Resiliency With Respect to Low Frequency, High Consequence Events

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Research objectives

The overall object of this task is to investigate the impact on the power grid of low frequency, but high impact events. Examples include geomagnetic disturbances (GMDs) and cyber/physical terrorism.

The initial focus of the task is the development and application of study tools to help with GMD mitigation.

GMDs impact the power grid by causing dc currents (GICs) which can saturate high voltage transformers. This saturation causes harmonics that are modeled as an increased transformer reactive power consumption

Importance for the future grid

A large scale GMD, such as occurred in 1859 (the Carrington event) or in 1921, would likely result in a rapid large-scale power grid collapse, and may permanently damage a large number of high voltage transformers. This could be a "game changing" scenario.

Impacts can be mitigated by operational changes or by the use of devices to block transformer neutral current.

Effective GIC mitigation requires that power system planners have access to tools to study the impact of GMDs on their systems; prior to the start of this project such a tool did not exist .

Research deliverables

Promised first year deliverables are a report and case studies looking at impact on example systems.

Final deliverables are case study results looking at the impact of low frequency, high consequence events on the major North American power grids.

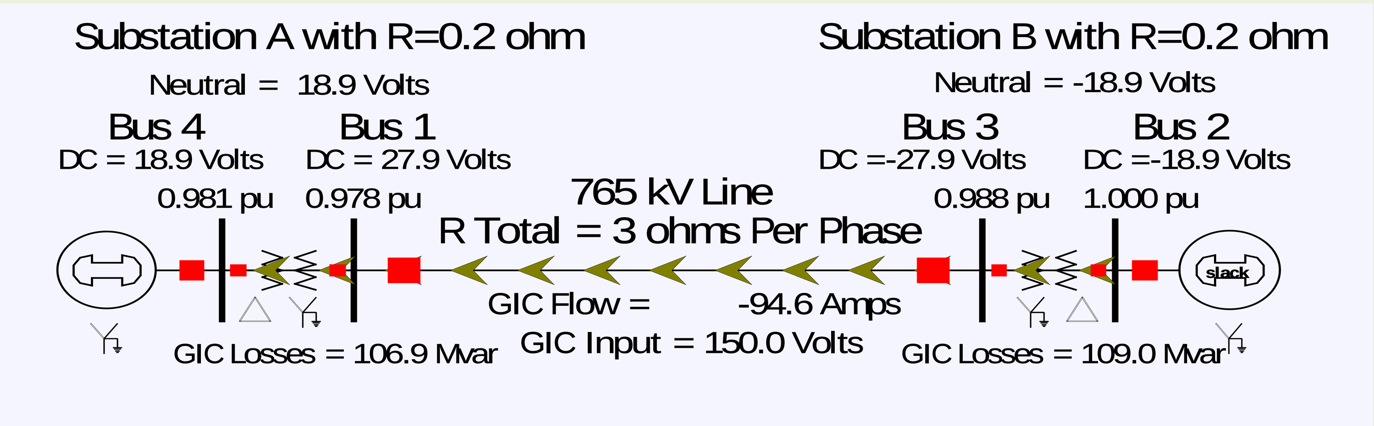
The rapid commercialization of this research should allow for an accelerated timeframe.

Research approach

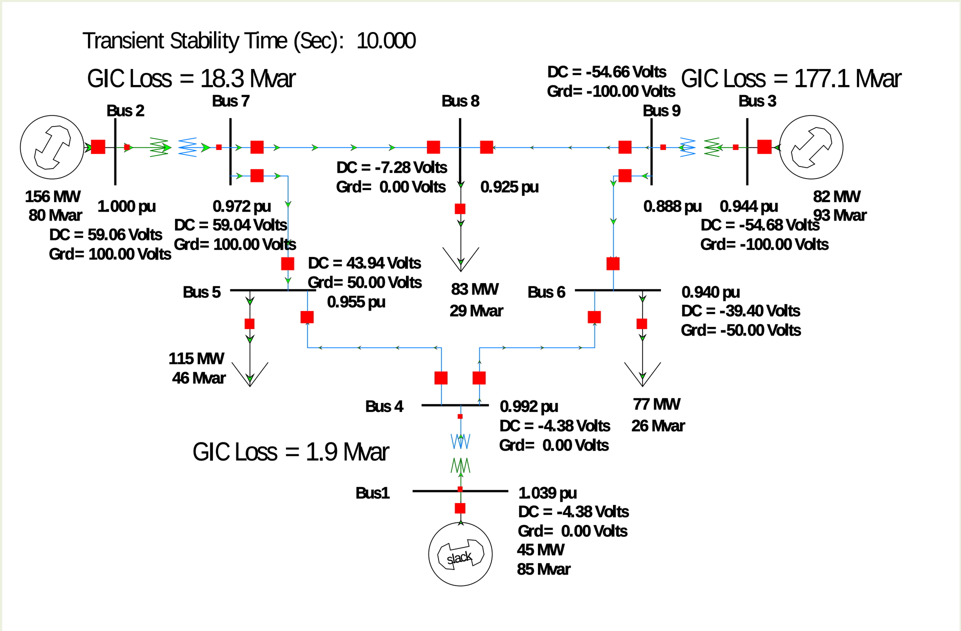
Our research approach has been to engage with industry to determine their needs. The initial engagement was in Summer and Fall 2011, which includes participating in the NERC Geomagnetic Disturbance Task Force (GMDTF).

