Powerless:
Northeast Blackout of 2003

Leadership ViTS
December 2007

Jim Lloyd
Deputy Chief, Safety and Mission Assurance
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.

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 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.