

ENHANCING POWER SYSTEM RESILIENCE THROUGH DISTRIBUTED INTELLIGENCE AND ADAPTIVE INFRASTRUCTURE



PROJECT SUMMARY

The power grid systems in Singapore and around the world are undergoing fundamental changes:

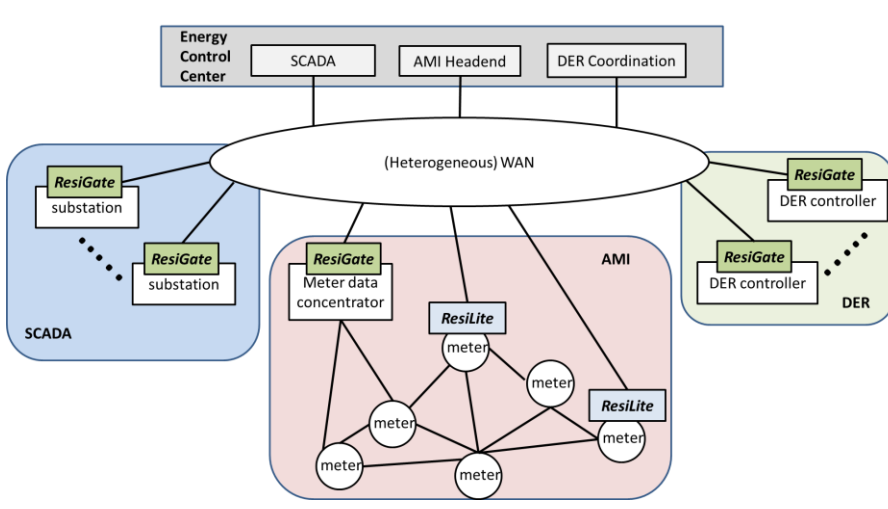
- Growing number of **connected intelligent devices**;
- Fast penetration of **distributed energy resources**;
- Rising of **cybersecurity risks**; and
- **Cross-dependences** among different power grid subsystems

Our project aims to address various resilience challenges at the edge of the grid, by developing a set of edge-based resilience-enhancing solutions (called **ResiGate** and its lightweight version called **ResiLite**) to achieve the following benefits:

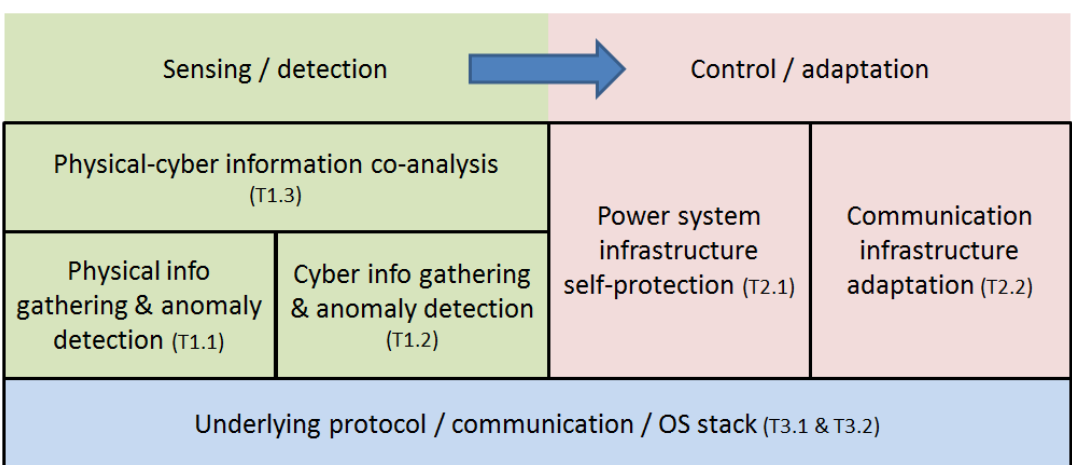
- Local disturbances can be detected earlier before they cascade into large-scale failures.
- Reduces operational risks of relying entirely on control center, which may be misconfigured, abused, or unavailable.
- Improved survivability by autonomously recovering from communication failures due to fault / attack.

We take a cyber-physical approach to address the resilience enhancement challenges at the edge of the grid:

- Our distributed intelligence technology make sense of locally available information based on cyber-physical co-analysis.
- Our adaptive infrastructure solution can autonomously determine self-protection & communication-adaptation strategy.



The deployment of ResiGate for enhancing power grid resilience at the edge, e.g., for the advanced metering infrastructure (AMI) and the distributed energy resources (DER)



An overview of our cyber-physical approach

PROJECT OUTCOMES



ResiLite: a lightweight, low-cost, resilience-enhancing communication solution for edge devices.

- Successfully deployed in multiple projects in Singapore (including PV monitoring, electric sub-metering systems, and water metering system).
- Provides the following key benefits:
 - Eliminates manual meter reading process, saving up to 45 man-hours per month for one of the projects.
 - Provides real time consumption data to users and supports easy maintenance and firmware update.
 - Supports heterogeneous wireless technologies, with embedded intelligence for network monitoring, analytics, and self adaptation for achieving network resilience under challenging environments (e.g., under wireless jamming and interference).

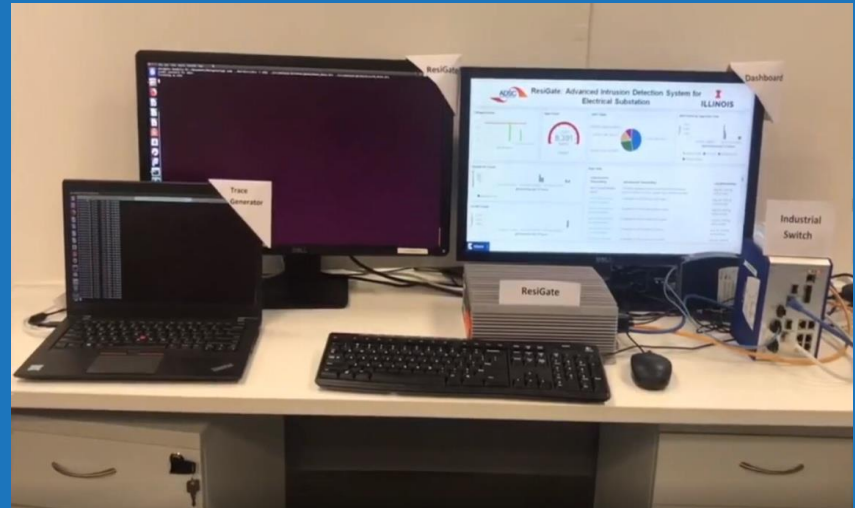
ResiGate: an advanced Intrusion Detection System for Industrial Control Systems (ICS).

- Tested under multiple deployment settings. The team has released a synthesized dataset for cybersecurity study of IEC 61850 based substations, and open source the toolchain for generating such testing dataset.
- Provides the following capabilities:
 - Developed a solution which combines physics-based and machine-learning-based analysis for accurate (i.e. zero false positive and false negative rate) and fast (i.e. less than 20ms) detection of stealthy attacks (including both false data and malicious command injection).
 - Automatic generation of detection rules based on Programmable Logic Controller (PLC) code.
 - Supports deep-packet-inspection of various ICS protocols, including IEC61850 standard.



Glimpse of Installation- RESILITE

ResiLite solution in a real-world deployment



A demonstration setup of ResiGate's intrusion detection capability

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