Project Title: CU-ShEEP
Clemson **U**niversity's **S**ync**h**rophasor **E**ngineering **E**ducation **P**rogram

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A. PROJECT DESCRIPTION

The objective of this project is to establish collaboration with a local utility – Duke Energy, in establishing a Situational Intelligence (SI) Laboratory that will be driven from a Real-Time Grid Simulation Laboratory (Fig. 1) and introduce new content in the power system engineering research and education at Clemson, especially in the area of synchrophasor technology and its application in a smart grid environment.

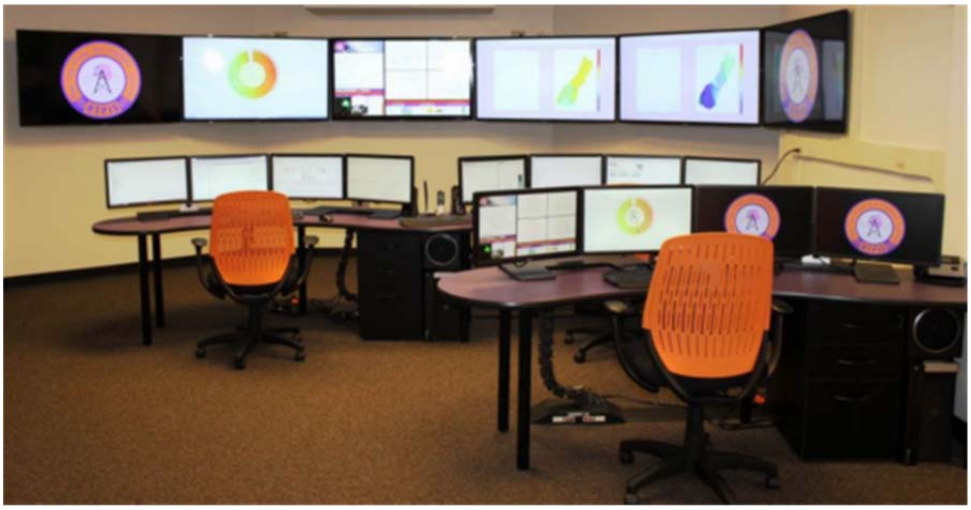

Fig. 1: Clemson University's Situational Intelligence Laboratory

The SI lab is a unique research and rapid prototyping/customizing laboratory for new real-time situational intelligence (SI) and intelligent control technologies for electric power control center deployment. Algorithms and methods for real-time situational awareness (SA) and intelligence, and visualizations for control centers are developed using in-house and third party software. The laboratory is focused on applications for generation, transmission, and distribution systems and microgrid control center operations. The SI Lab has system operator workstations besides the large control room displays. Many of the applications are parallelized for implementation on Clemson Palmetto cluster. Data is transmitted using a dedicated (~10-mile) high-speed fiber optic connection between the SI Lab and the Clemson data center.

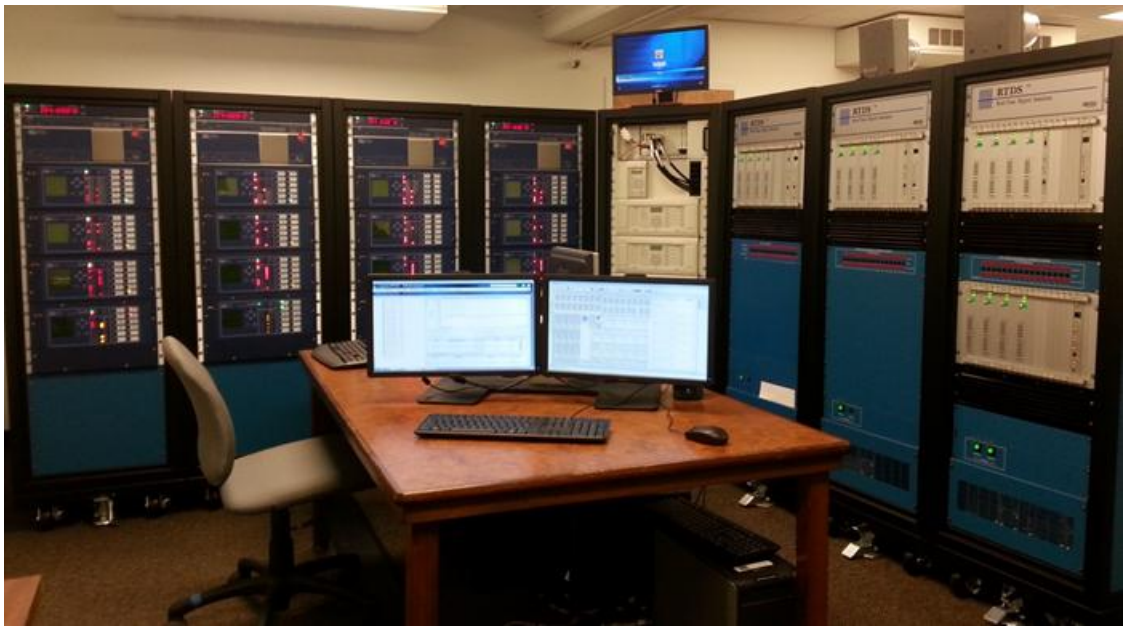

Fig. 2: Clemson University's Real-Time Grid Simulation Laboratory

Students involved with CU-ShEEP are expected to have experiential training opportunities at utilities and vendors. Short courses in synchrophasors and their applications in the control centers for non-power system, utility and industrial engineers are under developed.

B. EXPECTED RESEARCH OUTCOMES

- Researchers and students gaining hands-on experience on real-time grid simulation, control center operations and synchrophasor measurements.
- Development of distributed computing algorithms for analyzing and predicting smart grid data [1, 2].
- Applications of synchrophasor phasor data for real-time power system operations such online generator coherency analysis [3]; online oscillation of synchronous generators [4] and as tie-line bias control of a power system with high penetration of variable generation [5].
- Security evaluation of synchrophasor network for power system operations [6, 7].
- Development of situational awareness and situational intelligence algorithms and visualization tools for enhanced control center operations.

C. EXPECTED EDUCATION OUTCOMES

- Students educated and knowledgeable on synchrophasor technology as part of undergraduate and graduate curricula.
- Development of new contents on synchrophasors and its applications in over ten courses offered at the undergraduate/graduate levels.

- Clemson's synchrophasor engineering education with local utility's participation.
- Three short courses in synchrophasor and related technologies. These short courses are intended for utility and industrial professionals.
- Development of future workforce of electrical engineers, computer scientists and non-power system engineers who are knowledgeable about and experienced in synchrophasor analysis.

D. AREAS FOR POSSIBLE COLLABORATION

The project innovations/findings will be shared with other academic institutions and synchrophasor communities through workshops, panels at conferences and NAPSI meetings, and publications.

Possible areas of collaboration:

- Applications of situational awareness and situational intelligence algorithms and visualization tools to other utilities' synchrophasor/micro-synchrophasor data from transmission/distribution system, respectively.
- Custom distributed algorithms for other utility networks.

E. REFERENCES

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[7]. Beasley C, Brooks R, Venayagamoorthy GK, "A Survey of Electric Power Synchrophasor Network Cyber Security", *IEEE Power and Energy Society General Meeting (PES GM 2014)*, Washington DC, USA, July 27-31, 2014.