Using CIM to Support Network Model Management Inside the Utility

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Pat Brown, EPRI
Jay Britton, Britton Consulting
Transmission Network Model Management
In Support of Reliability

• Every tool requires its own network model, in its own format

• Every tool has its own users and maintainers

• Silos are both technical and organizational
Transmission Network Model Management

Technical & Organizational Silos

• Silos cause:
  – Duplicate effort
  – Synchronization problems
  – Consistency issues
  – “Trapped” data

Lots of energy invested in unproductive work
Errors can go unrecognized
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Industry Landscape

- Silos at multiple levels – TSO, ISO, Interconnect
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Encouraging Developments

- Consolidated model management
  - ERCOT model management implementation
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Encouraging Developments

• Consolidated model management
  – ERCOT model management implementation
  – Product configuration tools
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Support from the CIM

• Common Information Model (CIM) as foundation
  – Began as operational model in early 1990s
  – Support EMS components from different vendors
  – Became IEC Standard in mid-1990s
  – Understood as basis for semantic model for enterprise integration
  – Network model interoperability tests started in 2000 – more than 15 to-date
  – Planning (bus/branch) model added in 2008
  – Dynamics (transient behavior) model added in 2013
  – Projects, outage and contingency modeling are current topics

Now nearly robust enough to truly support NMM tool integration
Transmission Network Model Management

Existing Situation
Transmission Network Model Management

The NMM Vision — one source for each piece of data
NMM Requirements Overview

- Consolidated model management
  - Utilities ready to implement
  - Real NMM product market niche
NMM Requirements Overview

- Consolidated model management
  - Utilities ready to implement
  - Real NMM product market niche
  - Silos get in the way
NMM Requirements Overview Project

• 2014 Network Model Manager Requirements Overview supplemental
  – Overview of consolidated model management tool requirements
  – Sponsored and created by 8 utilities and 2 vendors
    ▪ TSOs - AEP, BPA, Électricité de France, NationalGrid UK, Oncor
    ▪ ISOs – ISO-NE, MISO, PJM
    ▪ Vendors – Alstom, Siemens/Siemens PTI
  – Results publicly available for free
  – Influence the industry

Accelerate utility interest
Broaden vendor vision
NMM Requirements Overview Project
Use Cases to Identify Requirements
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Use Cases to Identify Requirements

- **Process Group A**: Internal Input to the NMM
  - Enterprise Data Sources
    - Plans
    - Substation As-Built
    - Line Impedance Calculation
    - Line Rating Calculation
    - Circuit Description
    - Transformer Data
    - Generator data
    - GIS
    - Outages
    - Substation Load History

- **Network Model Manager**
  - PNM
    - As-Built Internal
    - As-Built External
    - Plans Internal
    - Plans External
    - Object Registry
    - CM

- **Process Group B**: Exchange with External Entities

- **Process Group C**: Testing & Validation Processes

- **Process Group D**: Exporting Base Cases for Operations and Planning Studies

- **Process Group E**: Input from Cases

- **Network Cases**
  - Validation Cases
  - Import/Export Cases
  - EMS Network Model
  - Outage Studies
  - Planning Base Cases
  - Protection Model
NMM Requirements Overview Project
Publicly Available Deliverable

• “Network Model Manager Technical Market Requirements” (EPRI Product ID 3002003053)
• Available at www.epri.com
NMM Requirements Overview Project

NMM Functional Overview
Model parts are maintained once ... and used in many different study case assemblies.

Unified Grid Model

TSO A

TSO B

TSO W

TSO X

Study Type 1

Study Type 2

Study Type n
WG13 Ref Model for a Network Analysis Case

Physical Network Model Parts Repository

- Full Model Parts
- Incremental Model Parts

Model Part Types:
- EQ
- DY
- SC
- DL
- OP
- GL

Measurement Sources

- Outage Schedules

Energy Forecasts & Schedules

Other External Sources

SSH Model Parts Repository

- Full Model Parts
- Incremental Model Parts

CIM Standard Datasets in a Network Analysis Case

- Topology (TP)
  - TopologyNodes
  - association to conducting equipment
- State Variables (SV)
  - Energized State
  - Island Topology
  - BusVoltage
  - Bus Injections
  - Terminal flows
  - Controls
  - Violations

