T-Nexus – AEP's new Network Model Management Solution

Margaret Goodrich
Cell: +1-903-477-7176
E-Mail: margaret@j-mgoodrich.com

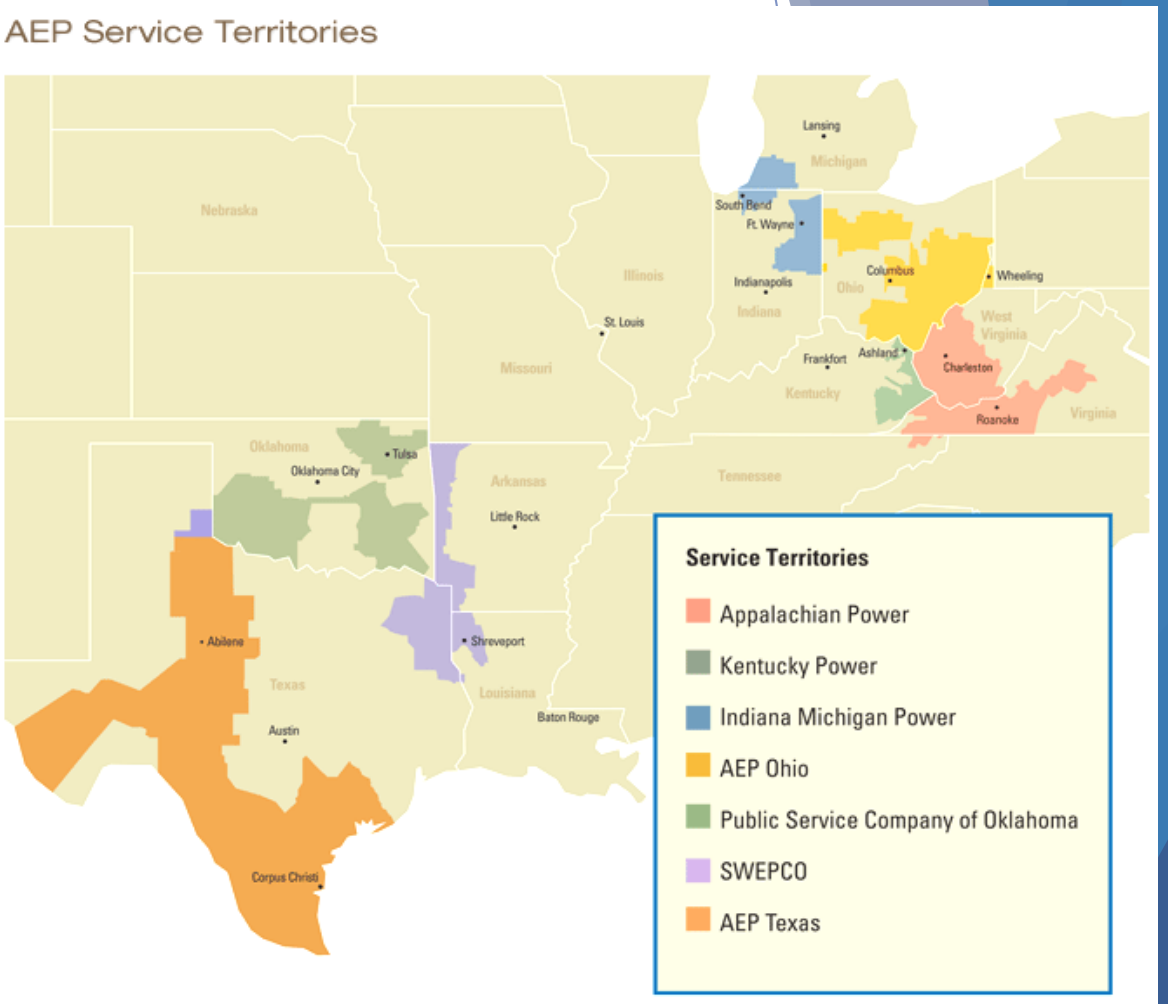
Network Model Management Improvement (NMMI) at AEP

- 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

Project Consultants

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.



Project Consultants

AEP T-Nexus

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

Project Consultants

AEP T-Nexus 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)

Project Consultants

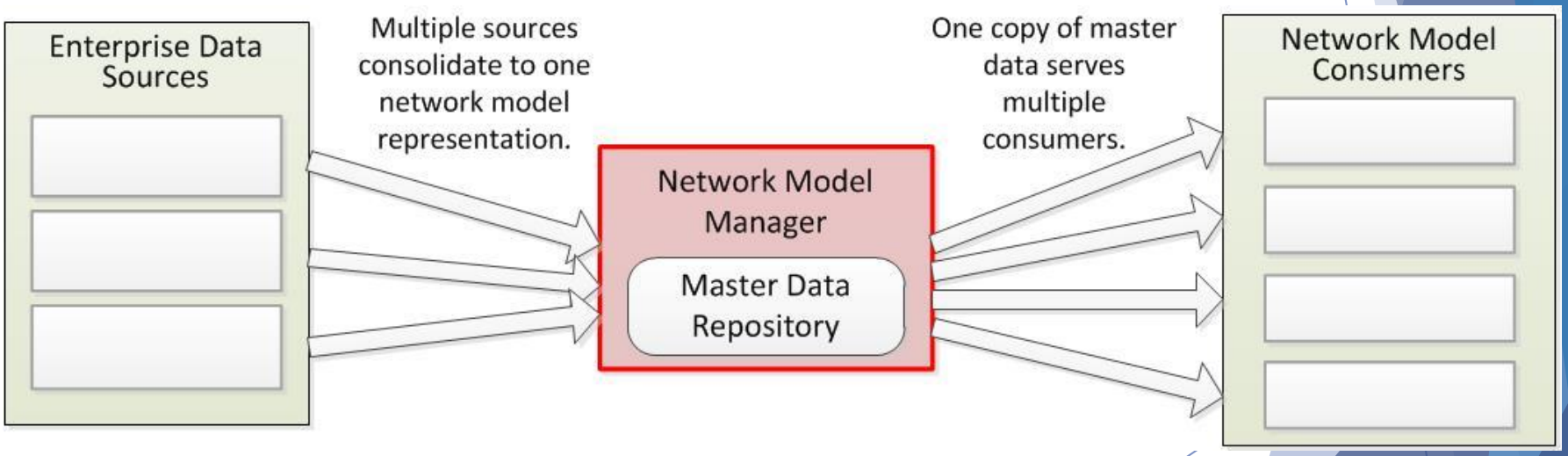
AEP T-Nexus Program History

- **2013** Integrated Network Model Management EPRI project
  - Scope: Operations (EMS and Outage Scheduling)

Project Consultants

AEP T-Nexus Program History

- **2013** Integrated Network Model Management EPRI project
  - Scope: Operations (EMS and Outage Scheduling)
  - Existing information flows
  - Network Model Manager (NMM) vision



Project Consultants

AEP T-Nexus Program History

- **2013** Integrated Network Model Management EPRI project
  - Scope: Operations (EMS and Outage Scheduling)
  - Existing information flows
  - Network Model Manager (NMM) vision

