Continuous Security Monitoring Protocols and Architectures for Energy Delivery Systems

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GOALS

Develop continuous monitoring techniques to improve EDS operators' awareness of their cyber infrastructure.

- Continually monitor and measure system vulnerabilities, configuration errors, malicious events, and compliance with security policies.
- Provide data analytics that aggregate and process a broad set of data sources to determine security concerns.
- Reduce the cost of performing security assessments.
- Thoroughly test and verify the proposed technologies within realistic testbeds and in real-world systems.

FUNDAMENTAL QUESTIONS/CHALLENGES

- Cybersecurity assessments are costly and time-consuming, preventing EDS operators from performing frequent security evaluations.
- Periodic assessments provide limited assurances of security. Industry reports suggest that an adversary might compromise a system in minutes[1], but the average time to detection is 205 days[2].
- NERC CIP standards have limited requirements for security assessments and monitoring of security data, including:
  - High-impact systems require active vulnerability assessments every 36 months.
  - High/medium-impact systems require paper assessments every 15 months.
  - Checks for new security patches or changes of baseline configurations should occur every 35 days.
  - Logs reviewed every 15 days.
- ***Question:*** Can the process of assessing security and verifying that systems meet required security policies be automated and performed on a regular basis?

[1] 2015 Verizon Data Breach Investigation Report. Verizon.

[2] M-Trends 2015: A View from the Front Lines. Mandiant.

RESEARCH PLAN

This project will explore techniques to help EDS operators continuously monitor the cybersecurity of their systems. This requires a number of key research tasks, including:

Identifying key security metrics

- Identify metrics to address the current security posture of the EDS:
  - Examples include patch levels, account logins, logs collected, configurations managed, and incidents detected.

Develop assessment techniques and protocols to collect security data

- Extend NIST's Security Content Automation Protocol (SCAP) to enable automated data collection.
- Explore methods to perform data collection on heterogeneous EDS systems (e.g., credentialed scans).

Explore assessment schedules to minimize the impact on the EDS

- Identify the impact of assessment techniques (e.g., scanning) on a variety of EDS devices.
- Optimize assessment strategies and schedules around inherent system redundancies.

Develop analytical techniques to validate the system's current security baseline

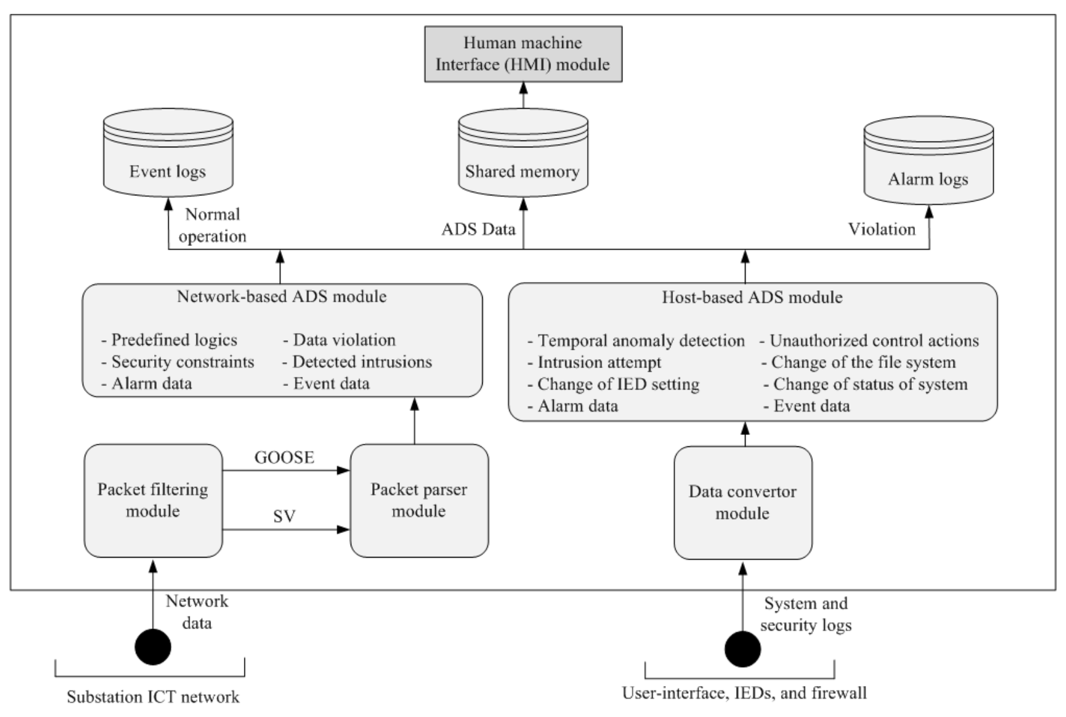
- Correlate data from a variety of sources, including assessment results, packet captures, netflows, IDS logs, and log files.
- Demonstrate the ability to validate compliance with security policies (e.g., NERC CIP) in real-time verification, rather than yearly basis.

