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Meeting Today's Planning Study Demands with Automation

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Outline

- The Past
  - Few Scenarios and Hard to Update
  - Need for Centralized Network Model
- The Present
  - Basecase Database
  - Parallel Processing
  - Automated Scripts
- The Future
  - Cloud Computing

THE PAST

Few Scenarios, Hard to Update, and the Start of the Centralized Model

Few Scenarios and Hard to Update

- Due to enormous complexity of physical power grid and computational power, compromises were historically made
  - Size of model reduced to solve smaller set of equations
  - Limited generation dispatches to look at most stressed situations
  - Single peak system load level typically tested to cover entire year
- When starting a study, a large length effort was needed to prepare the network model
  - Each future project would need to be tracked down from technical lead on project
  - Most planners only focused on local study area model
  - Update text file of system contingencies, cumbersome and error prone
  - Could take 3-6 months to prepare case for local planning study

Start of the Centralized Model

- The advent of the Forward Capacity Market created the need for a up-to-date system-wide model on a frequent basis
  - Old method was insufficient due to amount of time needed to prepare a model of the entire region
- New business need led to creation of centralized network model with a repository of all future projects
  - All new studies now started from same network model
  - All basecase corrections and future projects added to centralized model so it would be available for all users
  - New bridge program created to match EMS ratings and impedance data from real-time operations model to the planning model
  - New repository still insufficient for all business needs
    - No place to store auxiliary files used in planning studies

THE PRESENT

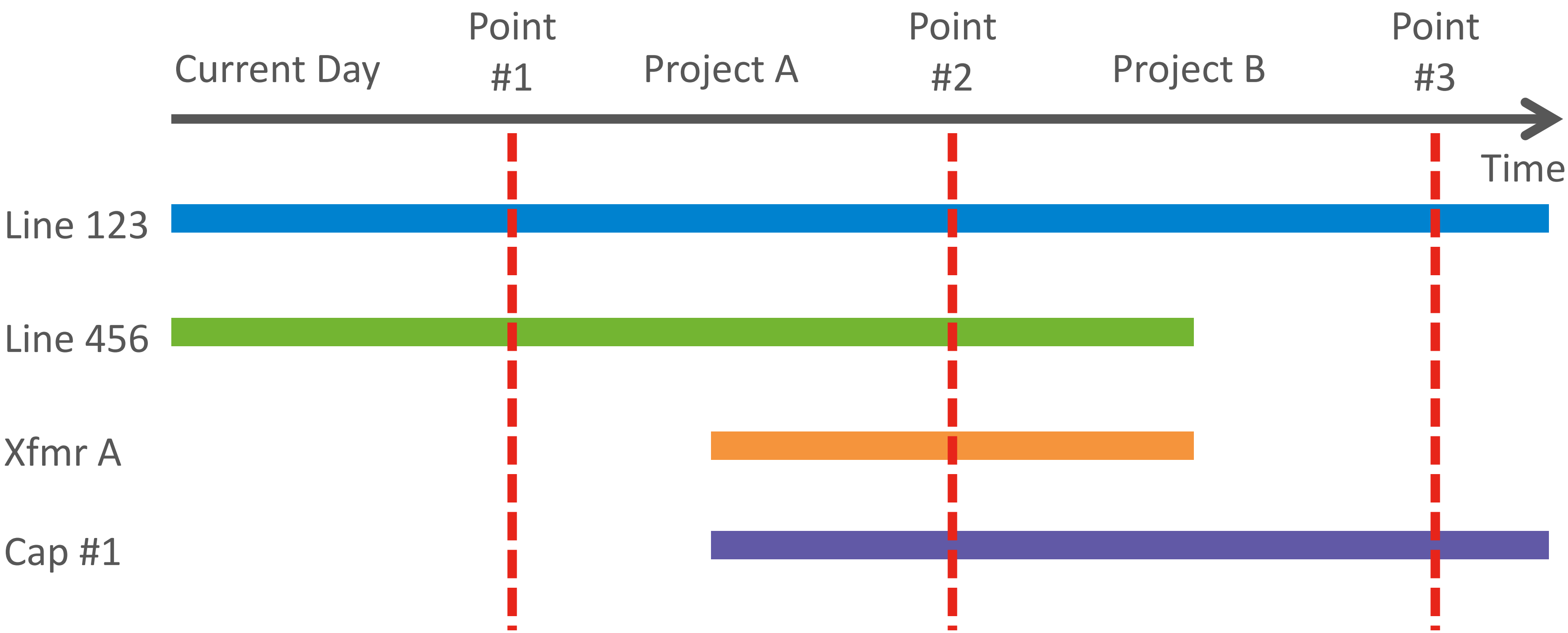
Basecase Database, Parallel Processing, and Automated Scripts

