ARPA-E Workshop: Accelerating Grid Technology Introduction and Deployment

resilient, Cyber Secure Centralized Substation Protection (*rCSP*)

Georgia Institute of Technology – February 29, 2024

1858-2615

Industry Recognized Problems without Near Term Solutions

- Relay mis-operations (10%) is a global reality which causes major disturbances and blackouts.
- Inverter dominated power systems exhibit new characteristics leading to more relay mis-operations
- Inability to detect hidden failures in protection and control and self-heal the system.
- Vulnerabilities: Cyber-attacks on protection, control and operation (false data and malicious control).
- Inability to provide fast full state feedback for fast control practices

rCSP : resilient and secure Centralized Substation Protection (ARPA-e)

Eliminates Relay Unreliability (mis-operations) by: Estimation Based Protection: fast (sub msec), reliable, immune to inverters.

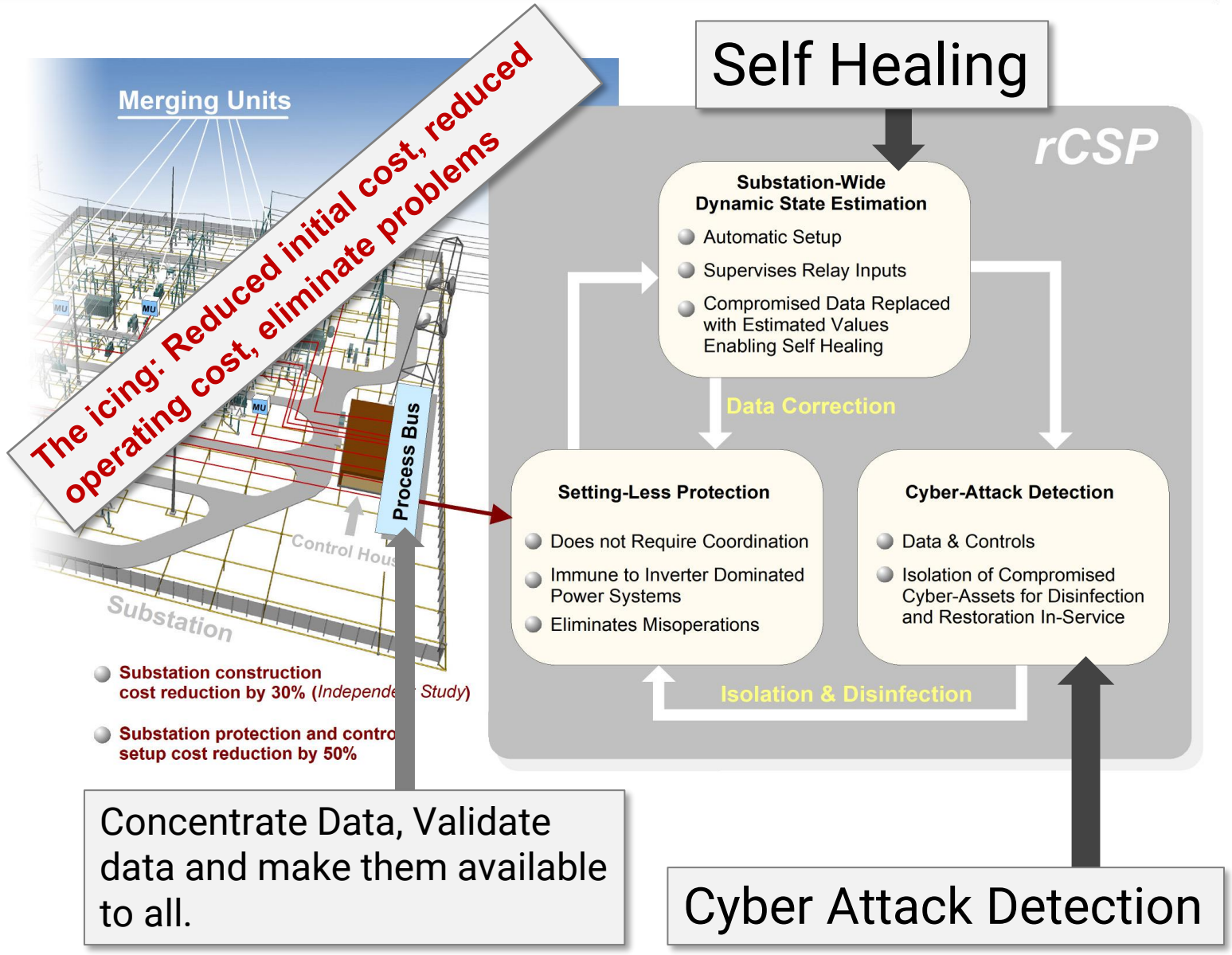
Real time monitoring of the health of the protection and control system by software approach.

