Network Model Management Improvement Program at American Electric Power (AEP)

Eric Hatter, AEP
Margaret Goodrich, Project Consultants
Jay Britton, Britton Consulting
Pat Brown, EPRI

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Network Model Management Improvement at AEP

AEP’s Network Model Management Improvement Program (NMMI)

- **Who** is AEP?
- **Why** do it?
  - and Benefits
- **How** did it happen?
  - History and Success Factors
- **What** is AEP doing?
  - Technical Foundation
  - Phase II Implementation Strategy
American Electric Power (AEP) as a Utility

- Headquartered in Columbus, Ohio
- Serves customers in 11 U.S. states
- Maintains the largest transmission network in the U.S. with over 40,000 miles of transmission
- Member of three RTOs: PJM, SPP, and ERCOT
- Combined PJM, SPP & ERCOT state estimator cases exceed 14,000 substations and 22,000 buses.

Who? Large, Transmission-Focused, Multiple Footprints
**AEP NMMI Program Purpose & Goals**

- **Purpose**
  - Revise network model management in the AEP Operations, Planning, Protection and Asset Management domains with the intent of gaining qualitative benefits across all AEP Transmission footprints

- **Goals**
  - Unify modeling processes across the AEP Transmission footprints
  - Reduce manual effort of mapping between applications
  - Improve data governance
  - Implement clear information flow throughout AEP Transmission organization
  - Enable data analytics
AEP NMMI Program Benefits

- Improved efficiency and reduction in operating cost
  - Eliminate existing duplicate processes
  - Facilitate automation
  - Decrease labor
- Improved overall accuracy of network models
- Reduced likelihood of serious operating / planning errors stemming from bad models
- Reduced time required to perform or update studies
  - Support for post-event analysis
  - Tracking of model changes with ability to recreate cases after changes
- Forward-looking solution positions AEP to effectively deal with future process or application changes (both internal and external)

Why? Efficiency, Accuracy, Future Flexibility
AEP NMMI Program History

- **2013** Integrated Network Model Management project
  - Scope: Operations (EMS and Outage Scheduling)
AEP NMMI Program History

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- **2014** NMM Tool Functional Requirements project
  - Industry vision for Transmission NMM architecture and tool
  - 8 utilities, 2 vendors

- **2015** AEP NMMI program launch
  - Multi-year, multi-million dollar integration/procurement project
  - Scope: Operations, Planning, Protection
AEP NMMI Program History

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  - 8 utilities, 2 vendors
  - EPRI “Network Model Manager Technical Market Requirements” (freely available at www.epri.com PID 3002003053)

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  - Multi-year, multi-million dollar integration/procurement project
  - Scope: Operations, Planning, Protection
AEP NMMI Program History

- **2016** NMMI Program progress
  - Initiated Program
    - Charter, stakeholder identification, groups & roles definitions
    - Executive approval
    - Consultants selected/engaged
  - Completed exploration/documentation of AEP current state
  - Articulated high-level design via Business Scenarios
AEP NMMI Program History

2016 NMMI Program progress

- Initiated Program
  - Charter, stakeholder identification, groups & roles definitions
  - Executive approval
  - Consultants selected/engaged
- Completed exploration/documentation of AEP current state
- Articulated high-level design via Business Scenarios
- Identified requirements (especially for Network Model Manager tool)
- Held technical training (Common Information Model & integration)
- Started product/vendor selection process
  - Initial demonstrations
  - Request for Proposal
AEP NMMI Program Success Factors

- An ‘improvement’ mindset
  - Goal was not ‘replacement’ or ‘new system’
- A effective champion
- Persistence
  - Continuous attention over multiple years
- Business alignment
  - Transmission is AEP’s business focus
  - Encouraged interest at all levels
- Engaging integration resources ‘early and often’
  - Integration expertise, knowledge of similar initiatives
  - Engagement with CIM standards community
- Fortuitous timing
  - Benefitted from other projects (ERCOT, ENTSO-E)
  - Benefitted from NMM Technical Market Requirements work
  - CIM readiness to support inside-the-utility data management

How? Inspired Vision, Business Alignment, Humility, Luck
Network Model Management Improvement at AEP

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Key Technical Drivers

- All engineering studies and operation centers derive models from the same core data building blocks.
- Any given grid element (like a transformer) will be represented in the same way in every study in which it is present.
- Consistent practices across AEP units in ERCOT, SPP, PJM.
- Different sets of data come from different sources.
  - Each datum should have one authoritative source.
  - Automated feed from engineering sources, including automated derivation of analytical models from detailed design.
- Repeatable build processes that minimize manual steps.
Probable Initial Operations Framework