Basecase Database

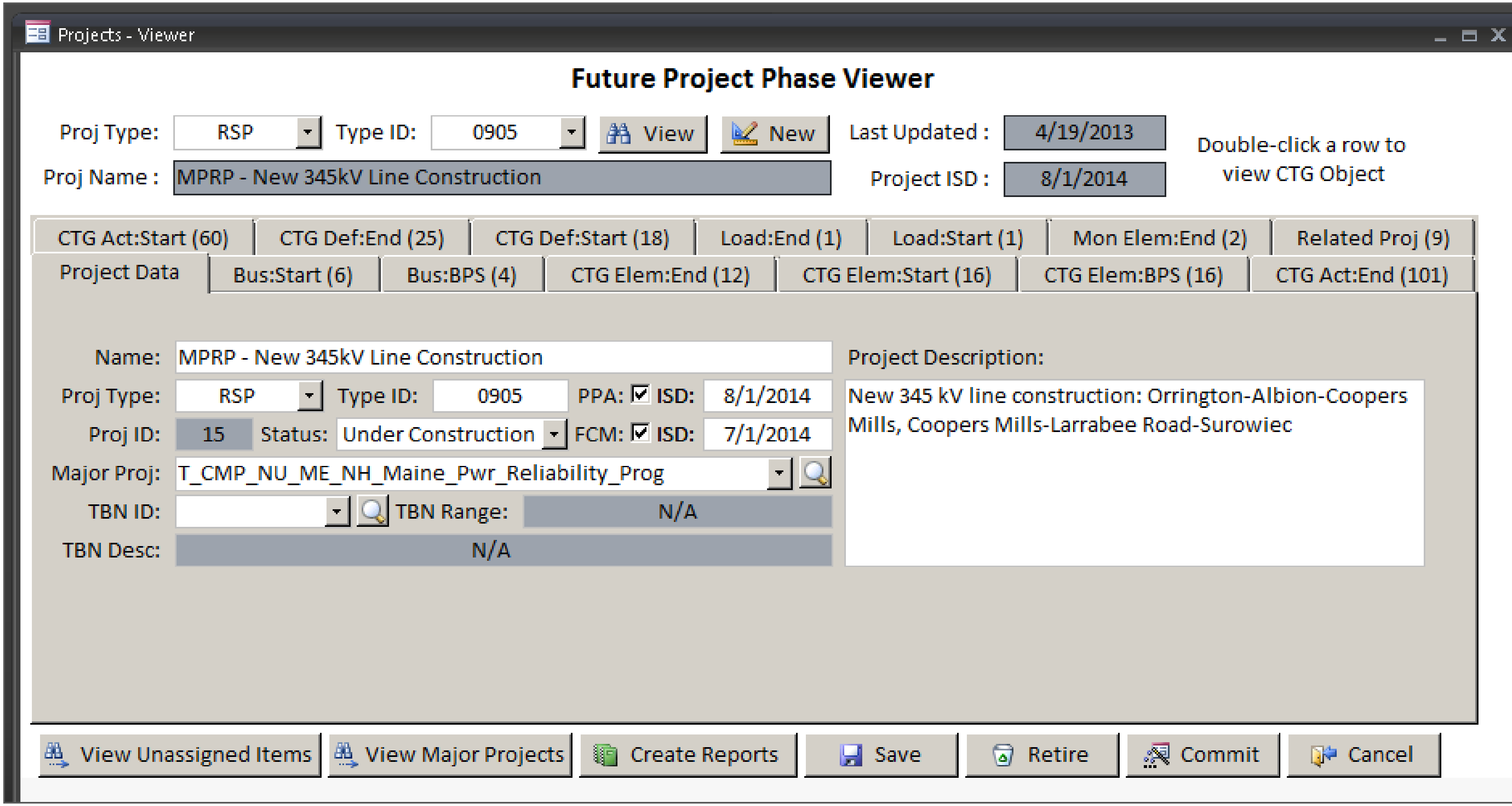
- Standardized contingency definitions a natural fit for a database that allowed
  - Centralized contingency corrections
  - Maintenance of future projects and their inter-dependencies
  - Customizable contingency lists
  - Standardized naming convention and comment methodology
- Further enhancements made to database to house more information
  - Load distributions
  - Demand resource and energy efficiency information (modeled as negative load)
  - Generator profiles (seasonal capabilities)
  - Auxiliary files used in steady state assessments (sub, mon, etc…)
  - Summary scripts
- Setting up a study now done in a matter of days instead of months

