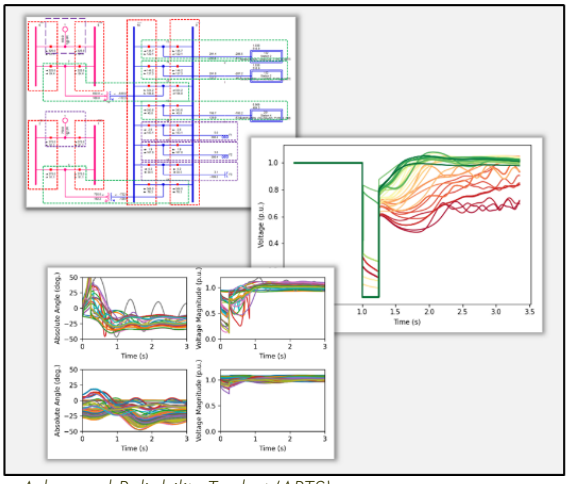
# Application of Advanced Tools for Transmission Contingency Analysis



*The Advanced Reliability Toolset (ARTS)*

- Automate the creation of contingency events for steady-state and dynamic analysis required for annual transmission planning assessments
- Efficiently screen and rank severe contingency impacts for both voltage and transient stability to allow for prioritization and detailed analysis
- Leverage increased computation and scripting capability to fully automate studies and analysis required for annual transmission planning assessments

## Background, Objectives, and New Learnings

As the nature of power system changes, it has become increasingly challenging to assess the reliability of transmission systems given the limitations of today's standard bus-branch, positive-sequence modeling approach. The latest transmission planning requirements and standards (e.g., NERC TPL-001-4 in North America and other relevant grid code planning standards) require a comprehensive set of contingencies to be evaluated including those involving the node-breaker topology of the system.

In addition to the complexities associated with the topological processing and generation of the contingency events, the need to evaluate and classify the stability impacts of any new or existing contingency events on the evolving power system are increasingly burdensome. As changes are made to the transmission system, new contingency events must be defined, and the impacts of existing contingencies must be re-evaluated. Evaluation requires categorizing events as stable and unstable. Unstable events require detailed assessment to identify and determine potential mitigations or solutions to the underlying contingency event.

Increased computational capability has introduced high levels of automation capability and parallelization in the transmission planning analysis, but the contingency definition process and post-processing analysis and evaluation still create significant bottlenecks. They are both labor intensive and require hundreds of engineering hours to ensure both processes are fully and accurately completed. To advance and improve this process, EPRI has developed a suite of tools called the Advanced Reliability Toolset (ARTS), that integrates applications developed as part of the EPRI Transmission Planning R&D program.

The ARTS suite of tools includes the Automated Contingency Generation Tool (ACGT), the Protection Control Group (PCG) Engine, the Contingency Screening and Ranking Tool (CSRT) – Dynamic Voltage Module (DVM), and CSRT – Transient Stability Module (TSM). These applications are designed to be interchangeably or collectively applied across the entirety of the transmission planning process. Through this supplemental project, EPRI would apply ARTS applications to automate the targeted stage of the transmission planning process.

## Benefits

The ACGT and the PCG Engine bring several levels of automation into the planning space allowing funders to fully leverage the node-breaker representation and fully automate the creation of contingency events required to complete annual transmission planning assessments. Full automation of this process alone could save hundreds of engineering hours annually.

The CSRT modules are aimed at improving the efficiency of the post-simulation analysis process. With the CSRT modules, funders can also screen and prioritize contingency events based on voltage and transient stability impacts from short-term, time-domain simulations (1 – 2 seconds post-fault). This can allow planners to determine which contingency events

create the most significant stability impacts on their systems using efficient, automated, script-based processes eliminating visual inspection processes. Overall, the ARTS suite of tools can be used to assess system reliability providing insights into system reliability issues while potentially saving hundreds of engineering hours annually.

## Project Approach and Summary

There are multiple objectives that can be achieved through application of the ARTS suite of tools. If the funder has existing automation processes to run and complete planning assessments, EPRI will work with the funder to integrate the selected tools into those processes. Funders can choose to apply the ARTS suite through the following tasks:

### *Task 1: Automated Contingency Generation Using Node-Breaker Models*

- Work with the funder's engineers to generate and evaluate accuracy of contingency definitions from a node-breaker model and integrate the ACGT and PCG Engine APIs into existing planning processes to run planning assessments.
- Facilitate verification that contingencies generated are accurate and capture all contingencies required for a complete compliance study.
- Quantify potential man-hour savings by generating contingencies directly from the node-breaker power flow case.

Note: A node-breaker model of the power system is required to use the ACGT. The funder must have a node-breaker case developed in *.raw or *.epc format to participate in this task.

### *Task 2: Contingency Screening and Ranking Assessments*

Work with the funder's engineers to evaluate the dynamic voltage or transient stability performance of the contingency events across a user-defined simulation window. For voltage stability screening, this evaluation can also include the application of composite load models in the positive sequence simulation platforms to determine the impacts of fault induced delayed voltage recovery (FIDVR). The funder can define any set of contingencies that will be evaluated, and there is no dependency on contingency events created using the ACGT and PCG Engine.

### *Task 3: Integration into High-Performance Computing (HPC) Platforms*

If the funder has access to HPC infrastructure, EPRI will facilitate the implementation of the selected tools into the automation process utilized with the HPC platform. All tools in the ARTS suite can be implemented through direct Python scripting which facilitates the integration into HPC and parallel processes.

## Deliverables

The following deliverables are envisioned:

- Final project presentation summarizing overall results
- An executive summary report
- Intermediate webcast and presentations as needed
- Any supplemental scripts or code developed to facilitate software integration for funders with access to the tools

### *Price of Project*

This project has the following structure for the listed tasks:

- Task 1: $75,000
- Task 2: $75,000
- Task 1 and Task 2: $130,000

Task 3 can be incorporated into any of the above through a tailored scope and price. This is necessary to understand the need for automation and integration into the member's HPC environment.

## Project Status and Schedule

The timeline for completion of this project is nine to twelve months. This timeline begins once the required data for the selected tasks has been transferred to EPRI.

## Who Should Join?

Members who are looking to introduce advanced automation processes to their transmission planning assessments and studies. Members who are looking to fully leverage the capabilities of the node-breaker power flow model.

## Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

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