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

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

Project Consultants

AEP T-Nexus Program History

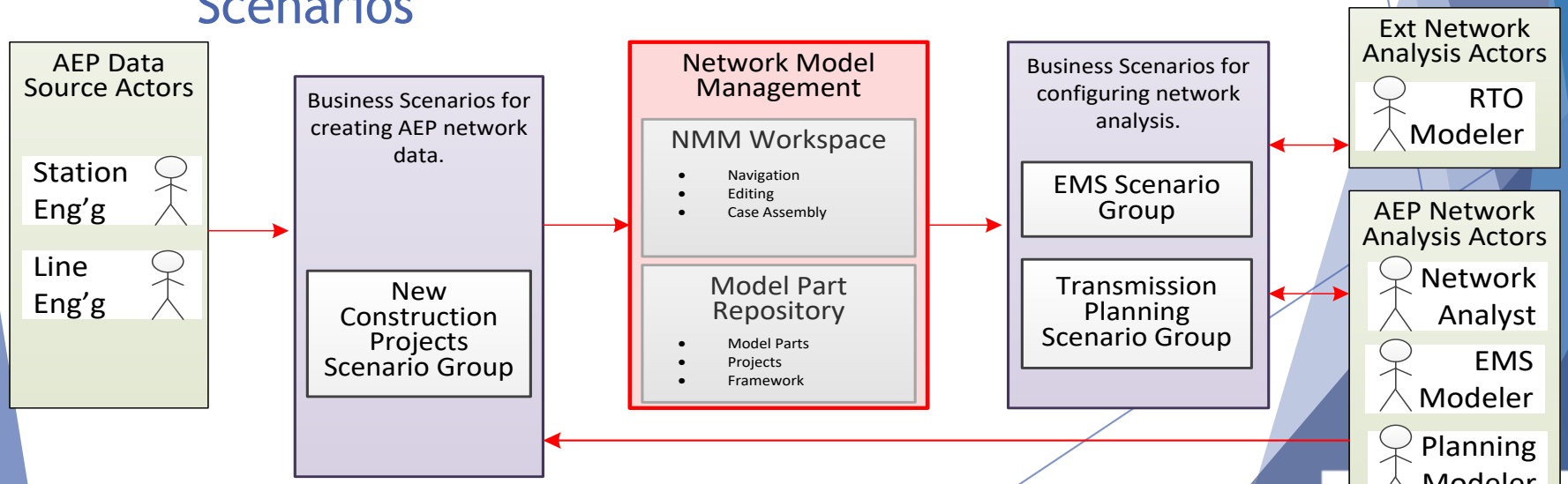
- **2013** Integrated Network Model Management project
  - Scope: Operations (EMS and Outage Scheduling)
  - Existing information flows
  - Network Model Manager (NMM) vision
  - ***EPRI "Guide to Exploring Centralized Network Model Management" (freely available at www.epri.com PID 3002000609)***
- **2014** NMM Tool Functional Requirements project
  - Industry vision for Transmission NMM architecture and tool
  - 8 utilities, 2 vendors
  - ***EPRI "Network Model Manager Technical Market Requirements" (freely available at www.epri.com PID 3002003053)***
- **2015** AEP T-Nexus program launch
  - Multi-year, multi-million dollar integration/procurement project
  - Scope: Operations, Planning, Protection

Project Consultants

AEP T-Nexus Program History

2016 T-Nexus Program progress

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



AEP T-Nexus Program History

2016 T-Nexus 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)
- Completed product/vendor selection process
  - Initial demonstrations-Complete
  - Request for Proposal - Complete
  - Vendor trials - Complete

