

GOALS

- Leveraging advanced simulation gear to train the next generation of power engineers on the emerging cyber and power relationships.
- Develop bus models that can be released publicly to facilitate hands-on training scenarios and exploration of impact.
- Engage undergraduates in developing and releasing prototypes of varying scenarios while training them on the systems.
 - Prosper Panumpabi (lead researcher)
 - Yu Cui: Protection Synchro-Check Relay
 - David Lee: Protection Generator Relay
 - Zeya Cai: Protection Directional Impedance Relay
 - Andrzej Borzecki: Protection Differential Relay
 - Iu Lunjie: Protection Directional Overcurrent Relay

FUNDAMENTAL QUESTIONS/CHALLENGES

- Protection relays are used to detect the occurrence of short circuits or any other abnormalities that might damage the power system or adversely affect its operation—whether through cascading failures, blackouts, loss of quality, reverse power, or loss of synchronization—and to prompt isolation of the affected areas of the power grid. Protection relays are used to mitigate the impact of faults, reduce the downtime, and prevent shock, arc-flash, explosion, or fire. Protection relays should be reliable, dependable, selective, secure, sensitive, speedy, and **trustworthy** devices.
- Because protection relays are becoming more and more computerized and network-accessible, they are subject to **attack**.
- RTDS (Real-Time Digital Simulator) offers an advanced, real-time means for studying, modeling, testing, and validating protection relays. The closed-loop capabilities make it possible to study protection schemes for the power grid before, during, and after a fault.



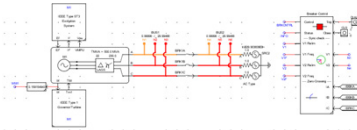
RESEARCH PLAN

1. Yu Cui: Protection Synchro-Check Relay

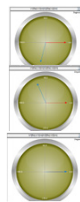
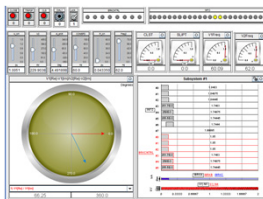
SEL Synchro-Check SEL-700G



Case Modeling



Run Mode



2. David Lee: Protection Generator Relay

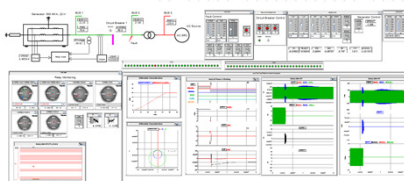
SEL-300G Generator Relay



Case Modeling



Run Mode

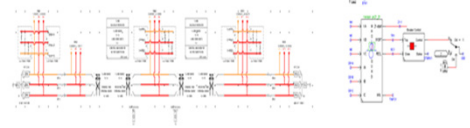


3. Zeya Cai: Protection Directional Impedance Relay

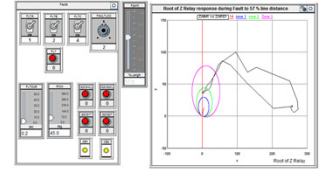
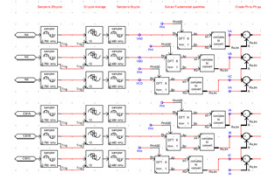
SEL-421 Directional Impedance Relay



Case Modeling



Run Mode

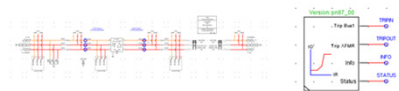


4. Andrzej Borzecki: Protection Differential Relay

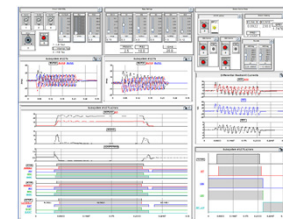
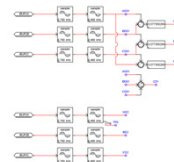
SEL-501 Differential Relay



Case Modeling



Run Mode

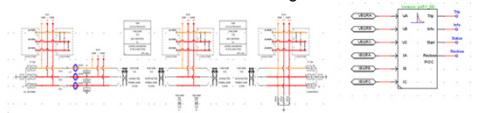


5. Iu Lunjie: Protection Directional Overcurrent Relay

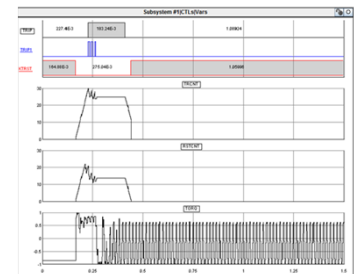
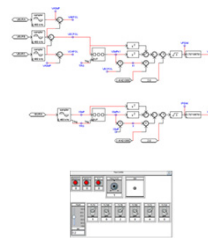
SEL-501 Directional Overcurrent Relay



Case Modeling



Run Mode



BROADER IMPACT

- Producing five scenarios for cyber research in protection systems.
- Releasing these models to the world while developing training around these concepts.

FUTURE EFFORTS

- The undergraduate students will refine their models and prototype the systems for hands-on use using a development platform.
- The designed prototype relay will be tested and validated using the Real-Time Digital Simulator.