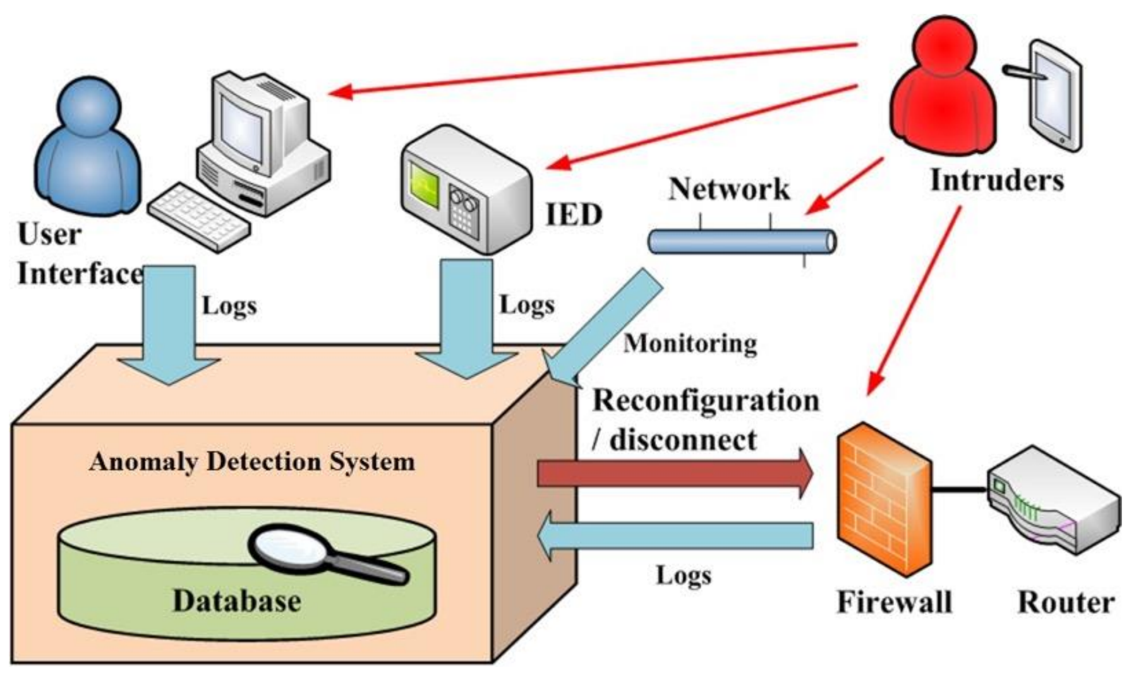
Test and validate the proposed techniques on various real-world devices

- Evaluate the proposed technique against real software platforms (e.g., EMS, DMS) and devices within the WSU Smart City Testbed and other CREDC testbeds.