AEP ERCOT LV
A
AEP ERCOT HV

AEP SPP LV
B
AEP SPP HV

AEP PJM LV
C
AEP PJM HV

Ext ERCOT HV
F
Ext SPP HV

Ext SPP-PJM HV
I
Ext PJM HV

D
E
G
H
K
L
M
Probable Initial Planning Framework

AEP ERCOT LV
A

AEP ERCOT HV
D

F
Ext ERCOT HV

AEP SPP LV
B

G
Ext SPP Bus-Branch
Planning

AEP SPP HV

H
SPP Bus-Branch Boundary Adjustment

AEP PJM LV
C

E
Ext PJM Bus-Branch
Planning

AEP PJM HV

I
PJM Bus-Branch Boundary Adjustment

J
NMM Functionality Overview

Network Modelers

TGIS

Data Import

Data Import

Data Import

EMS Configuration

Case Export

Engineering Studies

Case Export

Case Export

NMM User Workspace

User Interface

Workspace Model

Services

Scripts

SAVE

Load

RTOs

Case & Model Part Import / Export

NMM Repository

Projects

As-Built Model Parts
Overview of Scenarios

Business Scenarios for creating AEP network data.

Network Model Management

- NMM Workspace
  - Navigation
  - Editing
  - Case Assembly

- Model Part Repository
  - Model Parts
  - Projects
  - Framework

Business Scenarios for configuring network analysis.

Ext Network Analysis Actors

- RTO Modeler

AEP Network Analysis Actors

- Network Analyst
- EMS Modeler
- Planning Modeler
NCP: New Construction Projects

NCP1: Create or Update Planned New Construction Project

NCP2: Create or Update As-It-Will-Be-Built Model of Construction Project

NCP3: Project Model Goes Live with State Estimation

NCP4: Update As-Built to Reflect Newly Commissioned Work

END ACTIVE PROJECT
NCP2: As-It-Will-Be-Built Project Import from TGIS/IPS

Identify new content that is relevant for network modeling.

Select content to make new NMM project.

Add any additional modeling required to complete the MLSE models.

Create network model connectivity and single line diagrams.

Create line segment and compute impedance.

Compute ratings by MLSE.

Save project version.

Network Model Management

Compute 3-phase views of single phase equipment.

Define line sections and compute parameters.

Create line segment and compute impedance.

Integration

NMM

Equipment attributes

Planning Modeler

Operations Modeler

Substation Assets

Line Assets

Station Eng’g

Line Eng’g

A

B

C

D

E

F

G

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  - **Phase II Implementation Strategy**
AEP NMMI Program Next Steps – Phase II Activities

- **Vendor/Product selection**
  - Proof-of-concept ‘bake-off’ between 2 best products
  - Contract negotiation
  - Product deployment

- **Incremental Integrations**
  - EMS Integration (operations)
  - PSSE/MOD Integration (planning)
  - Aspen Integration (protection)
  - TGIS Population/Integration (transmission line engineering detail)
  - IPS Population/Integration (substation engineering detail)
  - TOA/DOL Population Integration (outage scheduling)
AEP Phase II Implementation Steps

- RTO Protection
- RTO Planning
- RTO Operations
- EMS
- MOD
- PSSE
- Aspen
- TOA/DOL

Existing:
- IPS
- TGIS
- Kremlin
AEP Phase II Implementation Steps

- RTO Protection
- RTO Planning
- RTO Operations
- EMS
- MOD
- PSSE
- Aspen
- TOA/DOL
- IPS
- TGIS
- Kremlin

NMM Deployment
AEP Phase II Implementation Steps

RTO Protection

RTO Planning

RTO Operations

EMS

MOD

PSSE

Aspen

TOA/DOL

NMM

IPM

TGIS

Kremlin

EMS Integration
AEP Phase II Implementation Steps

RTO Planning
RTO Operations
EMS
MOD
PSSE
Aspen
TOA/DOL

NMM

IPS
TGIS
Kremlin

PSS/E, MOD Integration
AEP Phase II Implementation Steps

RTO Protection

RTO Planning

RTO Operations

EMS

MOD

PSSE

Aspen

TOA/DOL

NMM

IPS

TGIS

Kremlin

Aspen Integration
AEP Phase II Implementation Steps

Circuit Sections/Branches in TGIS
AEP Phase II Implementation Steps
AEP Phase II Implementation Steps

- RTO Protection
- RTO Planning
- RTO Operations
- EMS
- MOD
- PSSE
- Aspen
- TOA/DOL

IPS Integration

New Kremlin

NMM
AEP Phase II Implementation Steps

RTO Protection
RTO Planning
RTO Operations
EMS
MOD
PSSE
Aspen
TOA/DOL Integration

IPS
TGIS
NMM
New Kremlin
AEP Phase II Implementation Steps
AEP NMMI Model Maintenance Processes

Phase II Completed
Phase II Completed