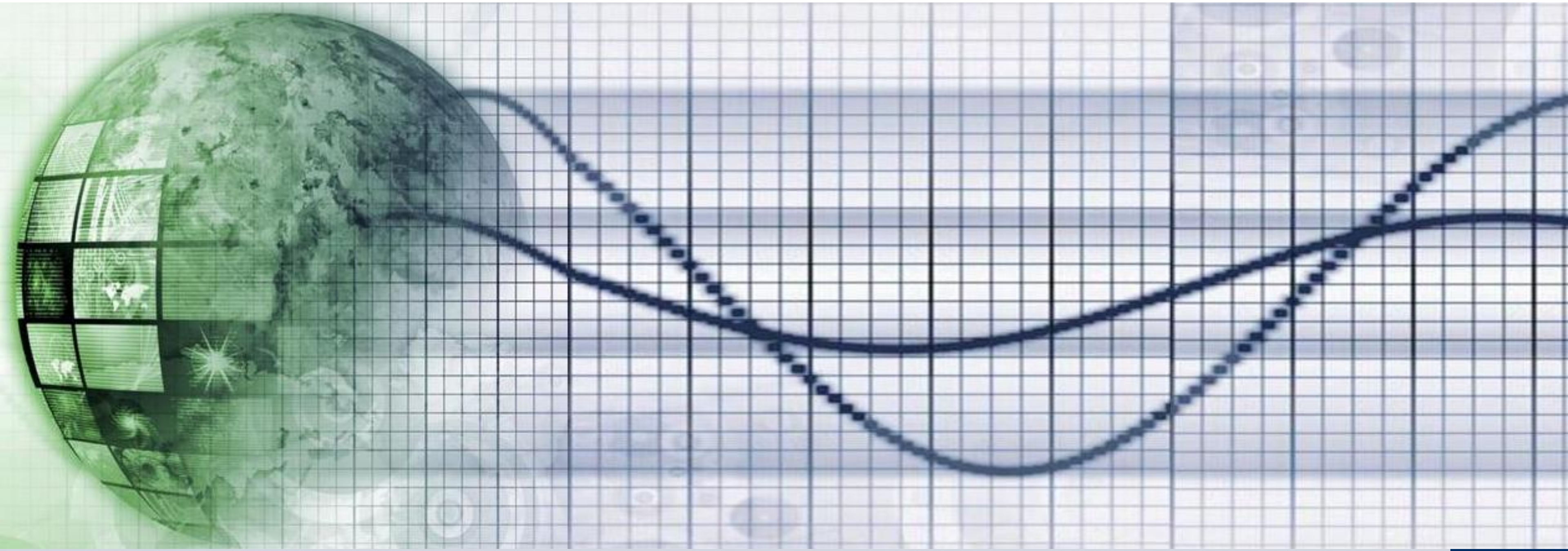
IPERC



Microgrid Controls

SPIDERS Industry Day

Darrell Massie, Ph.D., P.E.

18 June 2013

PO Box 616 | Fort Montgomery, NY 10922 | www.ipercsolutions.com

Intelligent Power & Energy Research Corporation
IPERC

Evolution to the Smart Grid

In telephony, private branch exchanges (PBXs) duplicated functions of large, remote central office switches

Distributed Intelligence and Autonomy = **Innovation in Technologies, Services, and Business Models**

In power delivery, microgrids will dramatically reshape today's grids and service providers

Brittle Infrastructure	vs.	**Flexible Infrastructure**
Significant Human Interaction		**Minimal Human Interaction**
Massive Fuel Storage, Significant Transport		**Onsite Energy Storage, Reduced Transport**
Random Loads		**Demand-Adjusted Capacity**

Intelligent Power & Energy Research Corporation

IPERC

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.