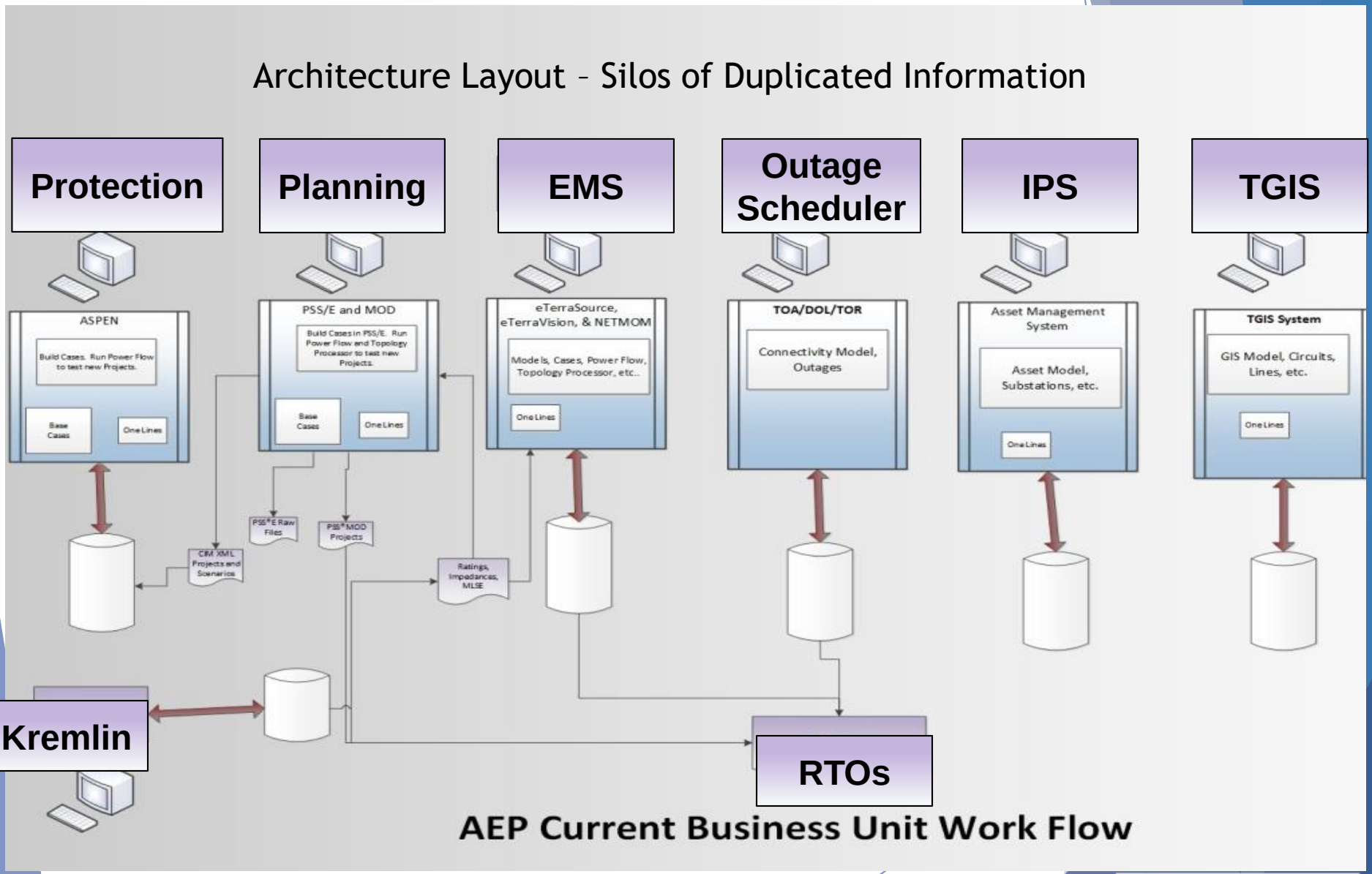
Project Consultants

AEP T-Nexus 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

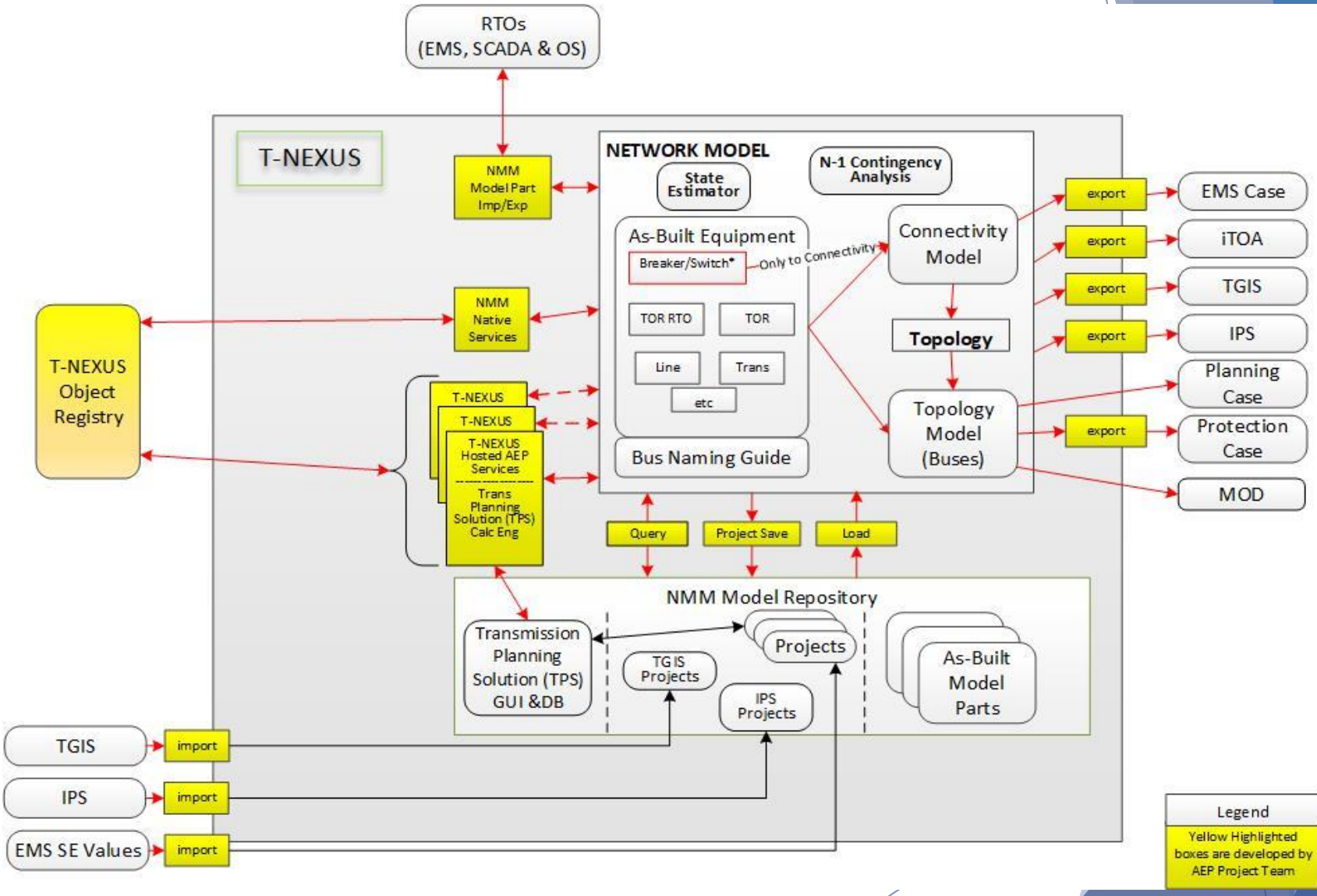
Project Consultants

T-Nexus Overview- What we have today



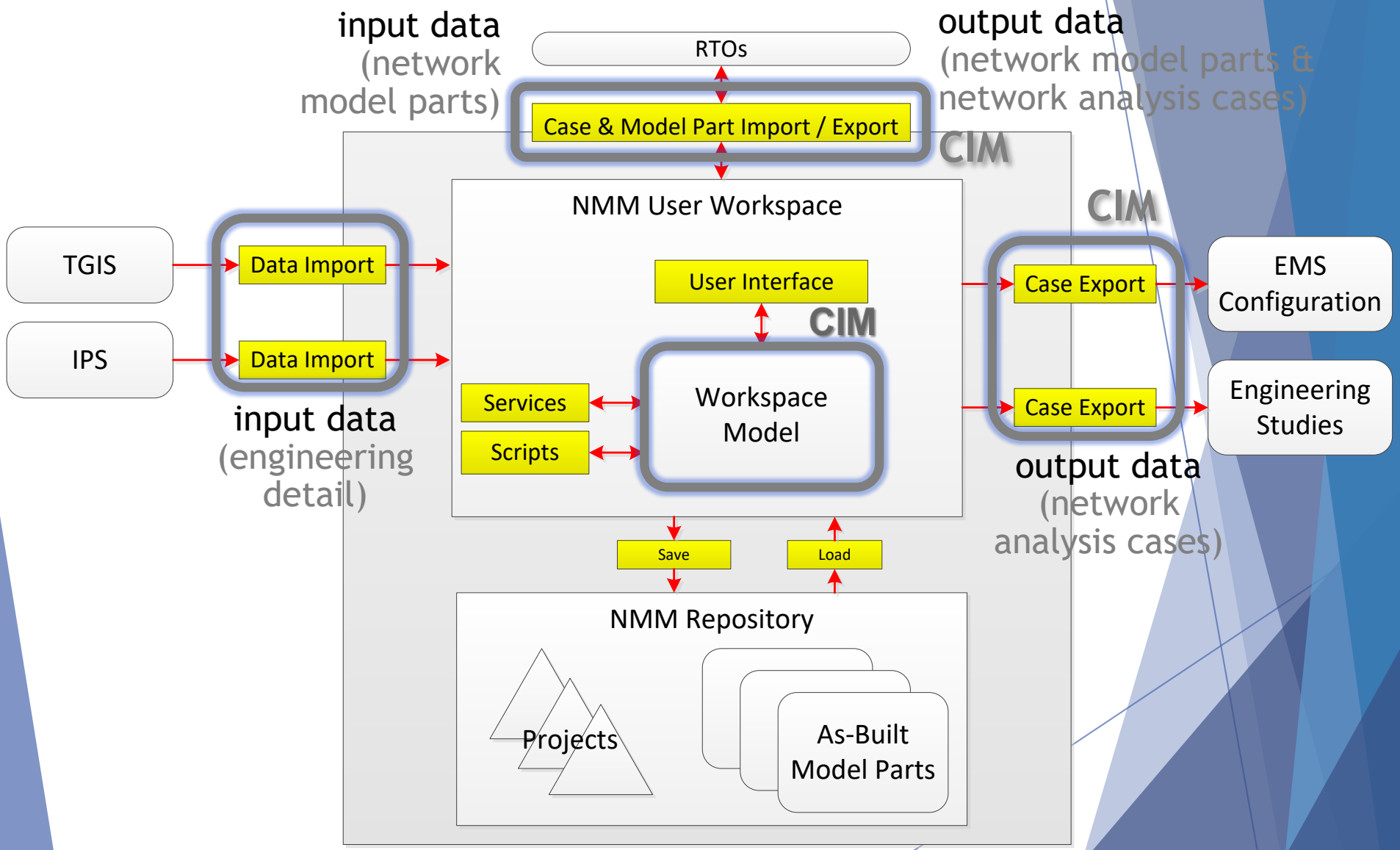
Project Consultants

T-Nexus Overview – Where We Are Going



Project Consultants

T-Nexus Overview – Where CIM is Deployed



Project Consultants

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.

Project Consultants

AEP T-Nexus Program Phases and Deployments

Vendor/Product selection – Phase I

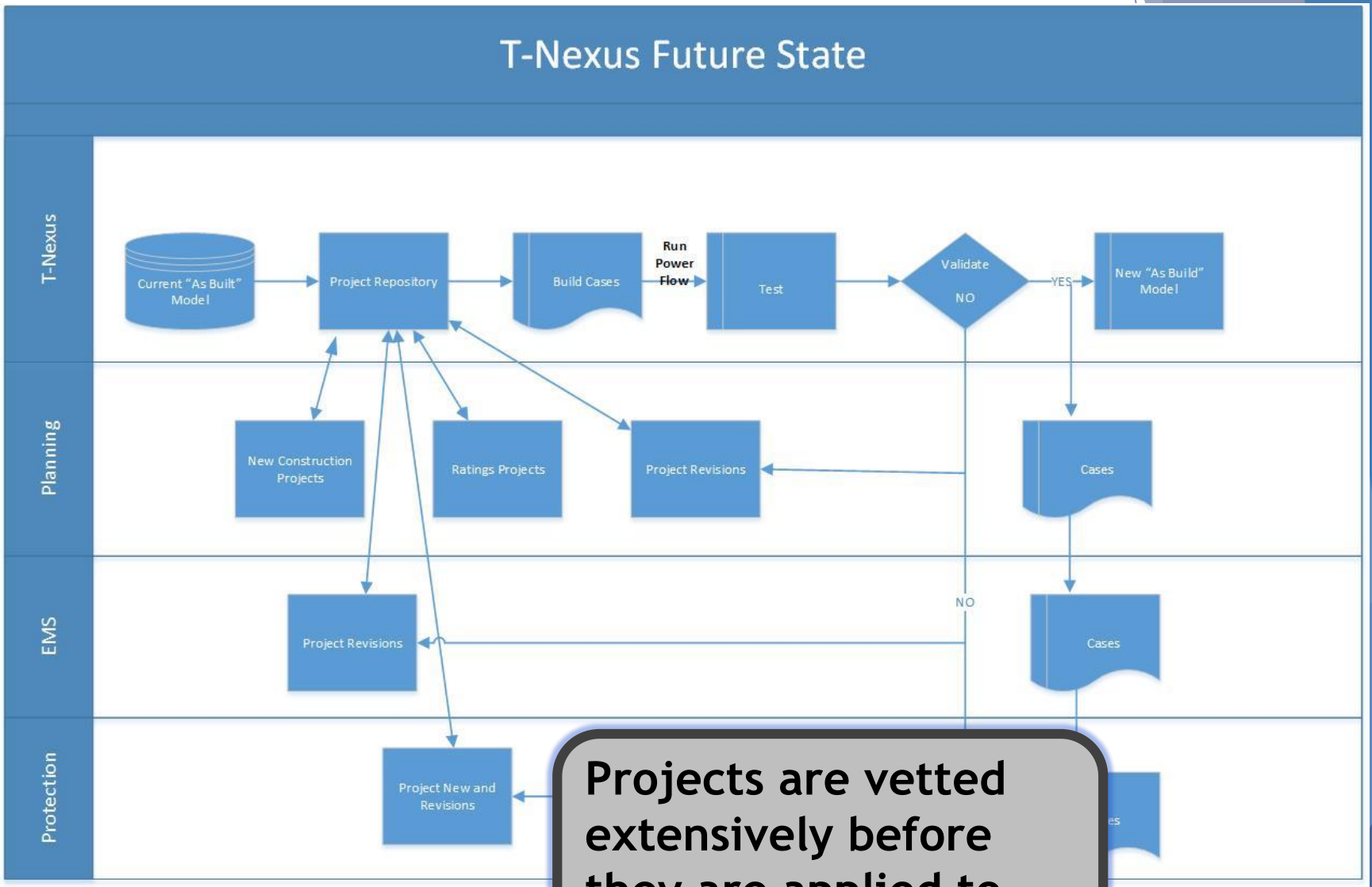
- Vendor Trials between 2 best products
- Contract negotiation
- Product deployment
- This was completed in January, 2017

Incremental Integrations – Phase II

- First Deployment – by January 2019
  - PSSE/MOD Integration (planning)
  - EMS and Planning Model Alignment
  - TGIS Population/Integration (transmission line engineering detail)
  - TOA/DOL Population Integration (outage scheduling)
- Second Deployment – By July 2019
  - EMS Integration (operations)
  - IPS Population/Integration (substation engineering detail)
- Third Deployment – By December 2019
  - Aspen Integration (protection)
- SCADA & ICCP Deployments – Phase III - 2020