Basecase Database, *cont.*

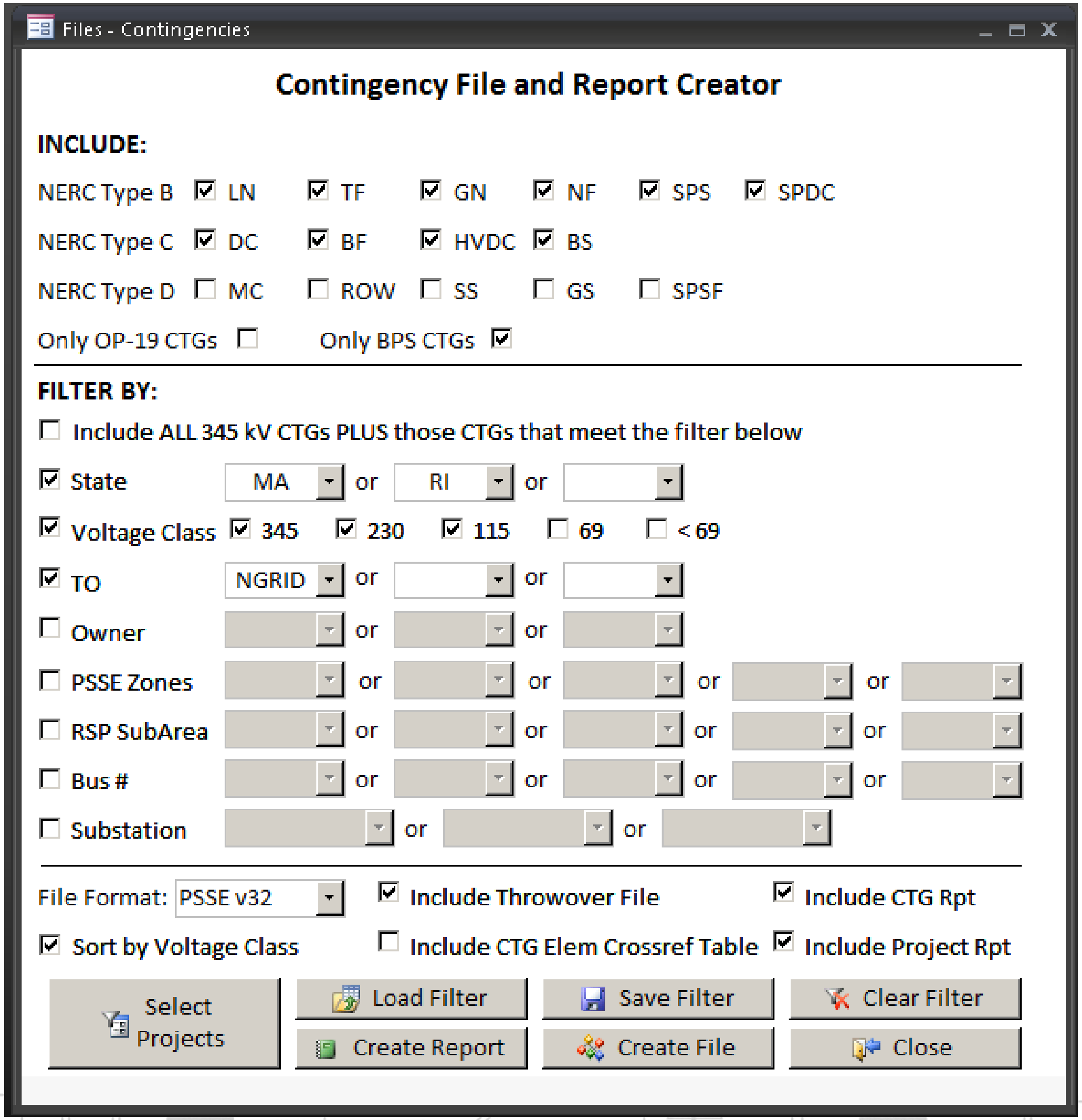
- Contingency Definition Project Dependency Example
  - Substation XYZ Breaker Failure Contingency ‘1T’
    - Project A adds Transformer A and Capacitor Bank #1 to definition
    - Project B removes Line 456 and Transformer A from definition



