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Dr. Amy Babay is an Assistant Professor in the University of Pittsburgh Department of Informatics and Networked Systems, with a joint appointment in the Department of Computer Science.

Her research focuses on distributed systems and computer networks, with an emphasis on enabling dependable critical infrastructure systems that are resilient to failures and cyberattacks, and on exploring next generation networked services.

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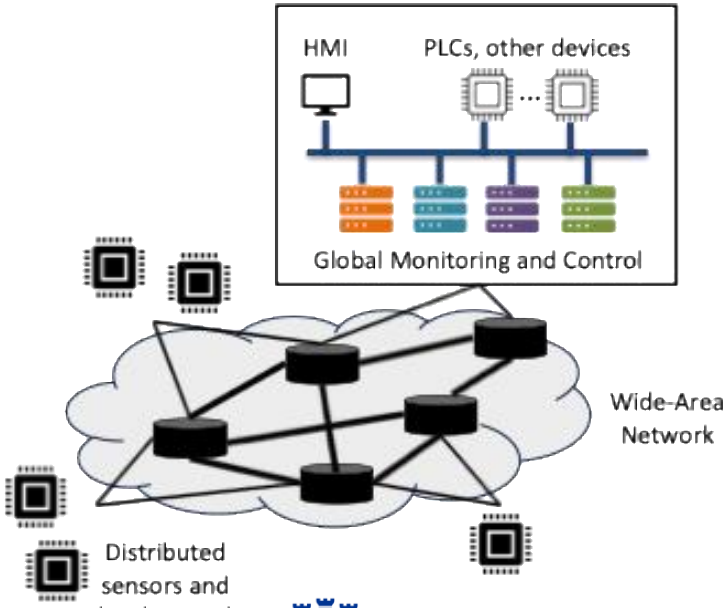
Resilient End-to-End Sensing and Control for Critical Infrastructure

Amy Babay

University of Pittsburgh



June 3, 2026

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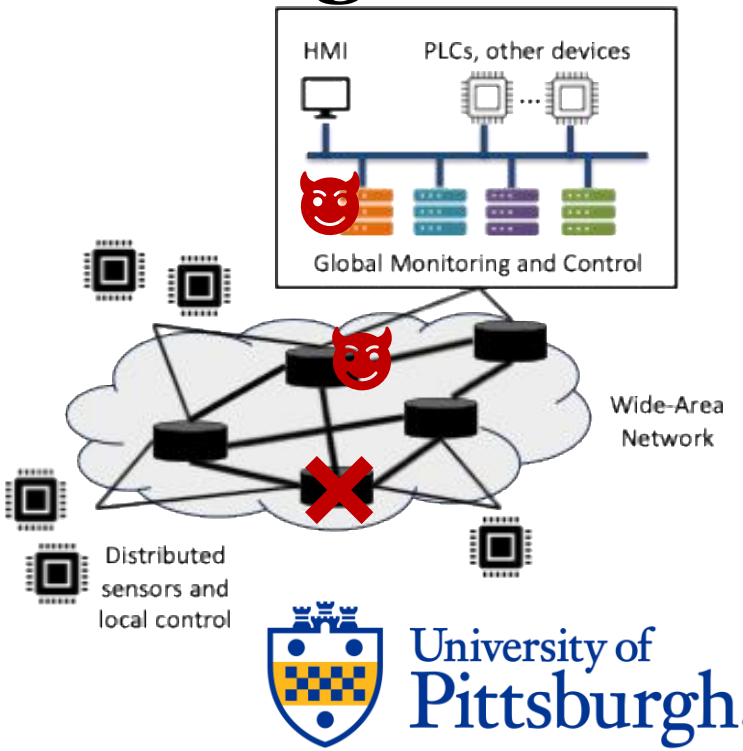
Resilient Infrastructure Sensing and Control: The Challenge

- How do we ensure that sensing data is **collected reliably**, and that the monitoring and control systems using it are **operating correctly**?
  - Even when components fail
  - Even when components are targeted by cyberattacks
  - Even when cyberattacks succeed (intrusions)