(a) validates data,

(b) identifies anomalies including hidden failures, and

(c) self-heals system against anomalies.

Differentiates between system faults and cyber-attacks with almost zero false positives.



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Team

Core Members: A. P. Meliopoulos, George J. Cokkinides (Technology Experts, Integration)

We work with many graduate students who would like to join a startup if the conditions and compensation is attractive (Siyao Cai, Zhengrong Chen, Zan Yang, Kayla Thames, Adam King, Abdulaziz Qwbaiban, Fahad Alsaeed)

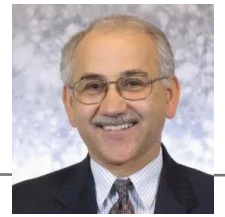
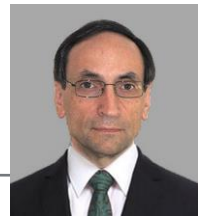
Industry members who would like to continue working with us:

- Paul Myrda, Evangelos Farantatos
- Ramadan Elmoudi, Bruce Fardanesh
- Clifton Black, Alec Kumpf

World Class Commercialization Team:

- David Zabetakis, Z.evolution, llc.
- Harshita Mira Vankatesh, Breakthrough Energy
- Sakis Meliopoulos, George Cokkinides (Georgia Tech)
- DeeAnne Abernathy, APC

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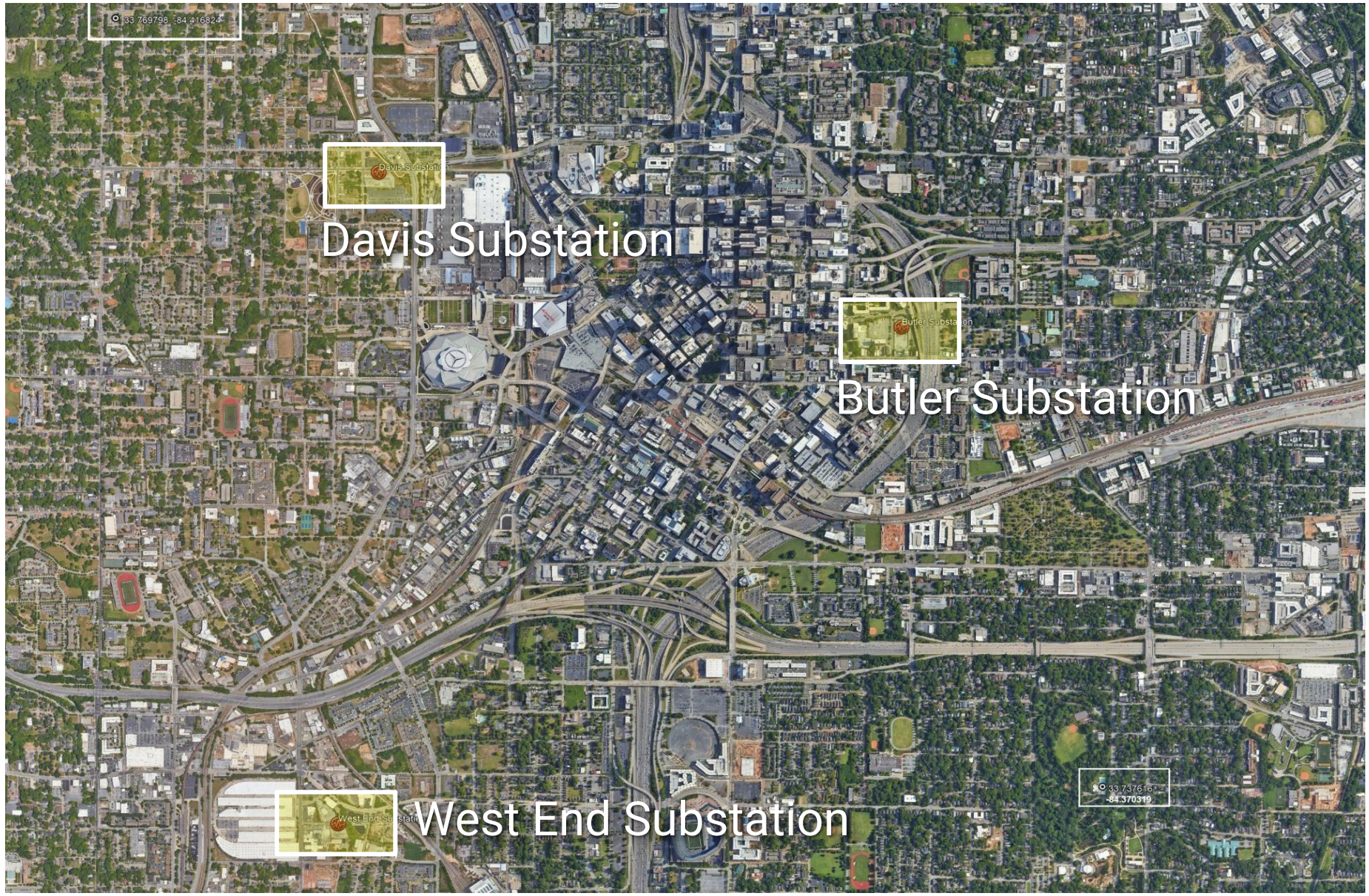
Pilot Programs: Field Verification and Validation

