The Distribution Grid of the Future

S&C Electric Company

Gary Wetzel

Recognizing Future Power Needs

- In 2010, the consumer electronics sector represents the largest single usage category for domestic electricity
- By 2020, entertainment, computers and gadgets will account for 45% of electricity used in the home and need the equivalent of 14 average-sized power stations to power them

The average US household owns 26 consumer electronic products

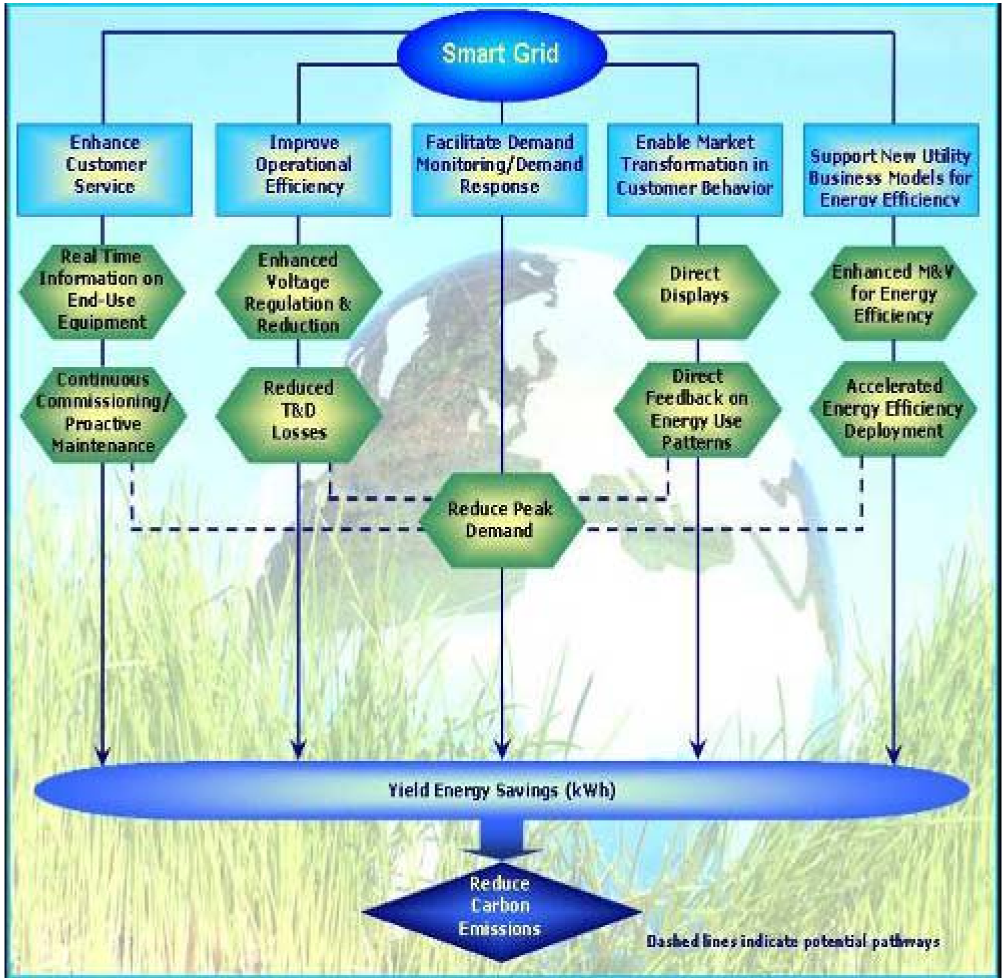
Further increases in dependency on electronic devices drive demand for near-perfect power quality and uninterrupted power availability

galvin center for electricity innovation at ILLINOIS INSTITUTE OF TECHNOLOGY

IEEE PES Power & Energy Society®

Is a Smart Grid a Green Grid?