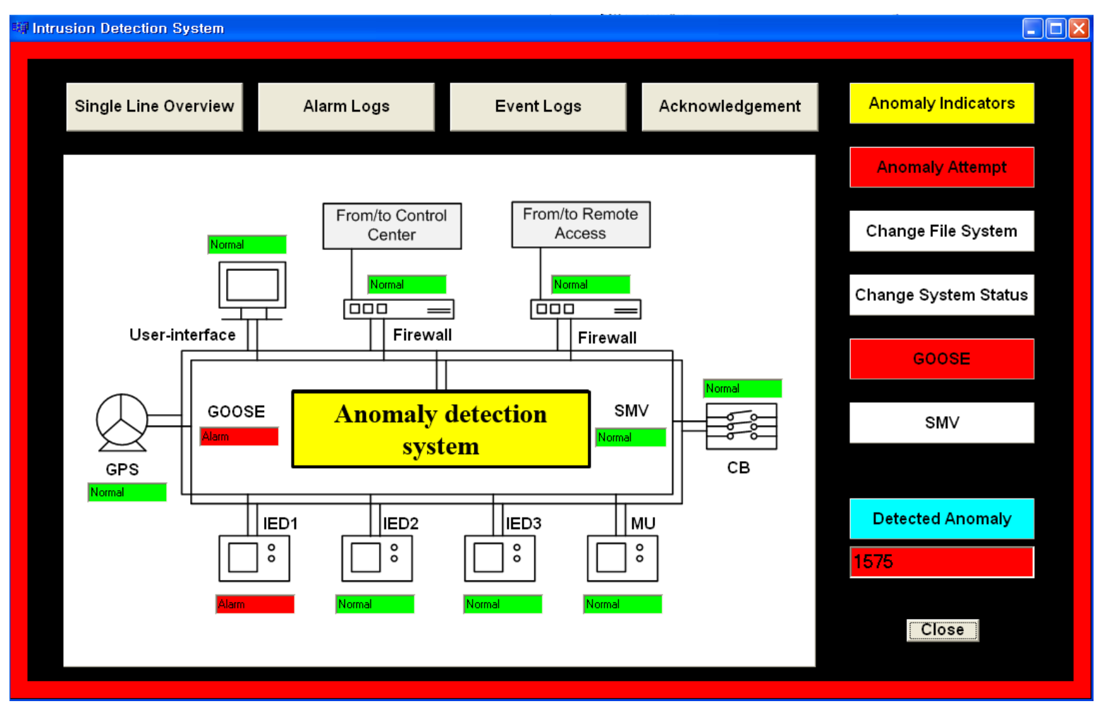
RESEARCH RESULTS

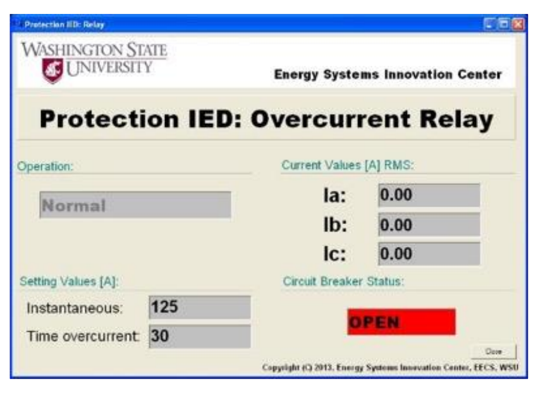
Host and network anomaly detection systems (ADS) for substation





Simulation and validation on WSU Smart City Testbed





Protection IED: Overcurrent Relay

Operation: Normal

Current Values [A] RMS:
Ia: 0.00
Ib: 0.00
Ic: 0.00

Setting Values [A]:
Instantaneous: 125
Time overcurrent: 30

Circuit Breaker Status: OPEN

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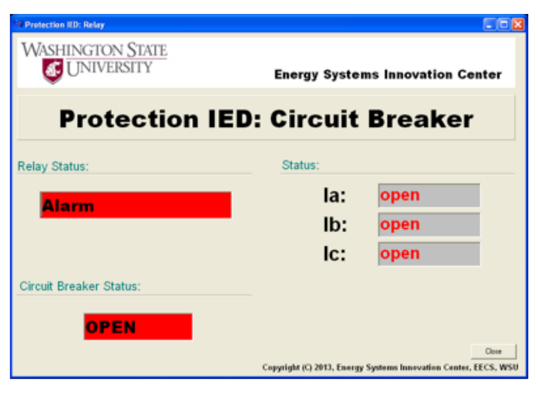