As a result of this engagement we determined that there is an urgent need for power flow and transient stability level tools that can be used by power system planning engineers to study the impact of GICs on their systems.

We then partnered with industry (PowerWorld Corporation) to develop such a commercial tool. This tool, which was presented to industry at several events in November 2011, is now ready for beta-testing. Several industry partners are moving forward with using this tool.



Small example system demonstrating GIC impacts



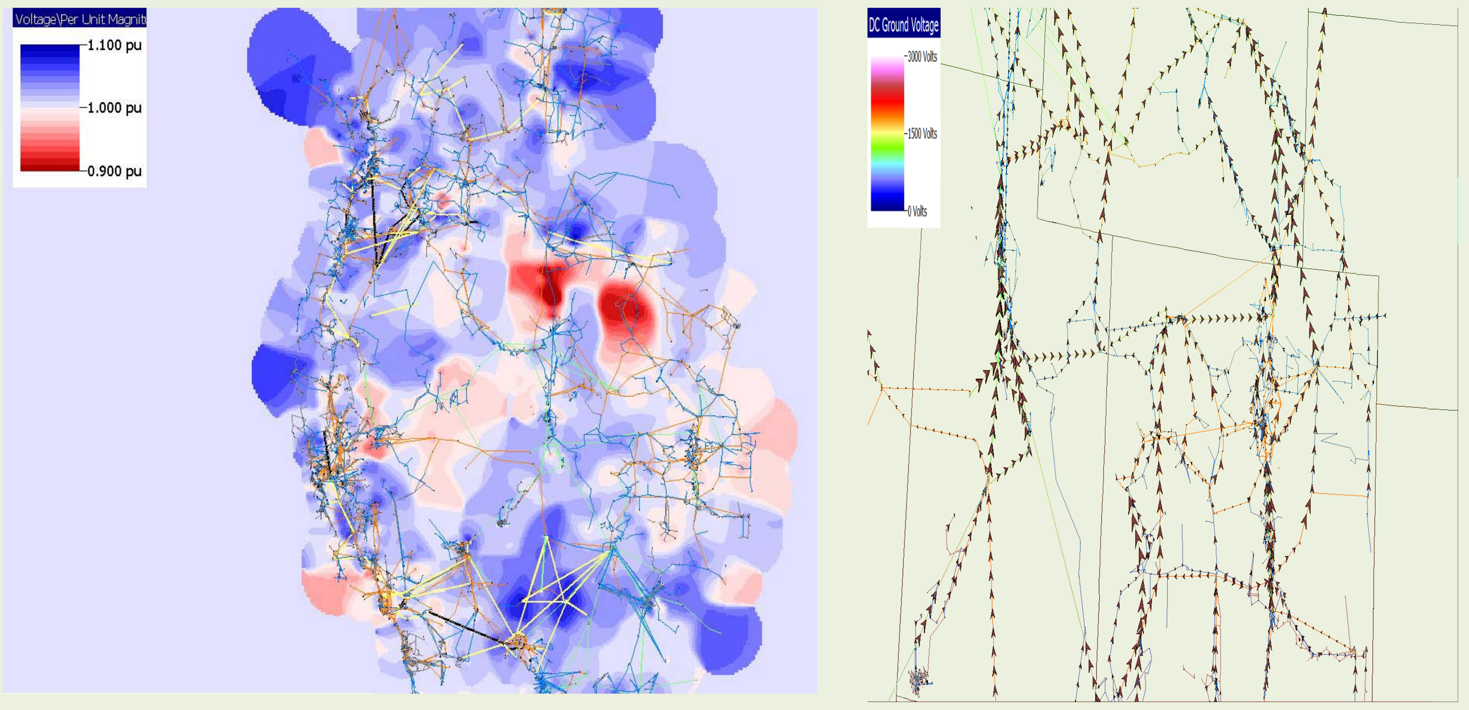
Nine bus system used to demonstrate a rapid, GIC induced voltage collapse

Research approach, continued

We are also using this tool for additional research, including looking at the impact of model size on GIC impacts, GIC validation using actual measurements, and transient stability implications of GICs.

Because the impacts of GICs on system operations are relatively unknown to many planning engineers, key focus areas are 1) providing tutorial type systems that can help explain the issues, 2) providing the ability to clearly see all pertinent system values, 3) providing innovative visualizations to help show potential system impacts.

GMDs of varying intensity, direction and duration are being studied.



Large system studies are starting with industry partners

Potential uses of this research

The key contribution of the research to-date has been the development of a power flow and transient stability level algorithm that is now being commercialized.

Power system planning engineers should be able to use this tool to study various GIC mitigation options, which have the potential to prevent large-scale, catastrophic power system blackouts

We are looking for additional industry partners!!