[AGM] Optimized Resilience for Distribution and Transmission Systems

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Challenge:

Transmission and distribution systems have traditionally been owned and operated by separate entities, largely due to a lack of active controls in the distribution network. Historically, a transmission operator could operate without detailed information or coordination with distribution operators. However, the past several years has seen incredible rises in active resources on distribution feeders like distributed energy resources (DERs), demand response (DR), microgrids, and other controllable technologies. This rise has yielded both challenges and opportunities that are difficult for industry to address without comprehensive wholistic modeling of both systems simultaneously. Therefore, the development of a single formulation for modeling joint transmission-distribution optimization problems, creating a basis for joint resource management and dispatch that goes far beyond scenario-driven, co-simulation methods, is critical for efficiently and reliably operating modern grid systems.

Technical Approach:

We have developed algorithms to find optimal operating conditions, using relaxation and approximation methods to obtain guarantees about those optimal conditions. The key approach is a combination of mathematical formulations, e.g., approximating the power flow physics to quickly obtain feasible bounds, and using those bounds to obtain optimal AC solutions. We leverage the large body of open-source optimization tools developed at Los Alamos, including **PowerModels** and **PowerModelsDistribution**, which separately model the power flow physics of transmission and distribution systems, respectively. We developed prototype algorithms based on these tools and tested them on transmission-distribution models of increasing complexity and size, building up to an ISO relevant problem including distribution resources to improve the response of the bulk electric system during an extreme event. The anticipated outcome is a demonstration of how using distribution network resources improves the overall resilience of a transmission system during such events. The project includes a collaboration with Northwestern University that promotes workforce development in this strategic area.

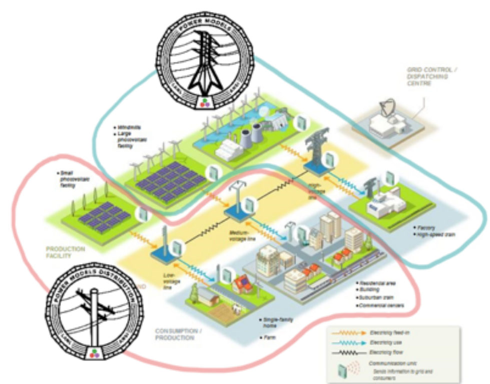

Figure 5-5: Power grids are typically separated into two categories in modeling: 1) transmission, which are generally treated as single-phase positive sequence networks, representing the bulk of all generation, and serving large industrial customers, and 2) distribution, which are more accurately unbalanced multiphase networks that serve medium to small customers and representing comparatively less generation than transmission.

Impact:

Advanced system co-optimization theory, methods, and tools are needed to provide system planners and operators with cross-domain visibility of system conditions and constraints. Without these advancements to optimization-based coordination, future deployments of controllable technologies in distribution networks could increase the possibility of coupled system collapse, especially during extreme events.