



IPERC

Implementation of a Cyber Secure Microgrid Control System Critical Elements, Requirements and Controls

Darrell D. Massie, PhD, PE

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ADVANCING *THE POWER OF ENERGY*

Microgrid Resiliency and Cyber Security

Key Features and Architecture

- ▶ Distributed Controls
- ▶ Advanced Decision-Making
- ▶ Control Hierarchy
- ▶ User Interface
- ▶ Energy Surety
- ▶ Comprehensive Security Strategy

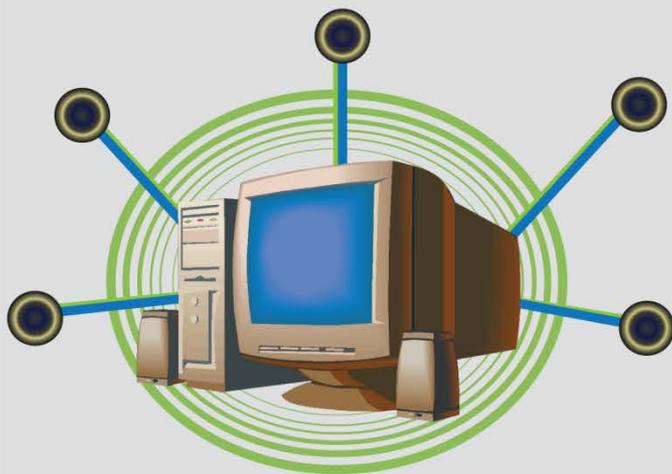
Distributed Controls

Conventional

Centralized Control
Mainframe Mentality

Single Point
Of Failure

Customized
Software Costly
To Engineer



Legacy Code
Vulnerable
to Attack

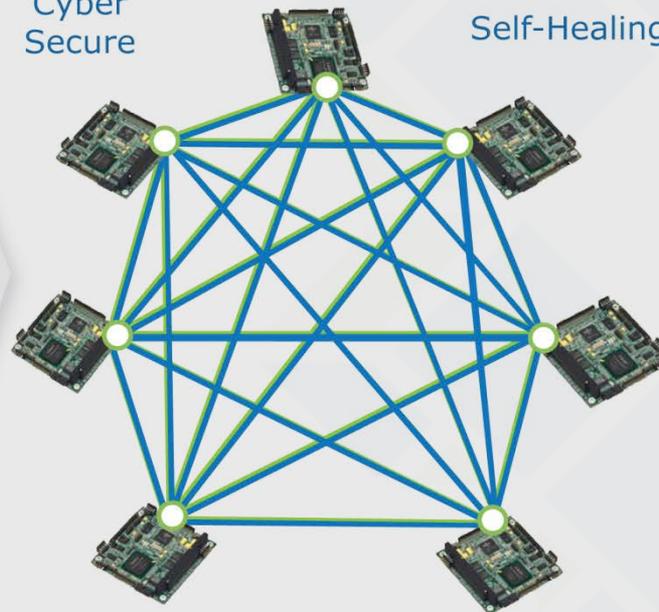
Custom
Configuration
Difficult to Scale

Microgrid

Distributed Control
Internet Mentality

Cyber
Secure

Self-Healing

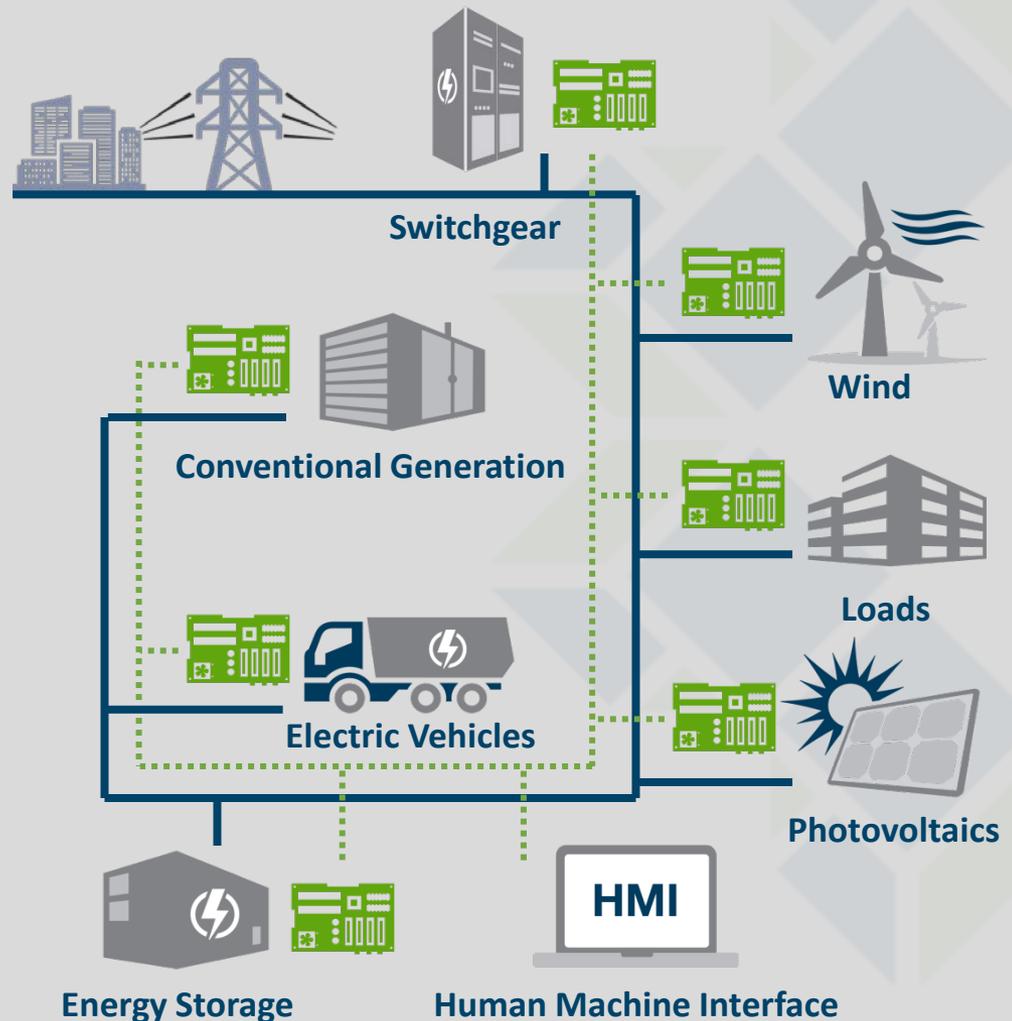


Automatic
Reconfiguration

Automatic
Optimization

Initial Microgrid Assessment

- ▶ Assessment of electrical connection to local area power system
- ▶ Assessment of installation assets
- ▶ Identification of critical nodes



Control Hierarchy Requirements

- ▶ Policy decisions set by operational commander (What are goals? Who gets priority?)
- ▶ Laws of physics (frequency and voltage compatibility)
- ▶ Contingency scenarios
- ▶ Environmental constraints (emissions, fuel source, etc.)
- ▶ Conduct modeling and simulation
- ▶ Human and automated execution



GridMaster™ Features & Capabilities

- ▶ Reliable
 - No Single Point of Failure
 - For SPIDERS II - Collaborative Intelligence
 - Fail safe operation
- ▶ Auto-optimization
 - Meets user needs (cost, efficiency, emissions)
- ▶ Inherent Resiliency
 - Multiple contingencies
 - Automated Microgrid Reconfiguration
- ▶ Comprehensive Security Strategy