Intelligent Power & Energy Research Corporation
IPERC

Microgrid Design Drivers

Key Driving Requirements

Plug-and-Play Capability (automatic reconfiguration)
Logistically sustainable (less manpower, resources)
Do no harm

Assumptions

Efficiency through energy sharing
Systems perspective

Design Drivers

Priorities

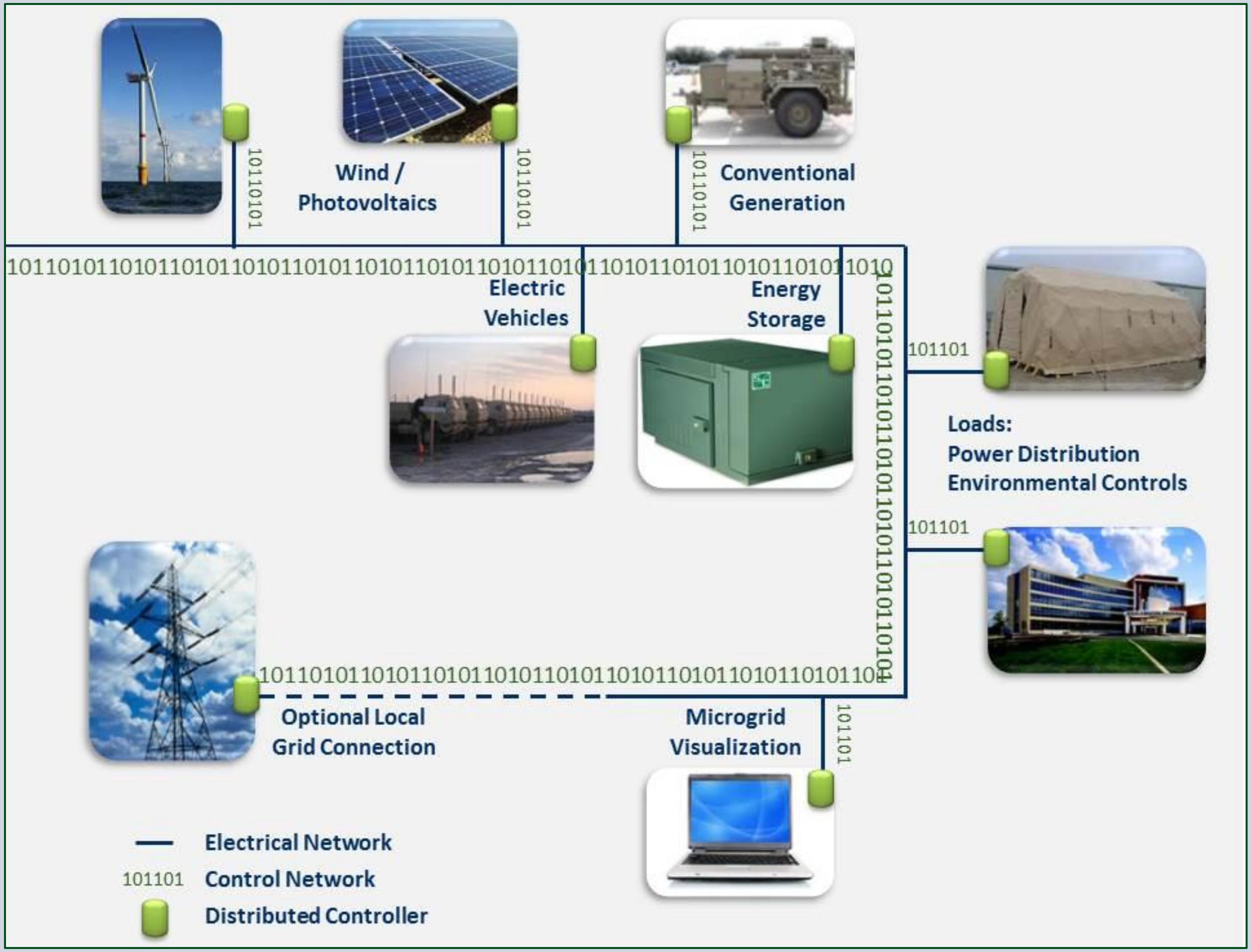
Reliable
Cyber Secure
User-Friendly
Interface with broad range of equipment
Fuel Efficiency