Project Consultants

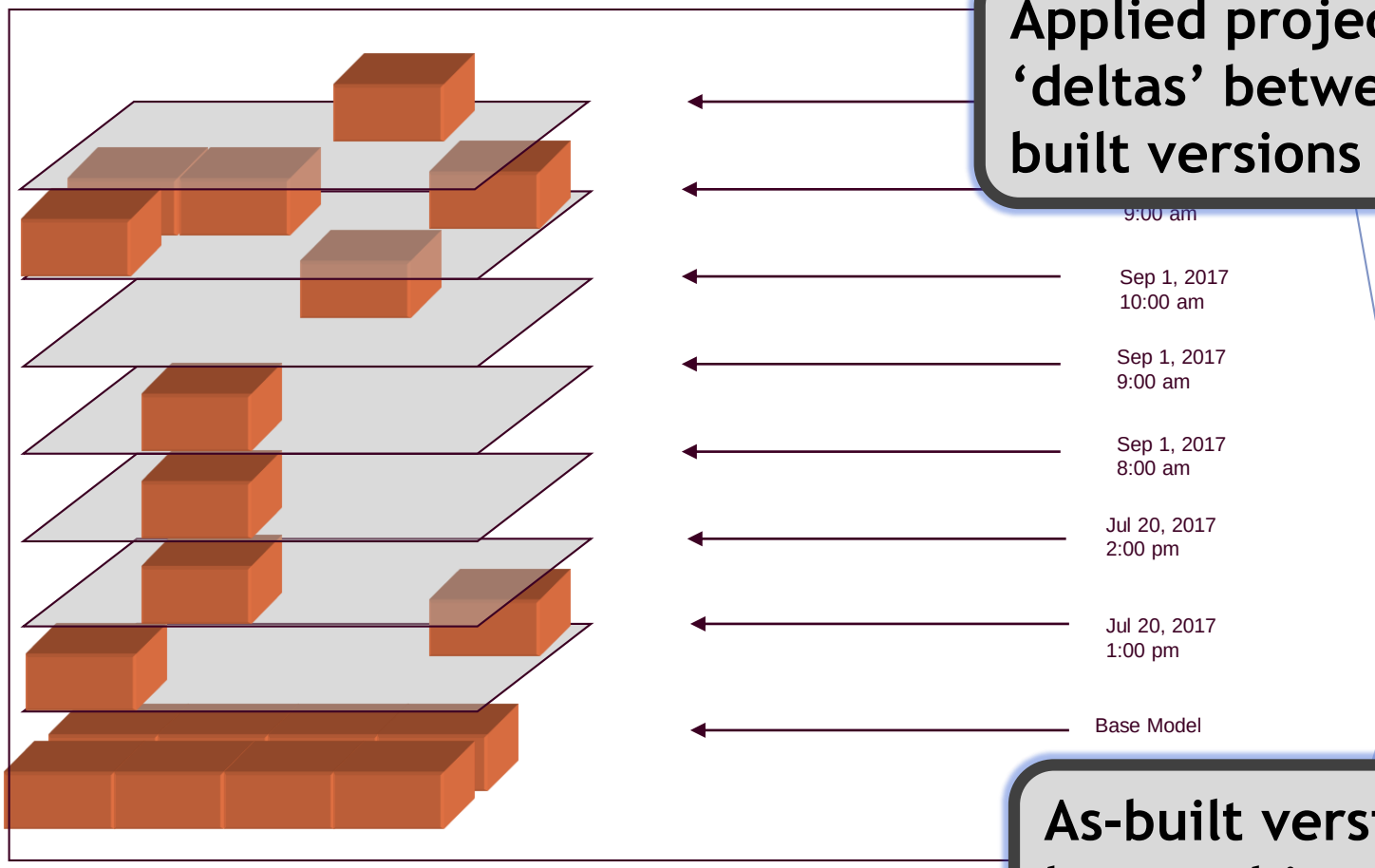
T-Nexus Overview- Future Data/Project Flows



Projects are vetted extensively before they are applied to as-built

Project Consultants

T-Nexus Overview- Model Building



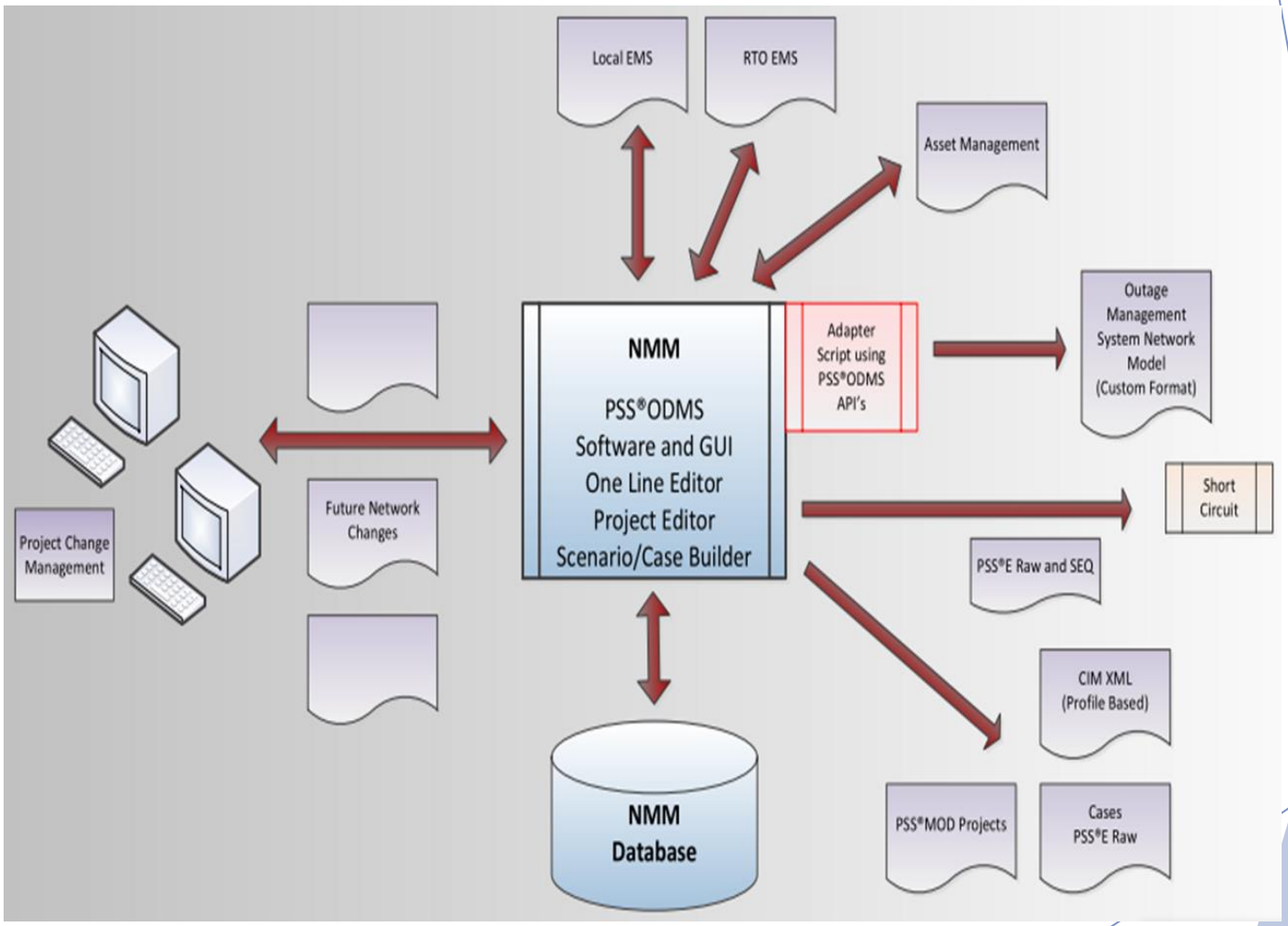
Applied projects define 'deltas' between as-built versions

As-built versions are kept as history

- A projection of all changes that are scheduled to occur on or before a given date/time on top of a base model.
- Slide Courtesy of John Moseley of ERCOT