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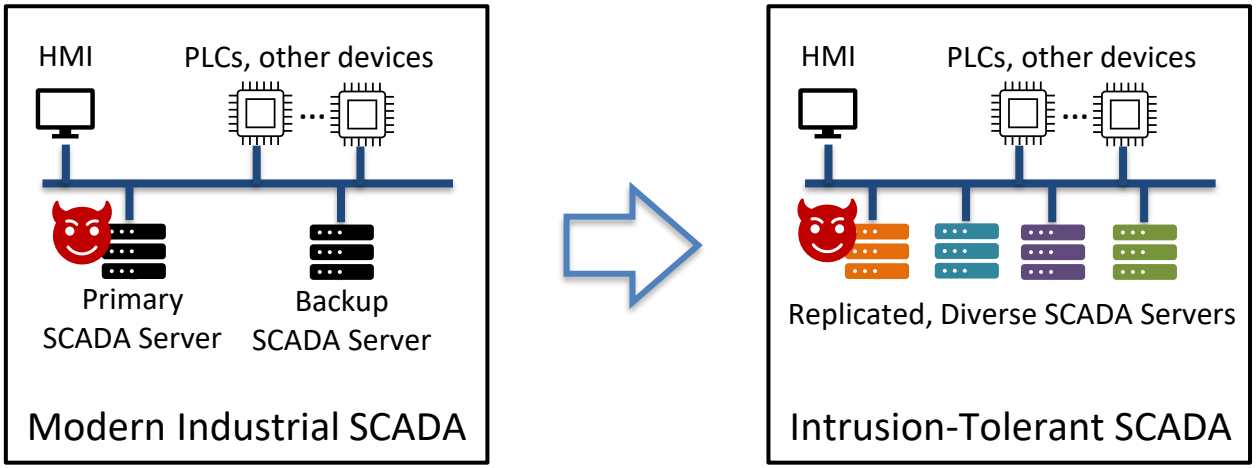
Intrusion-Tolerant Foundations: Replicated Control Systems



Spire Intrusion-Tolerant SCADA for the Power Grid: www.spire-sys.org
(v3.0 released May 2026)

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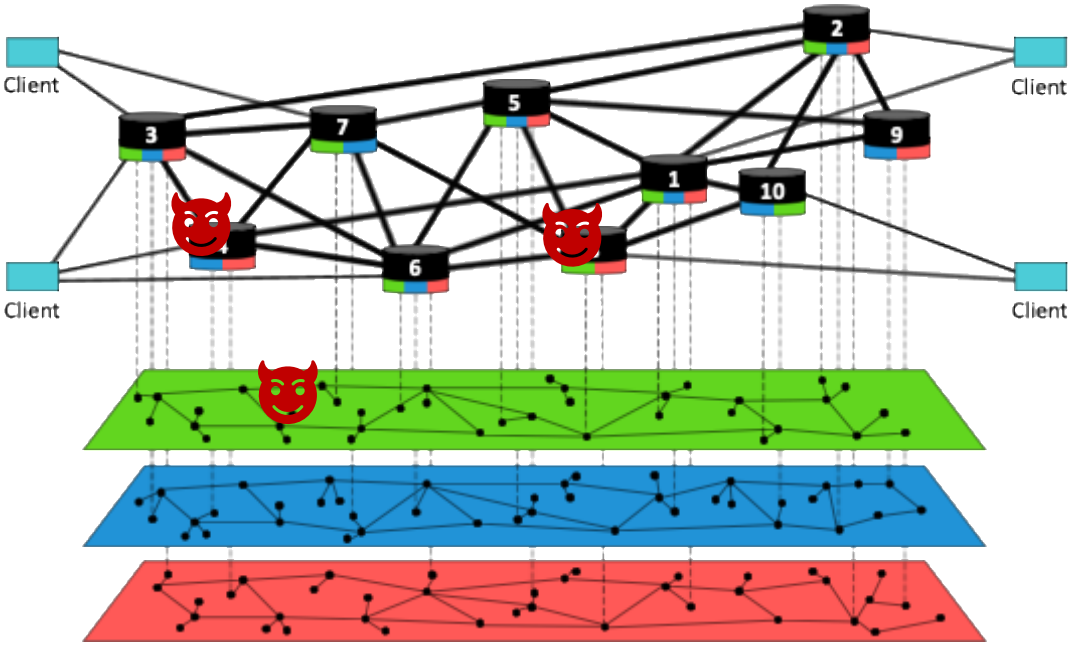
Intrusion-Tolerant Foundations: Overlay Networks