Basecase Database, *cont.*



Basecase Database, *cont.*



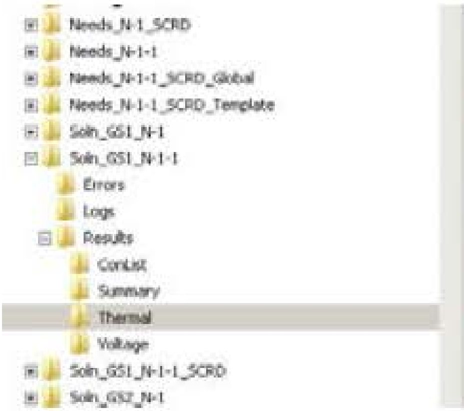
Parallel Processing

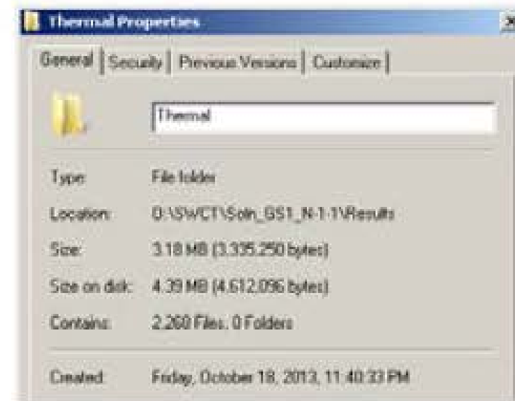
- There is a need to look at an increased number of scenarios in planning studies
  - Expanded N-1-1 testing as mandated by NERC
  - Necessary to look at multiple generation dispatch scenarios including accounting for potential generation retirements
- Parallel Processing
  - Modern power system tools capable of running N-1-1 assessment and multiple cases
  - Typically handled in a serial fashion
  - With affordable computation power the use of parallel processing allows to reduce the processing time by multiples of 10
- ISO Implementation
  - Ability to run 40+ scenarios in parallel
  - Typical study has 15 dispatches and 150 line-out scenarios which at a per job time of 3 minutes can take up to a week to complete
  - Using parallel processing on 40 nodes job completed in 4 hours

Automated Scripts

- Need
  - The results from the parallel processing jobs is split into multiple files
  - Scripts developed to combine the results into a single file
- Enhancements
  - Identifying direction of overloads
  - Flagging for short-term emergency ratings violations
  - Tagging geographical location of the violation
- Impact
  - Reduces review time by planning engineer
  - Allows fitting results into standardized report formats

Automated Scripts, *cont.*





Branch LTE Thermal Overloads

LTE_Overload: Yes

Max of LTE_Loading	Column Labels													
	A												B	C
Row Labels	1	2	3	4	5	6	7	8	14	15	16	18		
1570-2-UI - [redacted]	109.9%	103.4%	102.8%	106.6%	102.0%		101.3%				104.9%	107.2%	104.8%	101.4%
1710-1 - [redacted]	108.2%	102.9%		102.5%	102.1%						101.5%	107.7%	103.4%	
1887W-1 - ([redacted]	110.6%	110.3%	110.4%	110.3%	111.0%	110.5%	111.0%	110.5%	110.5%	110.4%	110.7%		109.1%	110.0%
3103C - ([redacted]	109.8%	120.5%	118.8%	121.1%	105.6%	117.7%	102.5%	114.8%	113.8%	116.5%	104.4%	124.4%		
84004 - ([redacted]							101.0%	101.8%						
8809A-1 - [redacted]			107.4%				114.4%						103.7%	
8909B-1 - [redacted]			107.3%				114.3%						103.6%	
GLENBROK 4X - ([redacted]														102.3%
GLENBROK 5X - ([redacted]														102.3%

LTE Violations | STE Violations | High Voltages | Low Voltages | Voltage Rise | Voltage Drop | Loss Of Load | Non-Converged Summary | SCRD Gen Adjust | SCRD Binding Elements | SCRD P...

Ready 90%

Net Effect and Future Challenges

- The use of a basecase database, parallel processing and automated scripts has resulted in:
  - More accurate base cases, auxiliary files and contingency files that can be created in a much shorter time
  - An ability to simulate several scenarios over multiple servers in about 1/40th the time
  - Smart combination of the result files that are easy to analyze and include into reports
- Future challenges
  - Internal servers used for multiple studies and for different programs
  - IT departments are faced with the challenge of expanding the available computing power with the growing needs of planning engineers

THE FUTURE

Cloud Computing

The Future – Cloud Computing

- In-house High Performance Computing (HPC):
  - Significant capital investment
  - High operating and maintenance costs
- Cloud Computing:
  - Easy access to large scale computing resources over the Internet
  - Computing resources (i.e., infrastructure, platform, and software) are provided as subscription-based services
  - Without the need of infrastructure maintenance
  - Pay-as-you-go pricing scheme
  - Encryption available to protect sensitive data

ISO New England Pilot Project

- Background:
  - Initiated in 2012
  - Investigate the potential of using cloud computing to improve the efficiency of the existing planning studies
- Primary results:
  - A special licensing structure is developed to allow the power system application to be easily installed and configured at each computing node;
  - Significant improvement in computing efficiency:
    - Number of Independent Scenarios : 4,100
    - Single desktop computer: 1,700 hrs
    - Internal computing cluster (40 cores): 40 hrs
    - Cloud computing (150 nodes * 8 cores): 1.5 hrs
      - Cost $60 (bid-in spot price, project could be interrupted)
      - AES-256 encryption used for the data transfer to and from the cloud nodes to protect CEII information

Questions