Constraints

Materials
Existing Equipment
Physical Requirements (weight, size)
Communications
Usage Climate (temp. range)
Cost competitive (first cost and life cycle)

Intelligent Power & Energy Research Corporation
IPERC

Initial Microgrid Assessment



- Assessment of electrical connection to local area power system
- Assessment of installation assets
- Identification of critical nodes
- Conduct modeling and simulation as necessary

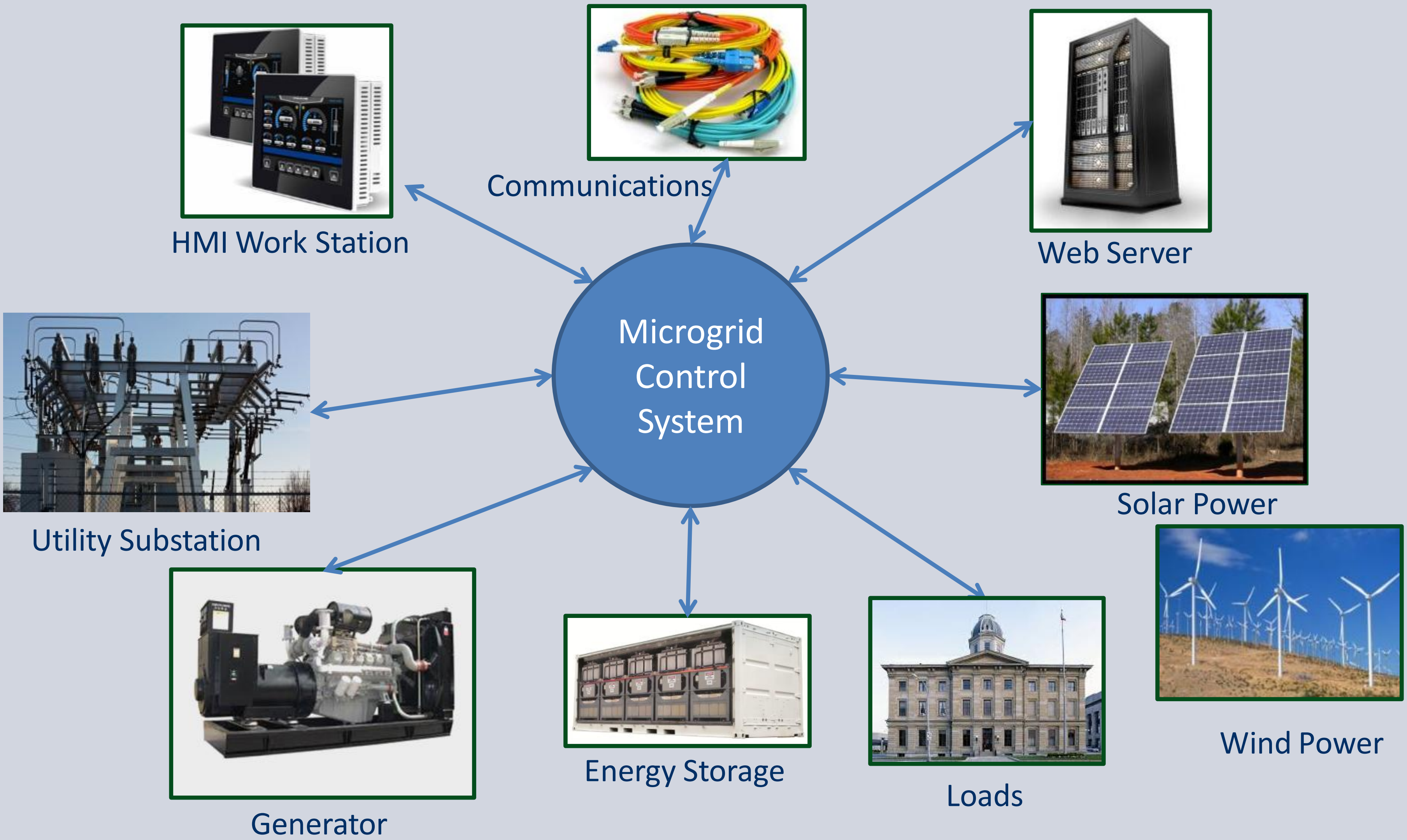
Intelligent Power & Energy Research Corporation
IPERC

