



Powerless: Northeast Blackout of 2003

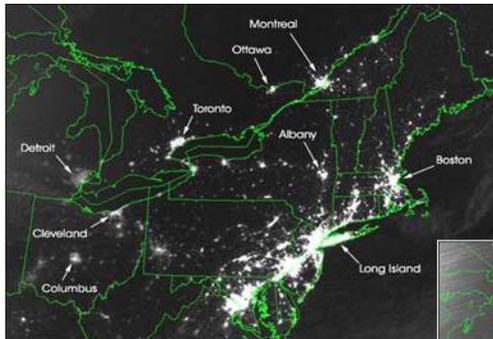
Leadership ViTS
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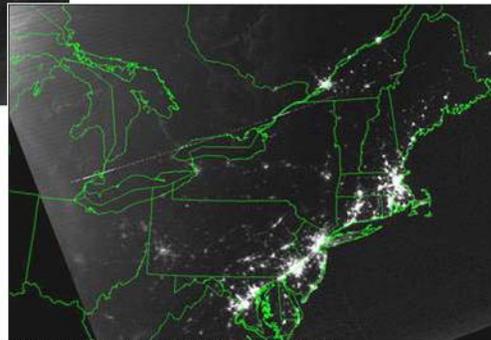


The Failure

- On the evening of August 14th 2003, the United States and Canada experienced the largest power blackout in North American history.
- The blackout affected 40 million US residents, and 10 million Canadians and cost between \$4 and \$10 billion.



August 14, 2003 • 9:29 p.m. EDT • About 20 hours before blackout



August 15, 2003 • 9:14 p.m. EDT • About 7 hours after blackout

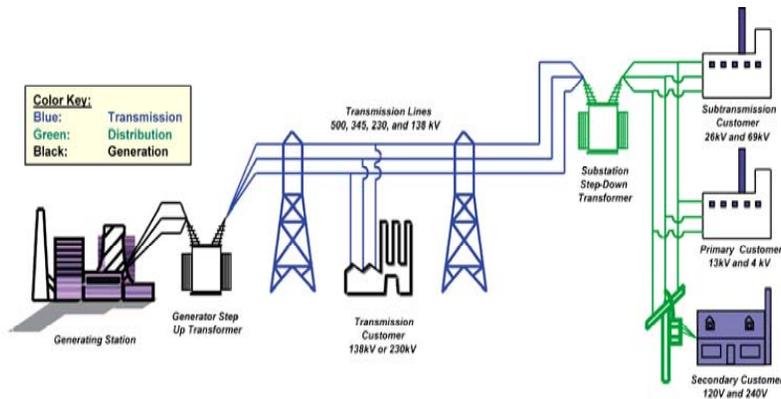
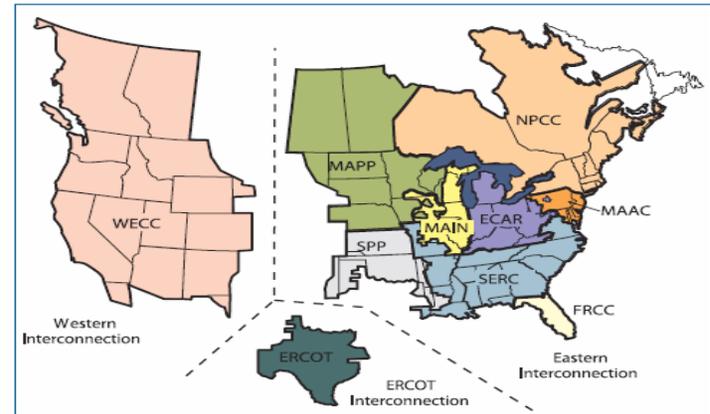
Critical Events

- Northern Ohio FirstEnergy's Eastlake 5 power generation unit exceeded system limits and automatic shutdown occurred.
- FirstEnergy's grid monitoring computer system failed to alarm thus allowing the 1,500 megawatt load imbalance to go unnoticed.
- The imbalance caused power surges which strained and overheated transmission lines causing them to sag, contact overgrown trees and shutdown.
- Within 7 minutes a cascade of line shutdowns had affected 9,300 square miles.



“The Grid”

- The North American power Grid is a large interconnected system considered by many to be one of the greatest engineering achievements of the past 100 years.
- Over 200,000 miles of transmission lines distribute 950,000 megawatts of power at 230,000 volts.
- 3,500 utility organizations serve over 283 million people across an infrastructure valued at \$1 trillion.



- The grid actually consists of *three* distinct power grids or “interconnections” that are electrically independent of each other.
- Overload of a transmission line or underload/overload of a generator requires utilities to disconnect the line or generator from the grid to prevent costly and hard-to-repair damage.



Proximate Cause

- The shutdown of the Eastlake 5 generator in northern Ohio caused a load imbalance which strained transmission lines and triggered a cascade of line shutdowns throughout the northeastern US and Canada as heavy power surges overheated lines, causing them to sag and hit overgrown trees.

Causal Web - Underlying Issues

- Lack of communication between operations and IT staff
 - IT Personnel knew of system crashes but did not notify operators instead performing “warm-reboots” to try and solve the problem.
- Inadequate system understanding and planning
 - Operators did not have a macro-view understanding of their system so could not react properly when problems arose.
- Neglected ‘vegetation management’
 - As transmission line loads increase, the generated heat causes lines to elongate and sag.
 - Power companies failed to prune trees sufficiently to prevent transmission lines from contacting them during normal operation.
- Lack of training and operator error
 - Operational planning studies and simulations conducted by FirstEnergy in 2002 and 2003 were not robust enough to understand the Cleveland-Akron grid vulnerabilities.



NASA Applicability

- Overall design requirements must take into account the needs of mission support personnel and provide an accurate, real-time, system-wide view of operational performance.
- Maintaining effective contingency plans for all conceivable off-nominal scenarios is critical to mission success.
- Ensuring mission support operators have a macro-system understanding will enable them to mitigate cascading and system-wide failures.
- Team communication cannot be overemphasized especially when lives and mission success are at stake.