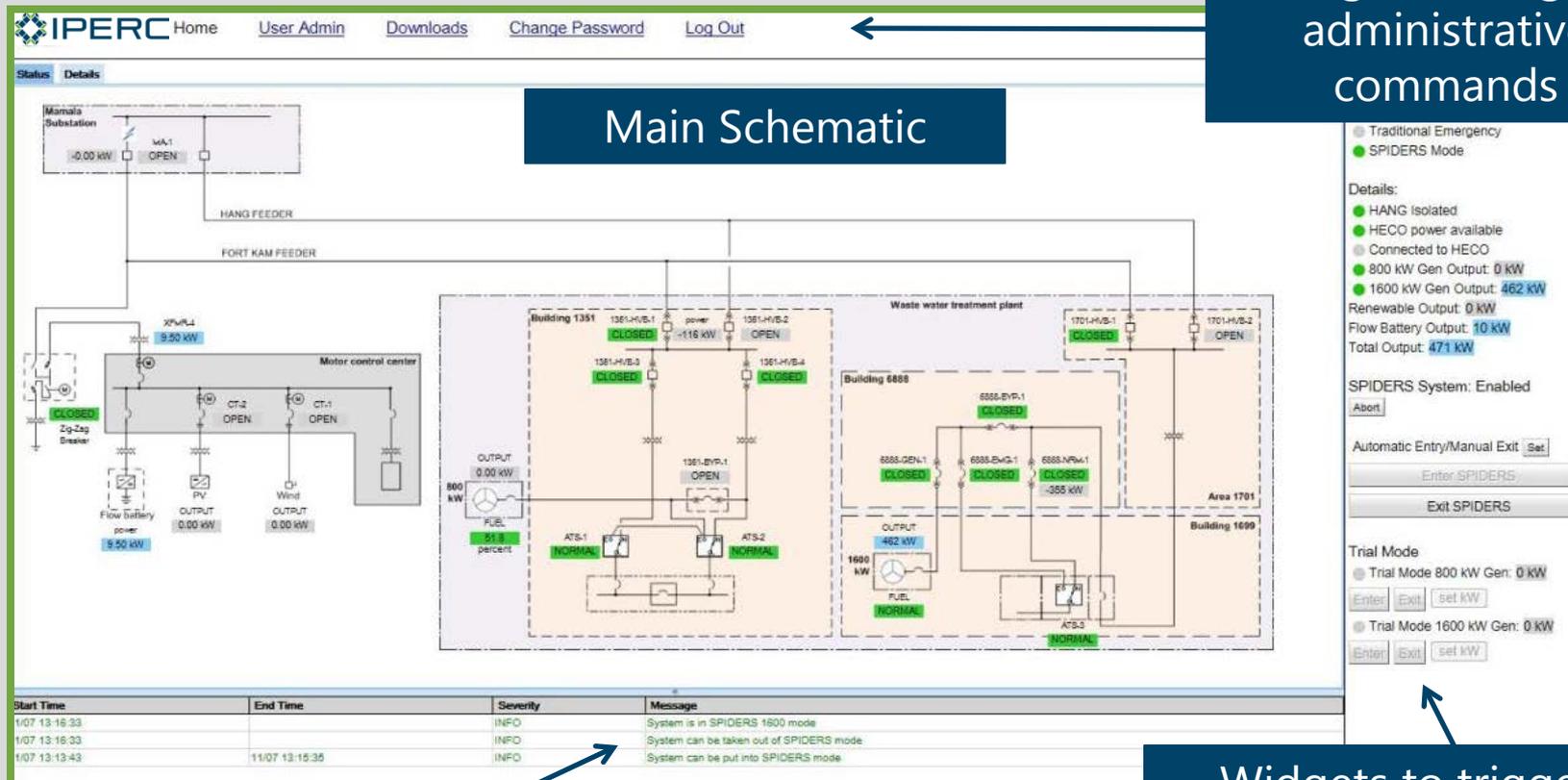
GridMaster™ Features & Capabilities

- ▶ Proprietary IPERC microgrid control unit
- ▶ Includes:
 - Single-board computer
 - Component interfaces
 - Communication interfaces
 - Hosted software
- ▶ Designed and tested for extreme conditions



Sample Graphical User Interface

Widgets to trigger administrative commands



Main Schematic

Display for messages (info, warning, alert)

Widgets to trigger commands and display for system status

Energy Surety = Electrical Resilience + Security

Two major aspects of Microgrids deliver elements of Energy Surety
Safety, Security, Reliability, Recoverability, Sustainability

Electrical

- ▶ Source vs. load optimization
- ▶ Prioritized load-shedding
- ▶ Modularity, flexibility
- ▶ Critical loads met 100%
- ▶ Stable power, ancillary services, power quality
- ▶ Improved integration of renewables

Security

- ▶ Protected data
- ▶ Intrusion protection
- ▶ Best practices
- ▶ Information Assurance controls
- ▶ Device and OS hardening
- ▶ Network security

*Evaluating and testing microgrid functionality is fairly straight forward.
How to secure microgrids remains elusive.*

