INDUSTRIAL SOLUTIONS LABORATORY

Company Information

Company Name	*Schweitzer Engineering Laboratories Inc.*	**Date Submitted**	*05/19/2022*
Project Title	*Comparative Evaluation of Centralized Protection & Control (CPC) Systems for a Distribution Substation at Duke Energy* **(SEL_CPC)**	**Planned Starting Semester**	*Fall 2022*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	Number	Discipline	Number
Mechanical		Electrical	2
Computer	2	Systems	

Company and Project Overview:

SEL invents, designs, and builds digital products and systems that protect power grids around the world. This technology prevents blackouts and enables customers to improve power system reliability and safety at a reduced cost. A 100 percent employee-owned company headquartered in Pullman, Washington, SEL has manufactured products in the United States since 1984 and now serves customers worldwide. Our mission is simple: to make electric power safer, more reliable, and more economical.

Project Requirements:

In a typical distribution substation, multiple intelligent electronic devices (IEDs) are used for protection, control, monitoring, and metering. Feeder IEDs are used for protecting distribution feeders and transformer IEDs protect substation transformers. Hence, the number of IEDs in a small distribution substation can be as high as 10. A centralized protection & control (CPC) system consists of a powerful hardware platform capable of providing protection, control, monitoring, and other critical functions for an entire substation. One CPC can replace tens of IEDs and still provide all necessary functionalities. There are clear financial and technical benefits of replacing multiple IEDs in a distribution substation with one or two CPC systems.

A CPC system can be designed to acquire current and voltage signals from conventional instrument transformers. For a modern substation, a CPC system will acquire signals from the merging units (MU). MUs can be connected to a CPC system via an ethernet network (using IEC 61850-9-2 Sampled Values protocol) or via point-to-point fiber connection. This project will explore three types of CPC systems.

1. CPC system using conventional hardwiring
2. CPC system using ethernet-based network connections (IEC 61850-9-2 Sampled Values)
3. CPC system using point-to-point connections

The objective of this project is to carry out comparative evaluation of three CPC systems for a distribution substation at Duke Energy. Duke Energy will provide engineering drawings of one of their distribution substations. The project team shall study the engineering drawings and redesign the substation protection and control (P&C) system using three CPC systems described above. The project team shall investigate various aspects like safety, financial benefits, technical benefits and challenges, and operational complexity of each CPC system. The team shall use some form of standard metrics when comparing these solutions. Finally, a recommendation to replace a traditional P&C system with a specific CPC system shall be provided.

Expected Deliverables/Results:

- Acquire a complete set of engineering drawings for an existing distribution substation at Duke Energy. Tabulate the number of IEDs used and total length of copper cables used for secondary systems.
- Document the working principle of three available CPC systems. Identify the strength and challenges of each solution.
- Design distribution substation P&C system using three CPC systems. Tabulate the number of devices and total length of fibers used. Calculate the total cost of each CPC system.
- Evaluate the reliability of each CPC system for loss of one or multiple equipment using fault tree analysis. Evaluate the operation speed of three systems by applying faults. Compare three CPC solutions using safety, reliability, operational speed, and cost as metrics.
- Final Report.

Disposition of Deliverables at the End of the Project:

Students are graded based on their display and presentation of their team's work product. It is mandatory that they exhibit at the Expo, so if the work product was tested at the supporter's location, it must be returned to campus for the Expo. After the expo, the team and supporter should arrange the handover of the work product to the industry supporter. This handover must be concluded within 7 days of the Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If

none please state none):

- Interest in Energy Conversion