Protection IED: Circuit Breaker

Relay Status: Alarm

Status:
Ia: open
Ib: open
Ic: open

Circuit Breaker Status: OPEN

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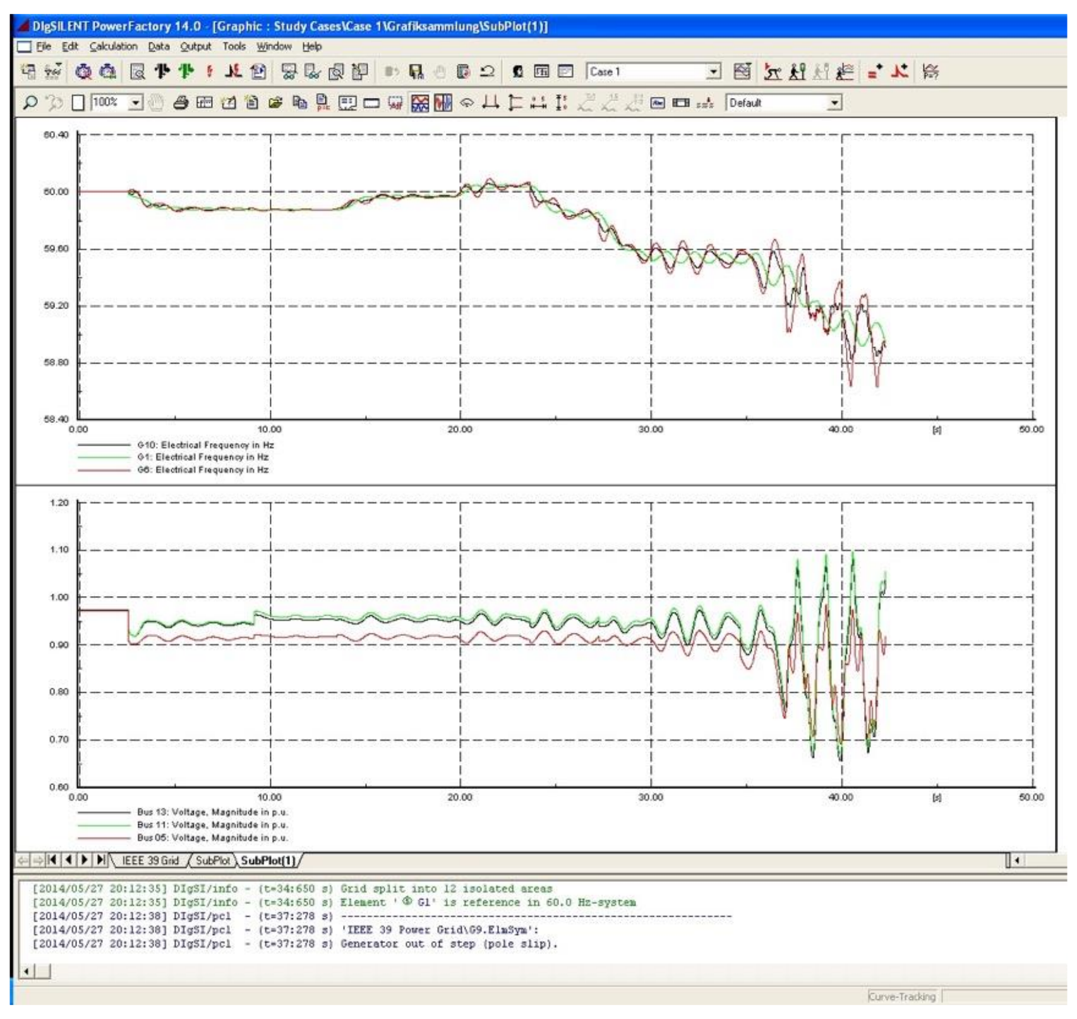
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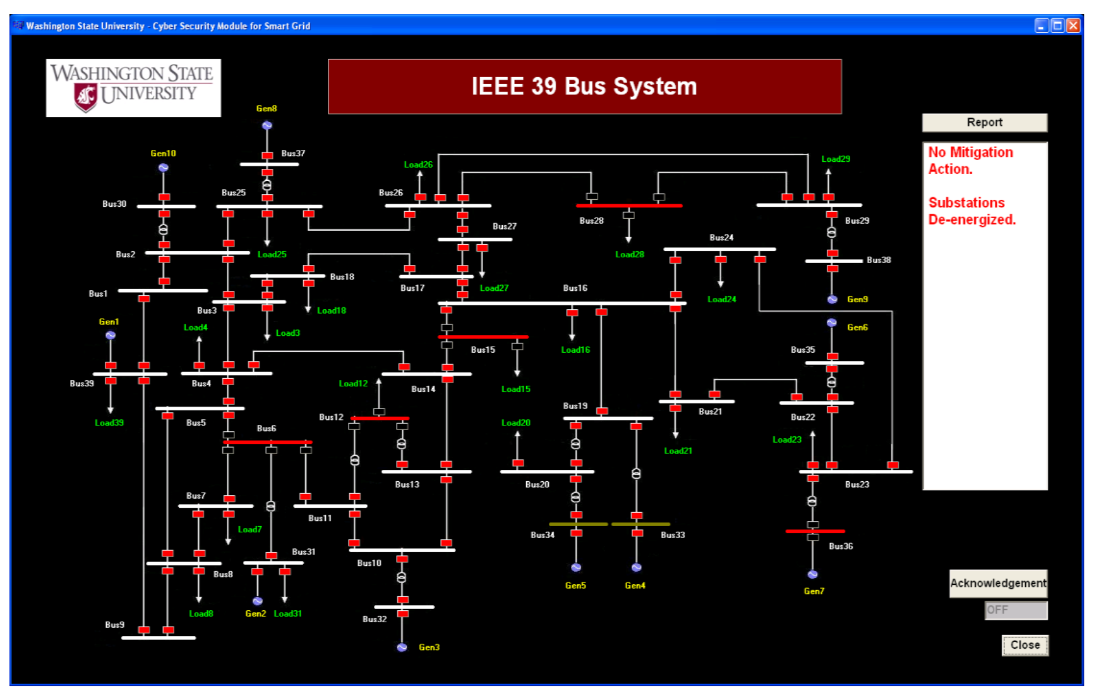
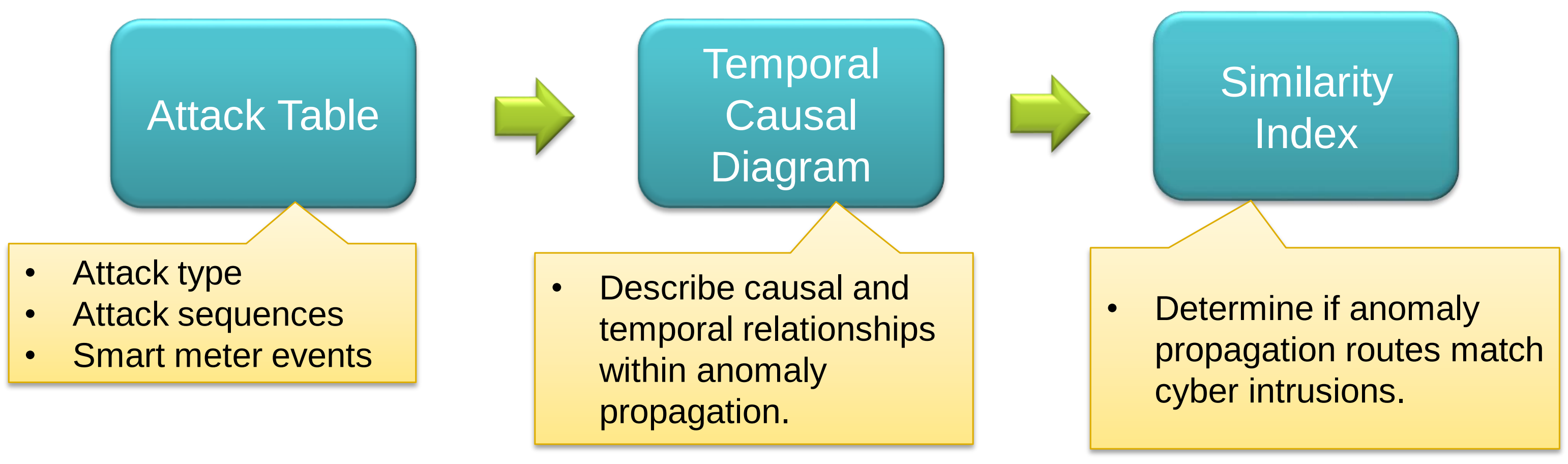