Pilot programs

Example of one utility in the Atlanta area



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Example Pilot Project

Each Installation Runs the Following Functions (Technology Summary)

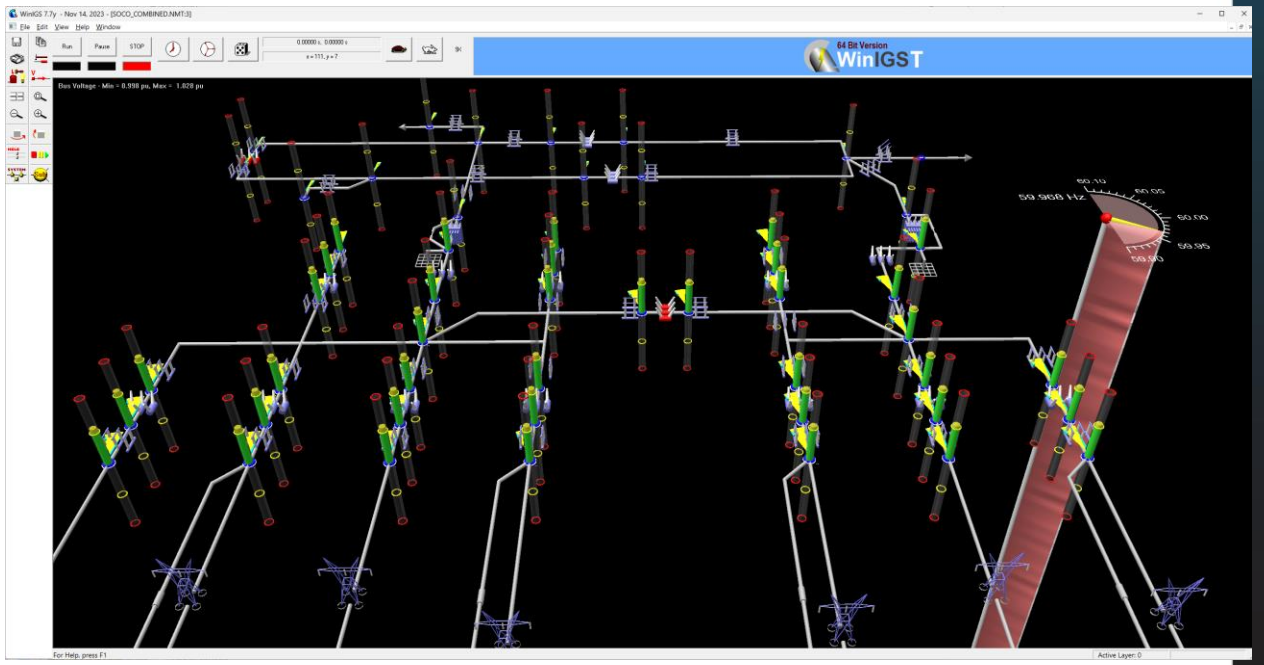
- Dynamic State Estimation Based protection.
- Substation centralized protection.
- Hidden failure detection and self-healing.
- False data and malicious control detection, isolation and disinfection - real time cyber security
- Full state feedback control (Closed Loop OPF)

Master

- System Wide Dynamic State Estimation

Front Panel View

Example Visualization
Substation Operating Conditions



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Market

- A 300 billion a year industry depends on protection and control (P&C) system reliability.
- rCSP is the basic enabling tool to **(a) provide operational security, (b) eliminate mis-operations of protection and control, and (c) operate the system securely under compromised conditions (cyber attacks).**
- Basic tool for the Digital Substation. Enables substantial savings - more than 30% in CAPEX and more than 50% in OPEX.
- Savings from drastic reduction of disturbances are potentially huge (2005 estimated cost of outages is 28 to 169 billion)
- In-field, real-time continuous assessment of the health of protection and control and self-healing in case of failures.

Development Plan

5 year plan to commercialize: demonstrations, more pilot projects, field assessments, documentation of technology merits.

Early Adopters

Southern Company

New York Power Authority

Rte Le réseau de transport d'électricité

(Two more in discussions)

Manufacturers interested in joining commercialization efforts

EATON Powering Business Worldwide

SIEMENS

Advisory team of industry experts for guidance.

We will work with utilities and other electric energy system stakeholders interested in being early adopters of this new technology.

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