Control Hierarchy Requirements

- Policy decisions set by operational commander (What are goals? Who gets priority?)
- Contingency scenarios
- Environmental constraints (emissions, fuel source, etc.)
- Supervisory control and optimization
  - Physical layers
  - Data acquisition layer
  - Communications layer
- Laws of physics (frequency and voltage compatibility)

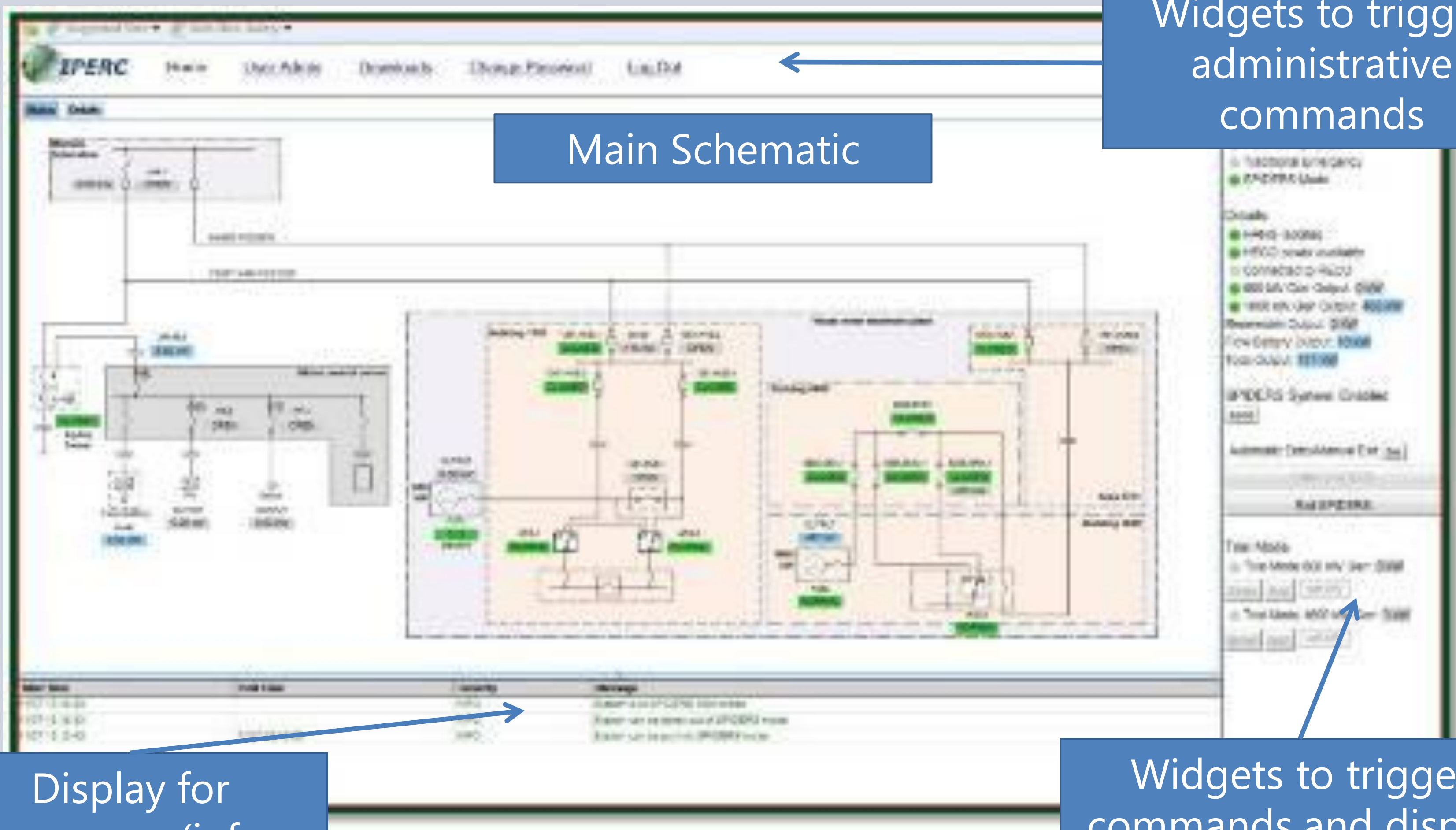
Controls must manage a variety of different decisions at different times

