INDUSTRIAL SOLUTIONS LABORATORY

Company Information

Company Name	*EPRI*	**Date Submitted**	*3/30/2023*
Project Title	*Research and Test Verification of Various Low Power Wireless Sensor Alternatives* ***(EPRI_WIRELESS)***	**Planned Starting Semester**	*Fall 2023*

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	3
Computer		Systems	1

Company and Project Overview:

EPRI is an independent non-profit energy research, development, and deployment organization, with three specialized labs. EPRI collaborates with scientists, engineers, government, and experts from academia and industry to shape and drive technology advancement by pushing the frontier of innovation from concept, pilot, operation to end-of-life.

The institute's work is funded by hundreds of organizations around the world, including the energy sector, academia, and government. Organizations who engage in EPRI research, development, and demonstration programs have unique opportunities to:

- Identify and solve critical and emerging industry issues.
- Stay at the forefront of technology innovation.
- Gain access to a comprehensive, timely RD&D portfolio.

- Collaborate and network with industry peers through advisory councils and committees.
- Implement technology through the support of our researchers and technical advisors.
- Reduce future investment risks.
- Inform policies with objective, science-based findings, and facts.

EPRI members help inform the development of EPRI's annual research portfolio, identify critical and emerging electricity industry issues, and support the application and technology transfer of EPRI's research and development.

Power generation plants have thousands of small individual equipment, ancillary systems, and components throughout the facilities that are not monitored and infrequently observed during operator rounds due in part to the high cost to perform such periodic monitoring. Some assessment of these systems, components and equipment may be made through operator rounds but the frequency and consistently in assessing equipment condition is highly variable. For example, the improper position and failed functionality of an air damper went unnoticed for an extended period leading to diminished plant performance. There are many other examples where diminished performance resulted from malfunctioning equipment and components in non-critical service.

Many utilities are increasing a plant's monitoring and diagnostic capability to improve the operations and maintenance functions. To increase the number of equipment and components being monitored, improve the frequency of measurement data collection, and reduce the need for manual data collection, deployment of industrially robust wireless sensors is being considered. Wireless sensors can offer increased flexibility for installation as they do not require the supporting infrastructure that is required for wired sensor installation. Examples of the infrastructure that is avoided or significantly reduced by using wireless technology include such things as cable and conduit installation that connect to each new wired sensor. The labor cost to install wired sensors can also be expensive and, in many cases, cost prohibitive. However, wireless technologies also require supporting infrastructure and assets such as wireless access points and their communication cables. Concerns for implementing wireless sensors include:

- Cost, security, and maintenance of a wireless communication infrastructure to support these sensors,
- Cost of replacing batteries, battery life and frequency to replace batteries,
- Ease of installation and maintenance/replacement of the sensor,
- Data quality for a given measurement, Latency and
- Cost to deploy several sensors so that the value of the investment is justified.
- Electromagnetic Compatibility

Based on this background and the above concerns, the primary research question for this project centers around the wireless sensor battery life versus the sampling frequency, payload and number of transmission in either direction (transmitter to receiver, and receiver to transmitter) for various commercial wireless sensor technologies and supporting platforms. In the context of

this research question, the term battery life is defined as the total number transmissions (including failed transmissions) that can be completed before the battery energy reaches a level that no longer supports reliable sensor operation. The research will summarize various sampling rate conditions and requirements along with the expected wireless sensor number of communication cycles before the battery needs replacement. The research will also explore ways in which the battery life is impacted by communication frequency (defined here as the number of communication cycles in each length of time), ambient conditions and wireless protocol, as well as explore ways in which maintenance, rechargeability or alternate energy sources could be utilized to maintain or replenish battery charge. Wireless sensor manufactures typically provide this type of information. However, this research will present and review what type and range of capabilities in battery life are generally available, provide a summary of that information in an easily reviewable and comparable format, and demonstrate and verify the published specifications for various environmental conditions.

Project Requirements:

The project team will, under the mentorship of an experienced EPRI research engineer, review past research and perform a review of commercial wireless sensor literature. This review will provide the team with practical engineering experience in the criteria used for wireless sensor and technology selection. Additionally, the project team will learn how to compare different wireless sensor capabilities and limitations (Reference EPRI report 3002011818, Wireless Sensor Survey), battery life vs. sampling frequency (how often data is recorded by the sensor) and considerations regarding environmental conditions. The team could learn about unique or innovatively useful characteristics of the sensors. An example of a useful characteristic would be if the sensor only transmits when the measured value changes from the last measured value to minimize battery drain. The team can learn about the pros and cons of different types of technologies. These types of considerations are what engineers must consider when performing design engineering work. The lessons learned in this first phase of the project will need to be summarized in the final report.

Based on the preceding research and documentation review, the project team will develop a plan to specify and then procure wireless instrumentation package(s), in accordance with budgetary limitations. Sensor(s) may also be obtained from EPRI. The project team will have an opportunity to gain practical experience with the sensor(s) by developing a plan for, and then demonstrating to the extent practical the functionality of the sensor(s) and battery life testing. The EPRI research engineer will provide guidance on best practices for developing this plan. Following the testing, the results will be described in a final report.

Expected Deliverables/Results:

- The expected deliverable is a final report that contains the topics that are described in the project overview and project requirements sections of this project input form. The EPRI research

engineer will work with the team to identify the items that are typically included in research reports of this type. Some of the topics that the team may gain practical experience in from this project include:

- Wireless sensor capabilities and limitations.
- Wireless sensor battery life management considerations
- Unique or innovatively useful characteristics of the sensors.
- How to develop sensor selection criteria.
- Practices to design and document testing of equipment
- Familiarity with engineering documents such as a network diagram, schematic, or connection wiring diagram of the test setup.
- How to summarize testing results
- Lessons learned from the equipment connection setup and testing phase of this project.

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):

The ideal team will have experience in the connection and setup of network based wireless components, have a basic understand of electrical and mechanical measurement and test equipment, have a basic understanding of how to read engineering drawings such as connection wiring diagrams, electrical schematics, skills in technical writing, and the ability to prepare written instructions that can be used for setup and testing, specify acceptance criteria.
SEGR student must have SEGR 4141 (Engineering Experimental Design) as a pre or co-requisite.