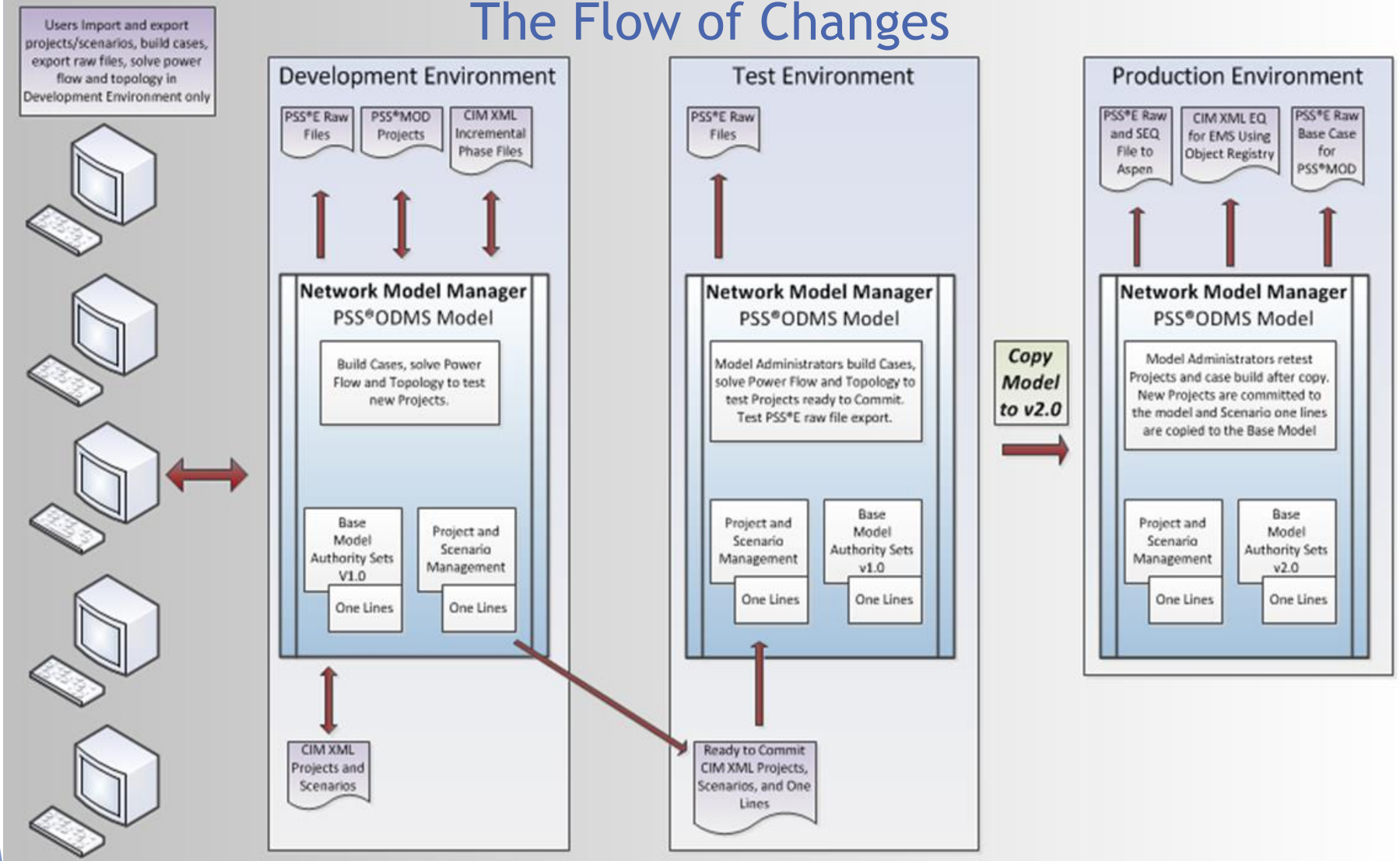
Project Consultants

The Flow of Data



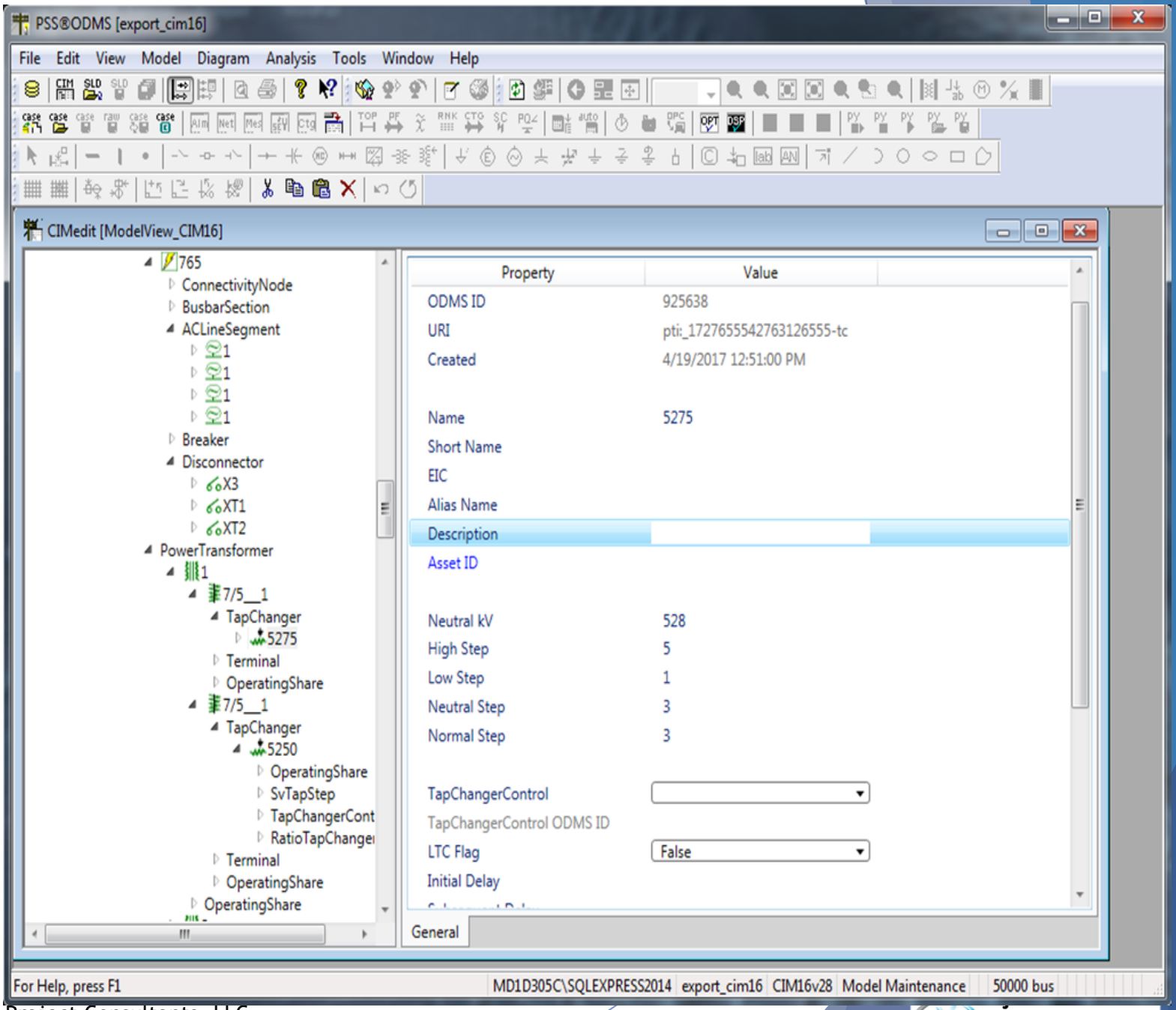
Project Consultants

The Flow of Changes

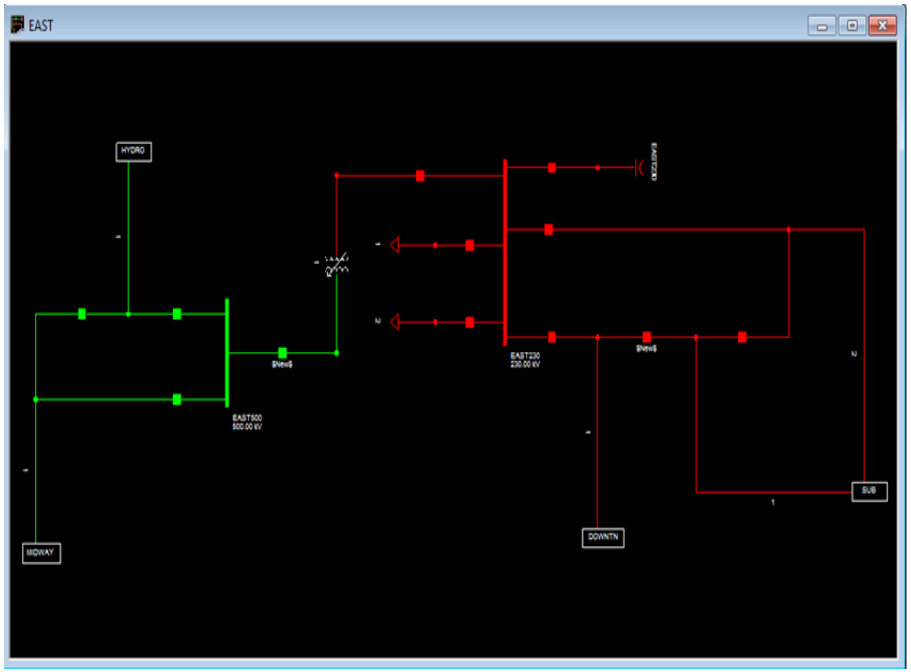


Network Model Manager
Project Work Flow

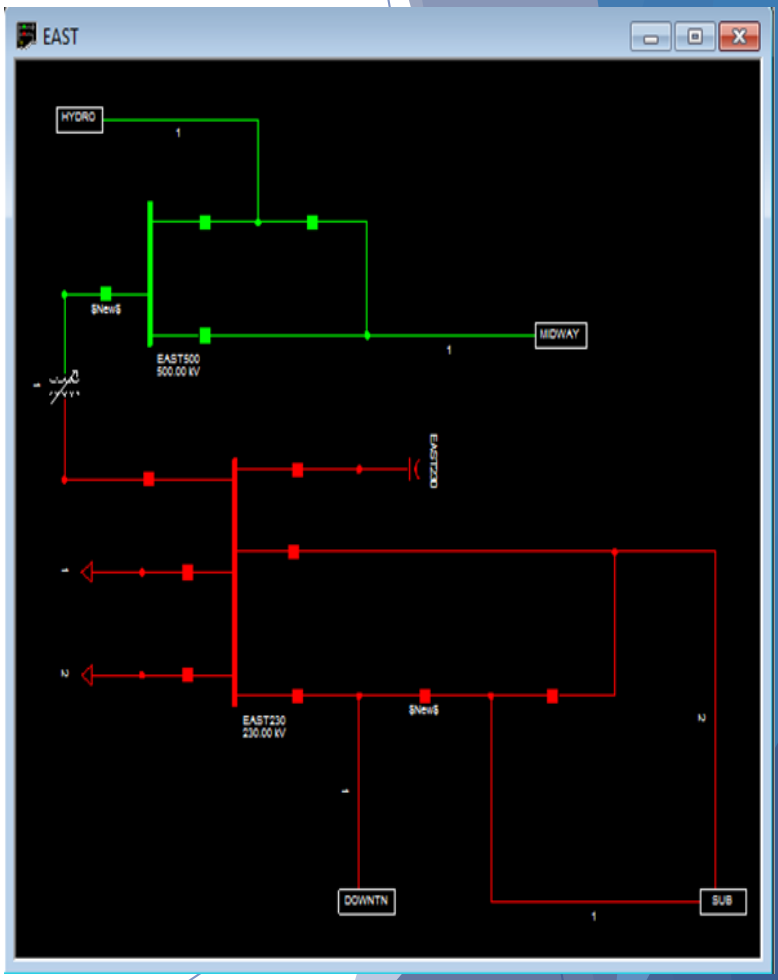
Data Viewing