- Initial estimated annual energy savings are 37 – 194 billion kWh
  - equivalent to reducing 24 – 126 million metric tons of CO2
  - equivalent to removing 4 to 20 million cars off the road



galvin center for electricity innovation at ILLINOIS INSTITUTE OF TECHNOLOGY

EPRI ELECTRIC POWER RESEARCH INSTITUTE

PES Power & Energy Society®

Vision for the Smart Grid

- Performs real-time simulation and contingency analysis
- Automatically adjusts to maximize efficiency and reliability
  - phase balancing
  - loss minimization
  - peak management
  - self-healing
- Interaction among distribution devices, meters, home area networks, and substations
- Readily accommodates distribution generation (DG) and plug-in hybrid electric vehicles (PHEV)
- Supports islanding and re-established interconnection
- Reports diagnostics and provides statistics

Distribution Smart Grid Technologies

- Distribution Grid Management
  - distribution automation
  - advanced metering infrastructure
- Distributed Resources
  - energy storage
  - distributed generation
  - electric vehicles
- Efficiency Improvements
  - Volt/VAR Management
  - condition monitoring
  - phase balancing
  - dynamic operating schemes
  - peak reduction/loss management

Technology Characteristics

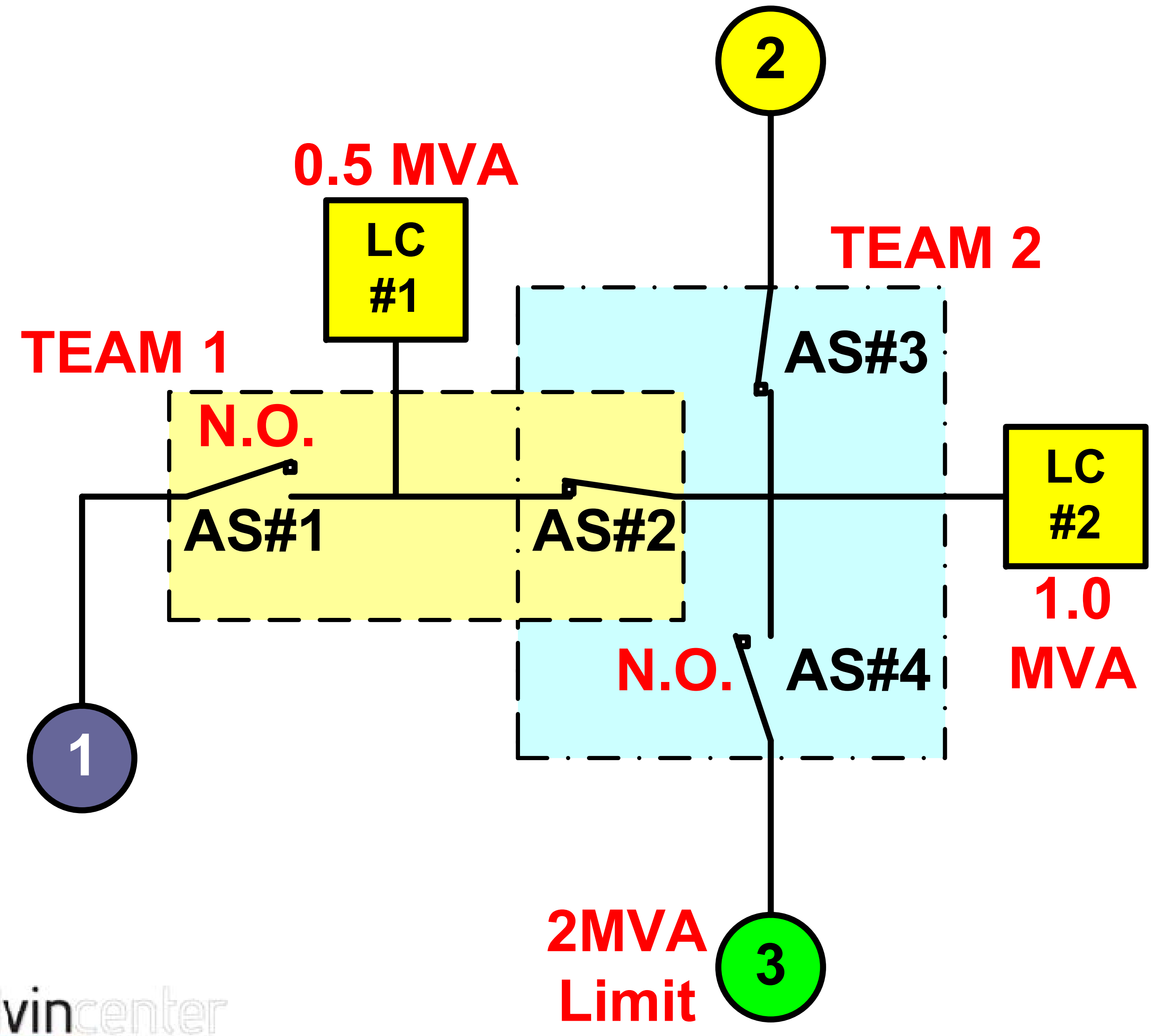
- Capable of being updated dynamically
- Supports present and future protocols, DNP compatible
- Uses the most secure technologies
- Deployable in stages, scaleable
- Utilizes integrated communications
  - adequate bandwidth – for AMI, DA, DG, PHEV
  - capable of prioritizing traffic — minimal latency
  - avoids interference and is redundant
  - supports peer-to-peer and peer-to-master communications