- Leverage multiple underlying networks (where available)
- Provide application-level multi-path routing control
- Tolerate intrusions in overlay *and* underlying network(s)

https://spines-org.github.io/

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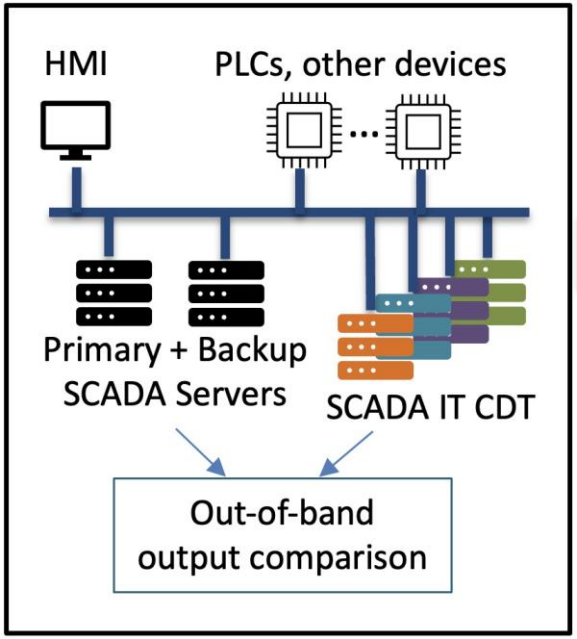
Intrusion-Tolerant Digital Twins

- Deploying intrusion-tolerant SCADA as a **digital twin** (rather than clean slate replacement) offers a **path to transition**
- Near term benefit: **intrusion detection** via **output comparison**



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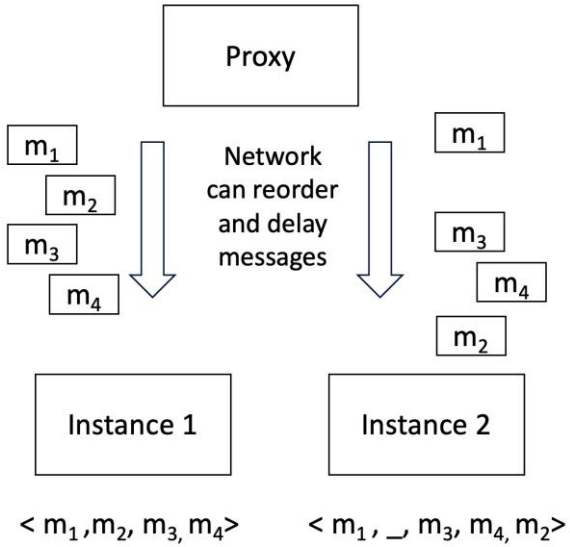
Monitoring the Monitors: Output Comparison

- Benign **network delay variation** can cause divergence between active and twin instances
- **How can we distinguish transient benign divergence from malicious activity?**
  - Application-specific invariant monitoring
  - Message history permutation checking
- Currently evaluating divergence and mitigation mechanisms using our digital twin prototype with commercial SCADA



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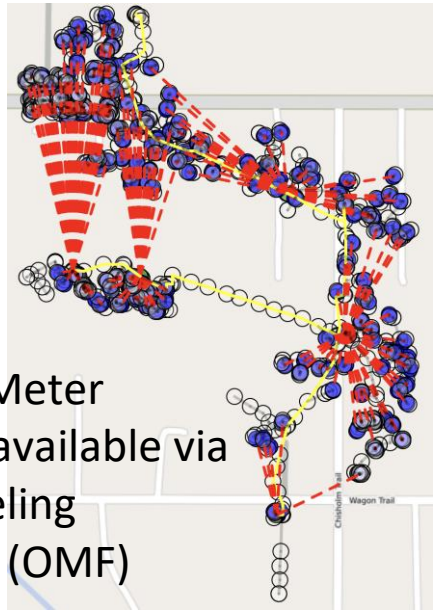
Resilient Sensing Networks

- How can we collect and integrate data from new sensing technologies in a resilient manner?
- Investigating how intrusion-tolerant **overlay topology construction** techniques and **communication protocols** originally designed for global Internet settings can be adapted to infrastructure sensing networks



e.g. Smart Meter topologies available via Open Modeling Framework (OMF)

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