Programmatically Generate and Manually Adjust Single Line Diagrams



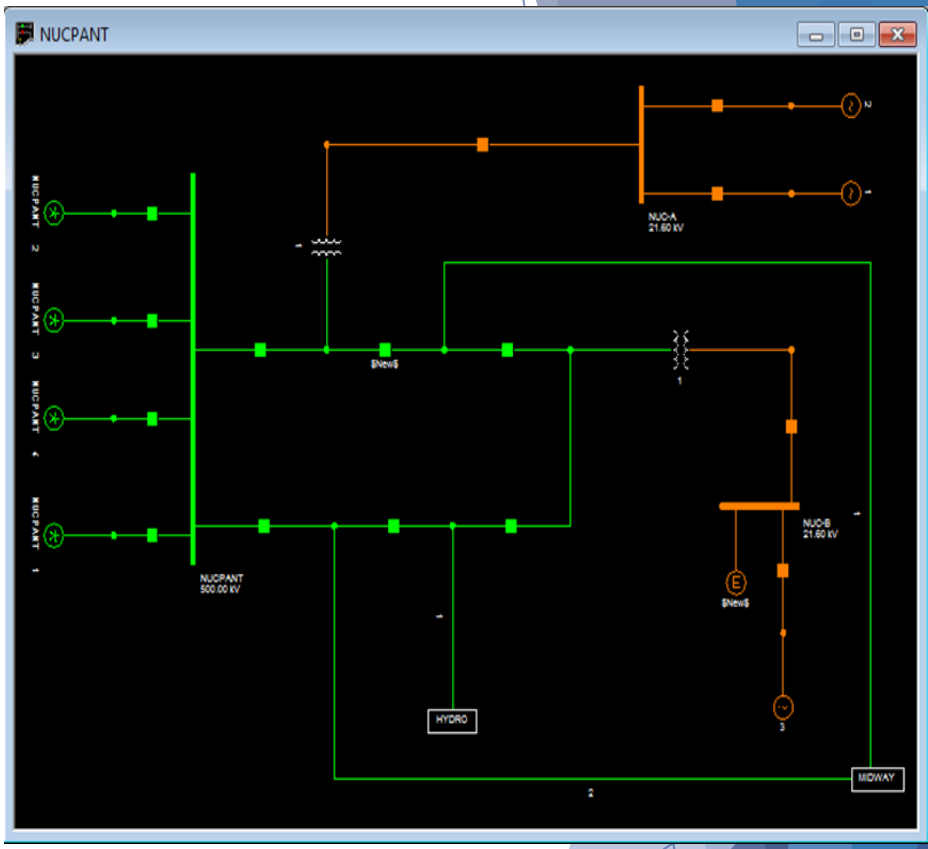
- Examples of Rendered one lines from the connectivity stored in the model
- Content of one lines are driven by the stored Model
- Layout can be adjusted to suit the needs of the users