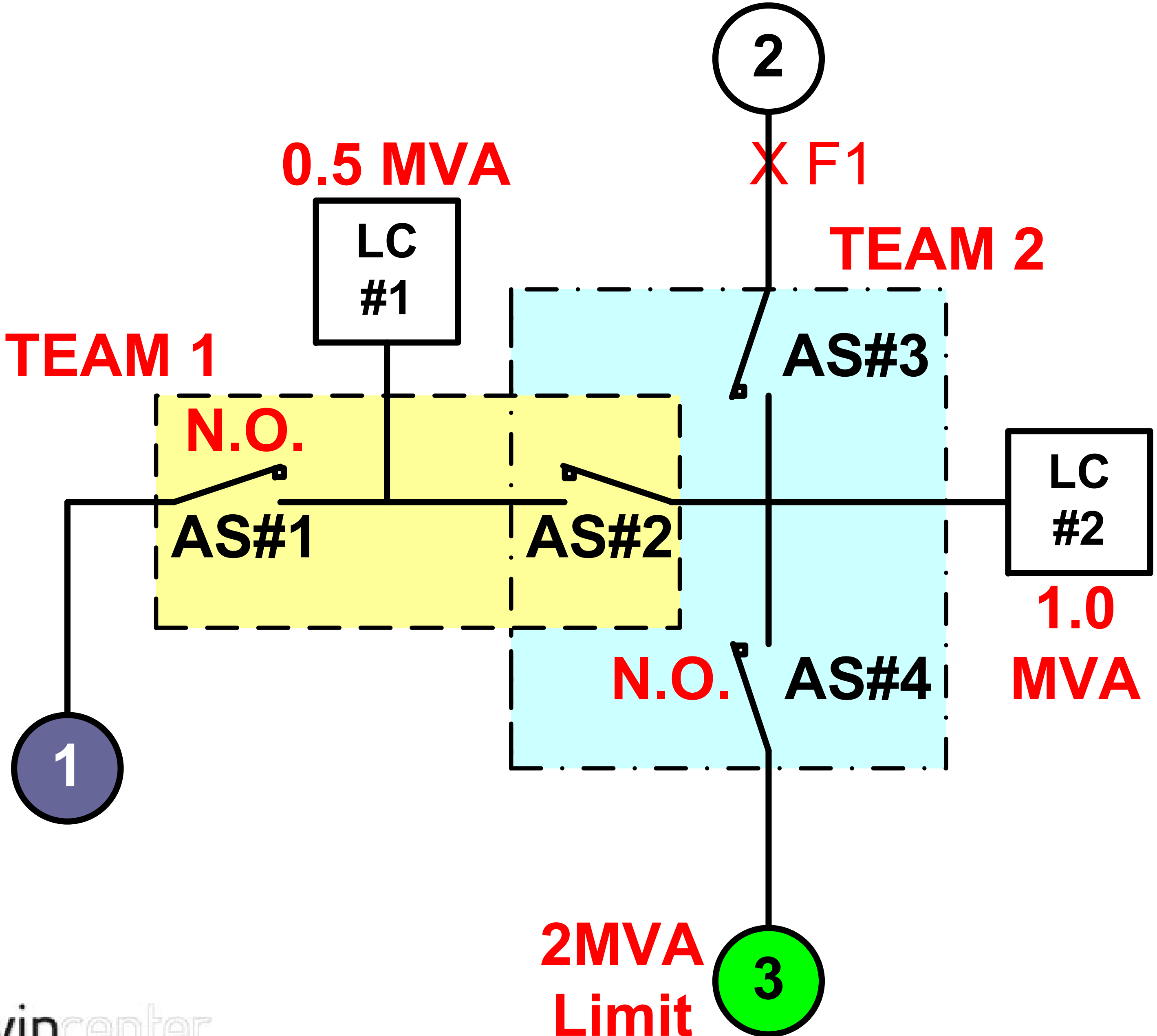
Energy Storage

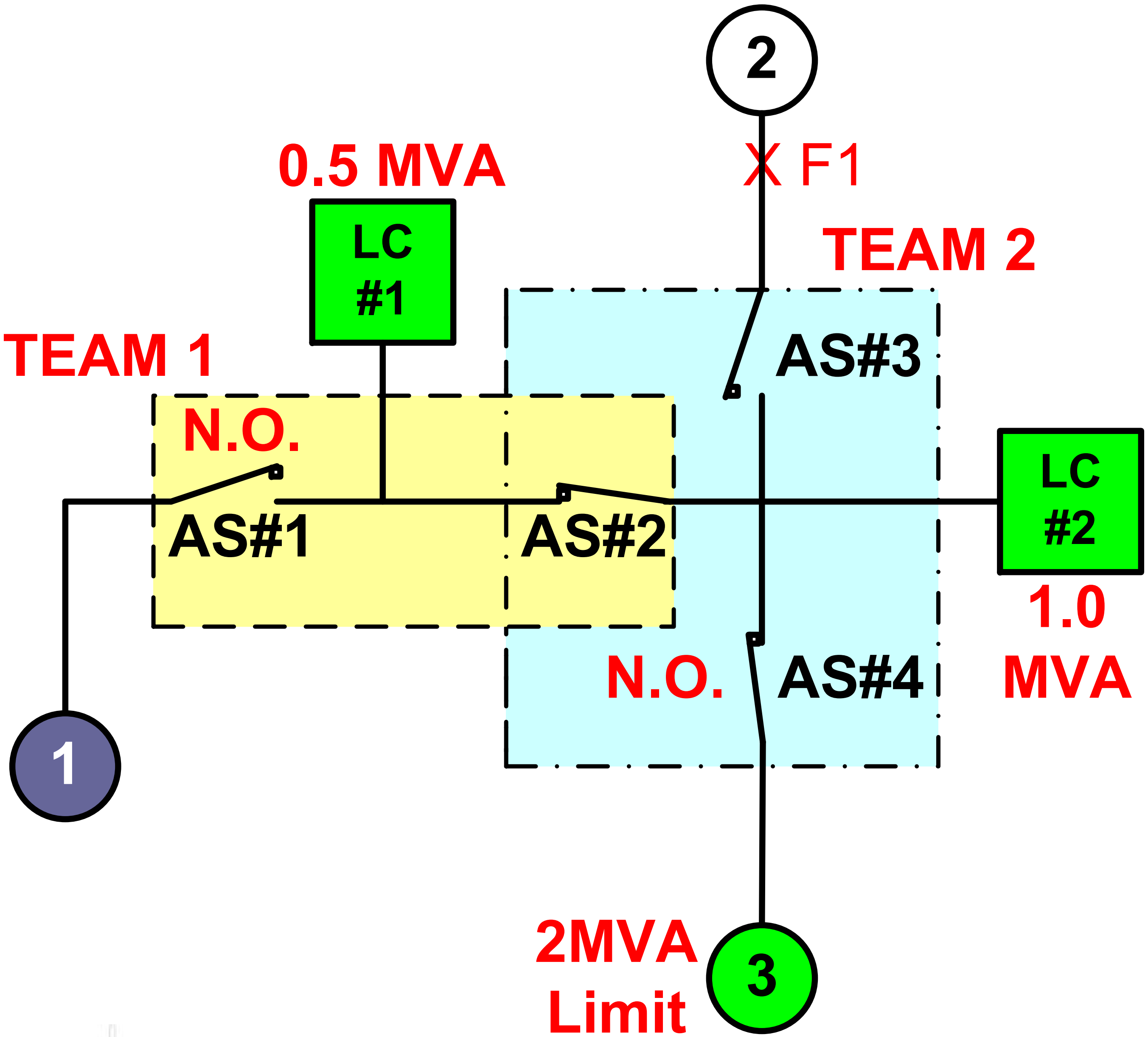
- Energy Storage Benefits
  - cost deferral of new substations
  - improved service reliability
  - less stress on aging infrastructur
  - integration of renewable energy
  - frequency regulation
  - peak shaving
  - dynamic islanding with distribution automation integration
  - facilitating more dispatchable wind generation