Cyber security of smart meters



Attack Table
- Attack type
- Attack sequences
- Smart meter events

Temporal Causal Diagram
- Describe causal and temporal relationships within anomaly propagation.

Similarity Index
- Determine if anomaly propagation routes match cyber intrusions.

BROADER IMPACT

- Provide utilities and other EDS operators with real-time awareness of their critical cyber assets, beyond traditional intrusion alerts.
- Decrease the window of time between when a security incident occurs and when EDS operators identify the incident.
- Reduce the cost and inconvenience of periodic vulnerability assessments.
- Inform EDS operators with consistent evidence of their compliance with organization or industry standard security policies (e.g., NERC CIP).

INTERACTION WITH OTHER PROJECTS

- The project will explore collaboration with other CREDC activities focusing on:
  - Detecting cyber attacks on systems and networks.
  - Performing big-data analytics of cybersecurity events.
  - Developing cyber-physical metrics for security.
- This research will also explore industry collaboration to obtain inputs from both vendors and EDS operators on the feasibility of the proposed techniques.

FUTURE EFFORTS

- Explore techniques to identify malicious activity on smart meters and other EDS systems, combining both network and host-based analysis.
- Begin exploring security assessment content that can be collected from EDS devices.
- Test current assessment activities (e.g., scanning, credentialed analysis) on real EDS devices.

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