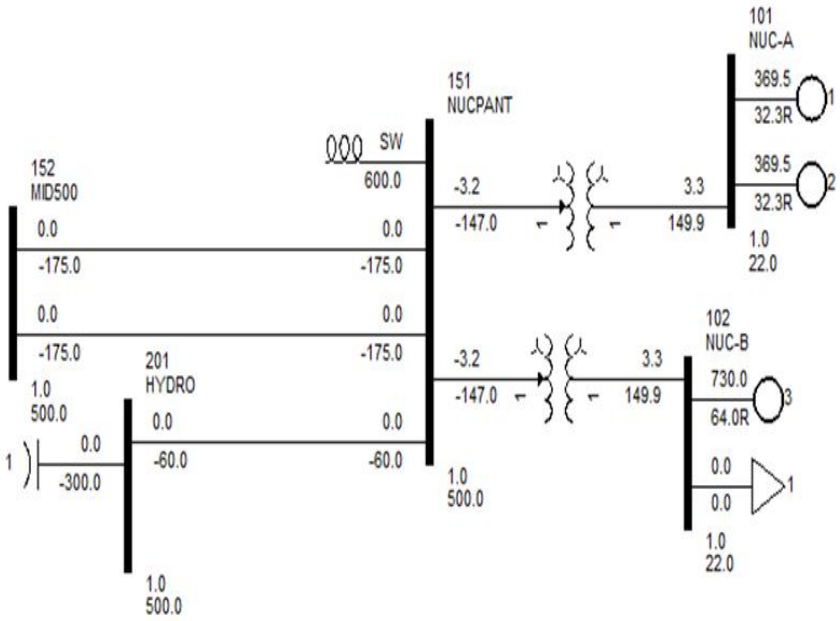


Project Consultants

Ability to collapse topology to Bus Branch

Support for collapsing all switching devices to export bus-branch model for planning studies

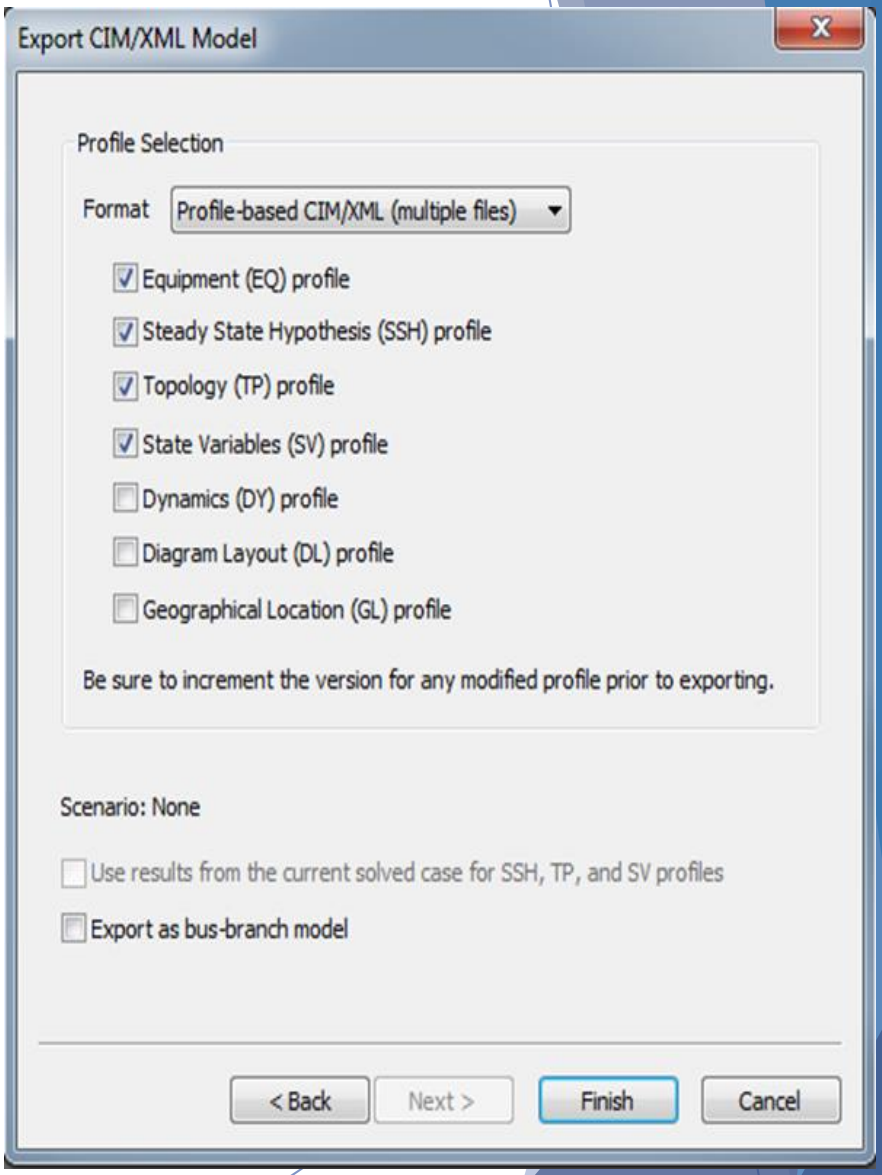




Project Consultants

Profile Controlled Export

- Screen to export CIM XML files by profiles in CIMv16 (Equipment, Dynamics, etc.)
- Each Profile contained in a separate file
- Exported files are zipped



Project Consultants

T-Nexus Functionality Overview- Testing Approach

5 Levels of Testing prior to Model/Case Release

Level 1

- Ran by User prior to “submission”
- Range Checks
- Association Checks
- Completeness Checks (may include Power Flow)

Level 2

- Model Coordinator Visual checks
- Additional Programmatic Sanity Checks

Level 3

- Engineer Review
- Assessment for Power Flow using the single project against the current As-Built

Level 4

- Power Flow test with the project incorporated with all other projects for a specified timeframe

Level 5

- EMS Testing in the EMS Staging Environment (includes attachment of external model and EMS Vendor validation processes)

Project Consultants

Thanks!

Margaret E Goodrich
Project Consultants, LLC
margaret@projectconsultantsusa.com
+1-903-477-7176