High-Fidelity High-Resolution and Secure Monitoring and Control of Future Grids: a synergy of AI, data science, and hardware security

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Project vision

- Harness advances of data revolution, AI, and security research in unlocking the full potential of PMU and advanced sensing technology
- Address vulnerabilities of substations to cyber attacks and develop provably secure computing architecture that enables critical sensing and control actions in events of attack.

Major technical challenges

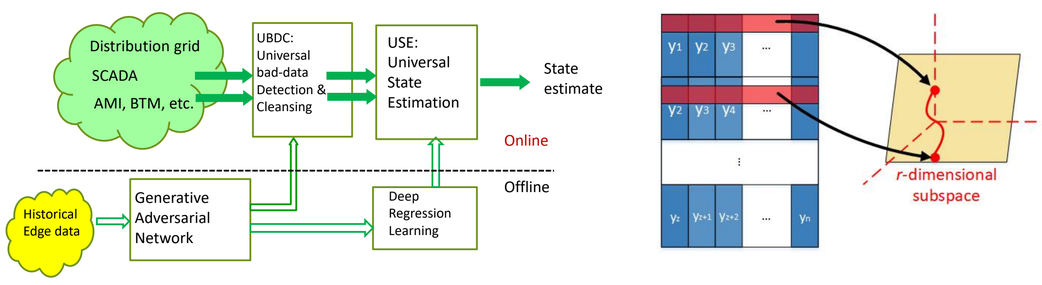
- Modern power systems are large cyber physical systems whose dynamic behavior are beyond precise mathematical characterization.
- There is lack high resolution, high fidelity, and secure data for real-time monitoring and control of large power grid
- There is a need for a computing architecture that is resilient to cyber physical attacks for substations and control center operations.

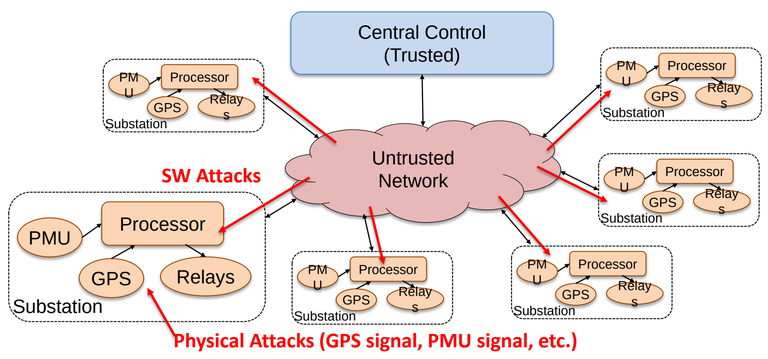
CPS research focus and scientific impact

- Develop ML and AI approaches to secure monitoring and control of highly dynamic engineering systems
- Science of CPS security: Develop secure and resilient computing architecture for digital substations and remote terminal units.
- Potential impacts on other CPS fields
- Secure autonomous CPS systems
- Multi-modal sensing and data fusion
- Human in the loop decisions

Technical approach and innovations

- Learning the unobservable: a deep learning approach to state estimation and anomaly detection.
- Structural data analytics: exploiting low-dimensional structure in high-dimensional data for real-time situational awareness
- Trusted execution environment (TEE): hardware-sensing algorithm co-design of computing architecture against real-time cyber-attack.





Broader impact on society

- System operators with concerns of energy infrastructure-security issues.
- Equipment vendors (PMU, digital substations, IoT), software developers, and industry/government standard organizations.
- Industry with AI and ML needs.

Broader impact on education and outreach

- Smart grid summer camp: week-long program for high-school students.
- Design your future day: one-day program for 11th grade high school girls
- Curie academy: rising junior students in math, science and computing.

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