Dynamic Islanding from Storage and DA

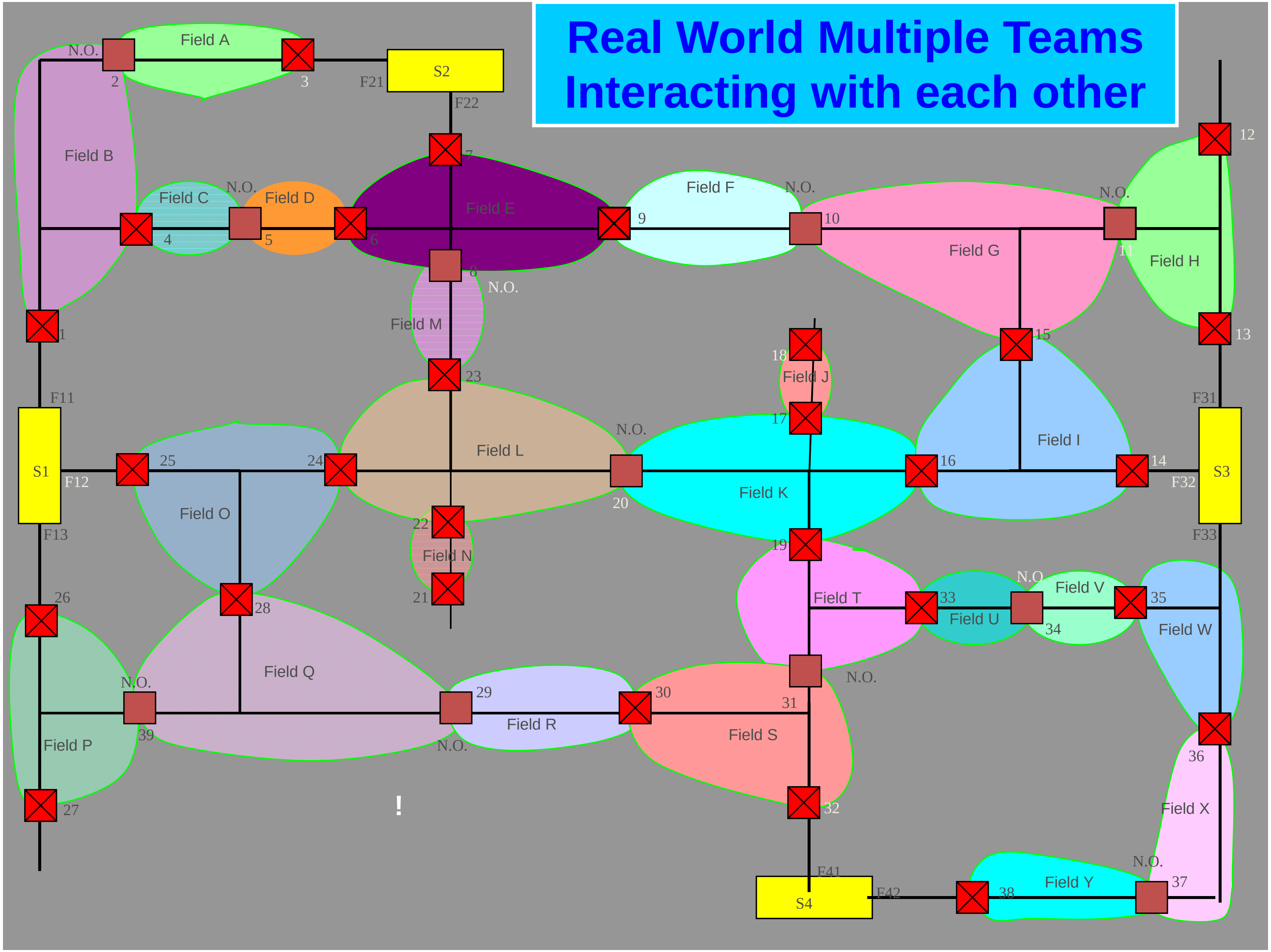
- Load information is captured by Intelligent devices
- Dynamic islanding activated upon loss of power
- The maximum number of customers are restored serviced by the battery based upon
  - last load information
  - energy in the battery
- The island can be minimized as the battery depletes
- Customer load served until battery is exhausted or power is restored