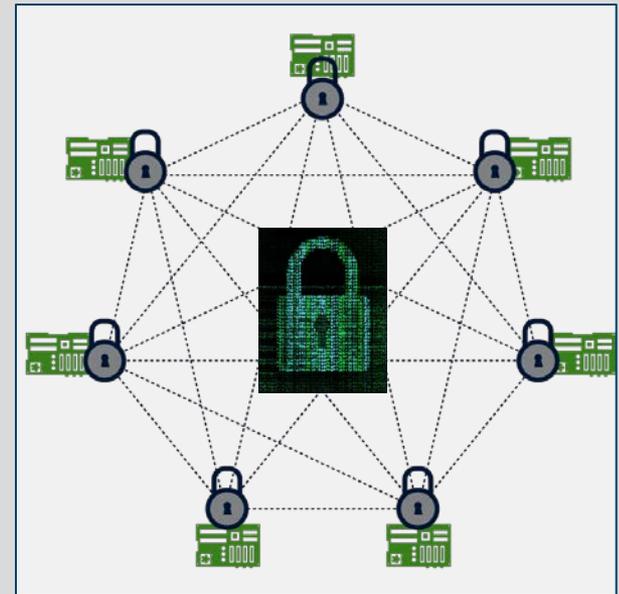
Comprehensive Security Strategy

GridMaster Cybersecurity Guidelines Used:

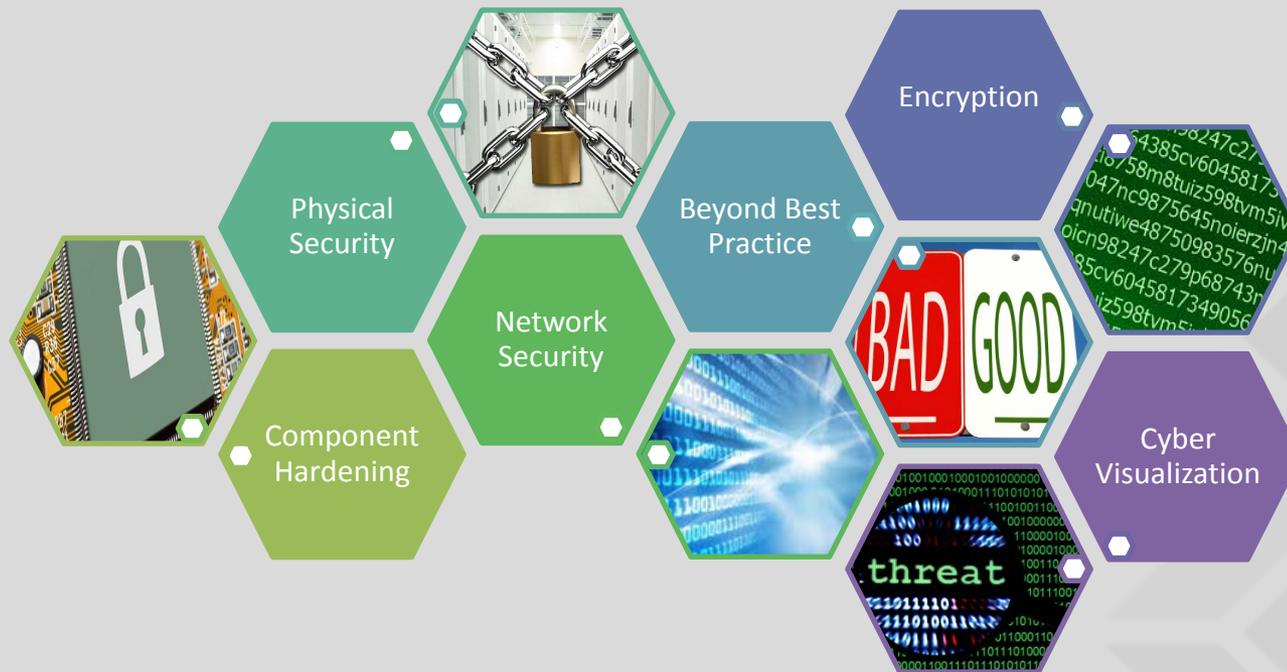
- ▶ **NIST 800-82**, Guide to Industrial Control System Security
- ▶ **NIST 800-53**, App I Security Controls, Enhancements, and Supplemental Guidance
- ▶ **DoDI 8500.2**, DoD IA Certification and Accreditation Process
- ▶ **CNSSI 1253 App I**, ICS Security Overlay
Vendor and DoD security guides for Network, OS, Application, etc.

GridMaster Risk Management

- ▶ DHS Cyber Security Evaluation Tool
- ▶ JCTD Red Team Attacks
- ▶ Risk Management Framework C&A
- ▶ Defense in Depth



Microgrid Controls Cyber Security



Effective Elements

- ▶ Physical Security
- ▶ Robust Perimeter
- ▶ Encryption
- ▶ IPv6
- ▶ Intrusion Detection
- ▶ Auditing and Alerts
- ▶ Component Hardening
- ▶ Whitelisting



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Dr. Darrell Massie
darrell.massie@IPERCsolutions.com
www.IPERCsolutions.com