System Interface Considerations



Intelligent Power &
Energy Research Corporation
IPERC

Sample Graphical User Interface



Intelligent Power & Energy Research Corporation
IPERC

Legacy Systems / Equipment Considerations

- With limited resources, what upgrades are most mission critical?
- Examine opportunities for making existing legacy equipment "smart"
- Identify tradeoffs between modifying legacy equipment and investing in new
  - Legacy equipment works in legacy mode
  - Modifications to existing systems often cost effective
  - Sometimes replacement best option

Analog control panel

Incomplete information on equipment label

You can either work with existing infrastructure or you can't. When you can't, it costs money!

Microgrid Controller Specification Considerations

- Determine control system features which best meet the overall objectives
- Identify key nodes of controller
- Identify fail safe considerations (computer, communications or hardware)
- Device drivers and protocols
- User interface
- Life-cycle performance (cost, durability, configurability)
- Scalability
- Cyber vulnerabilities
- Information Assurance and best business practices
- Technical support, updates, etc.

SPIDERS Controllers
IPERC Distributed Control Architecture

Characteristics

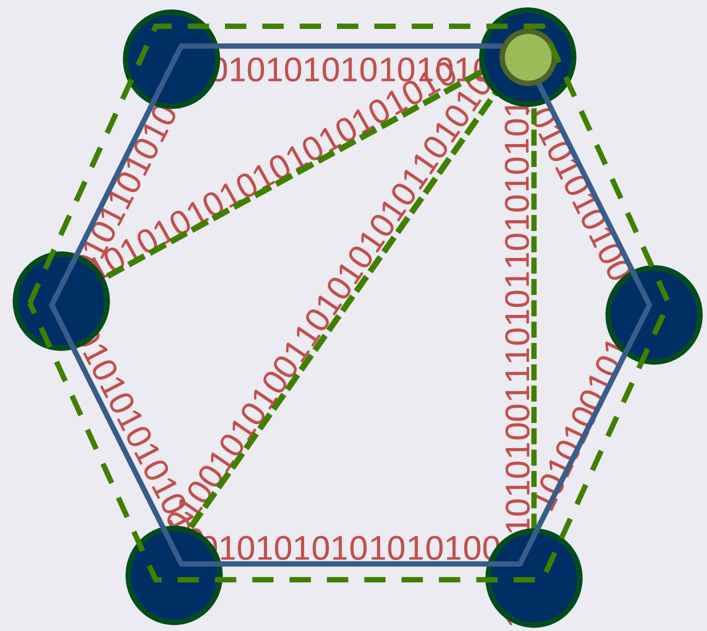
- "Smart" Distributed Agents
- Controller Flexibility
- Rapid Automatic Reconfiguration

Advantages

- Redundancy (No Single Point of Failure)
- Self Configuration/Reconfiguration
- Controllers adapt to resource behavior
- Graceful degradation
- Controllers can operate in isolation
- Lowest life-cycle cost
- Component vendor-agnostic

Disadvantages

- Design complexity
- Rapidly changing technology
- Lack of framework for how to secure



New Microgrid Functionality

- Optimized islanding from the grid
- Unlimited network nodes
- Inherently secure architecture

IPERC GridMaster^{TM}

- Single Board Computer
- Data Acquisition Board
- Environmentally hardened enclosure
- Distributed control architecture
- Cyber secured network
- Controls software

Thank You

darrell.massie@ipercsolutions.com