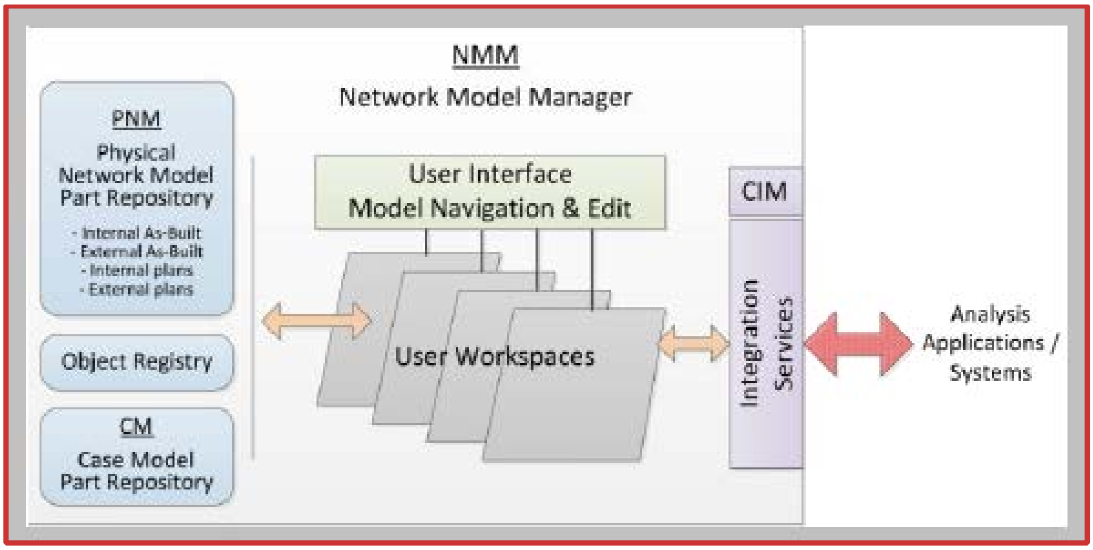

Figure 2. Nominal Components of a PNM Implementation

The most important part of the NMM is the master Physical Network Model Part Repository (PNM). The master PNM contains the data reflecting the inherent physical qualities and capabilities of the network as it is constructed (or as it is planned to be constructed). This data is both slowly changing (typically reflecting field construction activity) and critical to all network analysis studies. The Case Model Part Repository (CM) is the part of the NMM that defines the assumptions, rules and conditions that together allow the assembly of complete 'base cases' that can be supplied to analysis applications.

The Object Registry is the part of the NMM that manages the identity of all objects shared across applications served by the NMM. User Workspaces and the User Interface allow users to view, navigate and edit network model data and to assemble network models and cases for export. CIM Integration Services are the means by which the NMM communicates with other systems, both sources of data and targets of data.

2.3 Network Model Manager Core Requirements

The project defined a core set of high-level requirements which a commercial NMM product would be expected to meet. These requirements included:

1. Physical Network Model (PNM) Requirements

   The PNM shall enable management of a set of core master Physical Network Model Parts, which represent the electrical capabilities of physical grid elements (as opposed to choices about how to operate the grid). The PNM shall assure that master data items have one source (their 'Model Authority') and that they are organized such that they may be assembled or manipulated to meet all of the important network analysis requirements for study models. The PNM shall support the definition of Projects expressing changes to the physical network model and baselining of model history.

2. Object Registry Requirements

   The NMM shall support object registry services to manage the names of network modeling Canonical Objects in different contexts.

3. Workspaces Requirements

   The NMM shall support multiple workspaces for carrying out NMM operations in parallel.

4. User Interface Requirements

   The NMM shall provide users the capability to browse and edit NMM content.

5. Model and Case Assembly Requirements

   The NMM shall support the CIM 61970 modular concept for assembling network models and network analysis base cases.

6. Validation Requirements

   The NMM shall support development of a testing and validation regimen.

7. Integration Requirements

   The NMM shall provide CIM-based integration services that will allow the NMM to be integrated with other systems without additional custom code.

8. Extensibility Requirements

   The data content of the NMM shall be model driven, definable by an information model and compatible with the idea that a utility may have a Canonical Data Model from which CIM Dataset Types may be derived for the NMM.

3 Conclusion

A Network Model Manager architecture, with its integrated and unified approach to network model management, has the potential of reducing engineering labor and increasing the accuracy of utility network models. The high-level Network Model Manager requirements developed by the recently completed EPRI project could help utilities recognize the feasibility and benefit of consolidated model management, could help vendors enhance their product offerings and could help the industry at large to move toward viewing network model management as an enterprise, region, and interconnect-wide undertaking that calls for specifically designed model management software.

Appendix

Appendix A) None

List of Figures