Device Status Initialization/Edit

Control Setting Initialization/Edit

Monitoring Initialization/Edit

Energy Injection Initialization/Edit

Physical Model Select / Edit

Equipment (EQ)
- Equipment
- Containment
- Connectivity
- Controls
- SIPS
- Equipment Rating
- Normal operations
- Energy allocation

Short Circuit (SC)

Dynamics (DY)

Diagram Layout (DL)

Geo Location (GL)

Normal Operations (OP)

Steady-State Hypothesis (SSH)
- Status
  - Switch status
  - In Service
  - Branch end
  - Tap positions
  - Control settings
  - Voltage regulation
  - Flow regulation
  - SIPS
  - Monitoring
    - Operating limits
    - Other
  - Energy Injections
    - Bulk generation
    - Solar
    - Wind
    - Storage
    - Traditional Load
    - DR
    - etc.

Topography & Network Solution Algorithm

Diagram Layout (DL) Diagram Layout (DL) Diagram Layout (DL)
NMM Requirements Overview Project

NMM Functional Overview

PNM
Physical Network Model Parts Repository
- Internal As-Built
- External As-Built
- Internal plans
- External plans

Object Registry

CM
Case Model Parts Repository

NMM
Network Model Manager

User Interface
Model Navigation & Edit

User Workspaces

CIM
Analysis Applications / Systems

Integration Services

Analysis Applications / Systems
NMM Requirements Overview Project Physical Network Model Requirements

Mission: Support the IEC CIM framework concept for assembling EQ Model Parts

- This is the top layer of the case diagram.
- PN part retrieval is the first step:
  - EQ Model Part selection & loading
  - EQ Project selection & loading
  - Additional PN Model Parts as desired
- Validation against framework specifications
- Optional: built-in and/or locally-written services (simplification, mesh equivalents, etc.)
Mission: Support concurrent modeling activity by multiple users

- Multiple users – each has a private workspace
- Two primary purposes:
  1. To support user browse and edit of Model Parts.
  2. To support assembly of base cases for export.
- Supports functions
  - Standard
  - Custom
- Maintains audit trail of activity
- Supports packaging of actions into stored Procedures.
NMM Requirements Overview Project
User Interface Requirements

Mission: Provide the ability to create and manage Model Parts in NMM

- Directory of NMM stored Model Parts and Projects
- Browse any Model Part in a workspace
  - Graphically via schematics (including autogeneration of schematics)
  - Hierarchical
  - Tabular
  - Property sheets
- Editing to create Projects (including graphical edit of connectivity)
- Review and manage audit trail
- Execute any stored procedure or operation
- Meet all industry security guidelines
Mission: Support the IEC CIM modular concept for assembling network analysis base cases

- Starts from a composed set of PN Model Parts
- A complete SSH must be assembled for the PN extent. This has a number of relatively independent sub-parts:
  - Status of devices
  - Regulation by controls
  - Monitoring limits
  - Energy in and out
- Stored sub-parts may be initialized by:
  - User editing
  - Custom initialization processes from external sources
  - Saved previous sub-parts
Mission: Support integration with NMM without impact to the core NMM product

NMM shall be ‘integration ready’:

- CIM import / export of individual Model Parts and Projects
- CIM import / export of assembled models and cases
- Integration processes can invoke NMM services, such as stored procedures

- Name translation via object registry services
- Consistent approach to transformation to and from external formats
Mission: Assure high quality source material for network analysis

Validation must be supported at the following levels:

• Consistency with standard CIM forms
• Reasonability checks
  • Including the ability to create custom validation logic
• Algorithm based tests
  • Topology processing service
  • Power flow service
• Testing procedures
Mission: support utility extension of the core Canonical Data model without modification of the core NMM product

NMM provides facilities for extending and updating the Model Part schema such that:

• Model Parts in the previous schema are transformed to the new version
• Core product functionality of the NMM adapts to the new schema without modification of the product.
• i.e. The NMM is model driven!
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Pat Brown
EPRI
pbrown@epri.com

Jay Britton
Britton Consulting LLC
jay.britton@comcast.net