2
0.5 MVA
LC
#1
TEAM 2
TEAM 1
AS#3
N.O.
LC
#2
AS#1
AS#2
1.0
MVA
N.O.
AS#4
1
2MVA
Limit
3

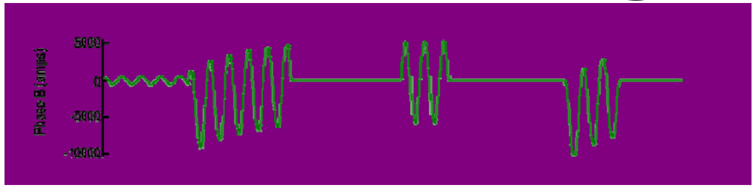

2
0.5 MVA
X F1
LC
#1
TEAM 2
TEAM 1
AS#3
N.O.
LC
#2
AS#1
AS#2
1.0
MVA
N.O.
AS#4
1
2MVA
Limit
3

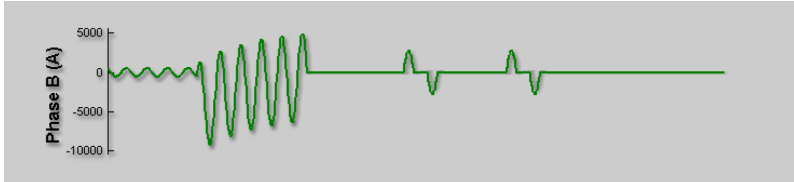

2
0.5 MVA
X F1
LC
#1
TEAM 2
TEAM 1
AS#3
N.O.
LC
#2
AS#1
AS#2
1.0
MVA
N.O.
AS#4
1
2MVA
Limit
3

Real World Multiple Teams Interacting with each other



Reclosing vs. PulseClosing





- Conventional Reclosing
  - Test by closing – causes another fault
  - Significant system stress
  - Through-fault on transformers
  - Voltage sags
  - Damages

- PulseClosing
  - Test by PulseClosing
  - <2% of let-through energy
  - No stress on system
  - No transformer through-fault
  - No voltage sags
  - Will not damage cable

galvincenter for electricity innovation at ILLINOIS INSTITUTE OF TECHNOLOGY

IEEE PES Power & Energy Society®

Impact for Utilities

- Think through the macro smart grid roadmap
- Work with others for technology assessments
- Gain experience with large-scale integrated deployments
- Validate business case assumptions

Conclusion

- Smart Grid is critical to maintaining reliability, especially in light of new challenges
- The industry is on the cusp of a wave of change presenting a growing opportunity for innovation, collaboration, and, ultimately, success
- Microgrids are part of the solution
  - Military
  - Industrial
  - Campus
  - Remote access locations
- Microgrid challenges
  - Similar to Smart Grid
  - Unique to Microgrids

Smart Grid-Microgrid Evolution