Proposal

Team, Sponsor, and Proposed Project Description:

Individual students on team: Andrew Bryan, Luke Wilkerson, Jordan Kooyman, Andrew Holm
Sponsor Name: Dr. Ali Ozdagli
Company Sponsor is Affiliated with: FGCU
Sponsor Contact Info: aozdagli@fgcu.edu

High-level description:

> Our senior project aims to develop an open-source framework for efficiently managing low-cost sensors designed to detect and monitor the structural health of civil infrastructure. These sensors will be similar in nature to those commonly used in various industries, such as wind turbines, flood warning systems, and air quality monitors, with the added potential for incorporating green energy components like solar panels.

Key Needs/Goals:

1. Multi-Sensor Management: The framework will address the need to manage multiple sensors simultaneously, allowing users to deploy and oversee sensor networks across various infrastructure sites.

2. Low-Cost Sensor Integration: The project will focus on integrating low-cost sensors into the framework, making it accessible to a wider range of applications and organizations with budget constraints.

3. Data Storage: The framework will provide robust data storage capabilities to capture and securely store sensor data over time, ensuring data integrity and accessibility for analysis.

4. Data Visualization: Users will have access to intuitive data visualization tools, powered by platforms like Grafana, enabling real-time monitoring and historical data analysis for informed decision-making.

5. Sensor Management: The framework will include features for managing sensor configurations, calibration, and diagnostics, streamlining the process of deploying and maintaining sensors in the field.

6. Open Source Framework: The project will contribute to the open-source community by developing a flexible and extensible framework, allowing for collaborative improvements and customization by other developers and organizations.

Technology Stack:
The project will leverage the following technologies and tools to achieve its goals:

1. Arduino IDE and ESP32 Boards: These will serve as the hardware platform for the low-cost sensors, offering flexibility and ease of development.

2. InfluxDB: InfluxDB will be used as the time-series database for storing sensor data efficiently and providing easy retrieval and querying capabilities.

3. Grafana: Grafana will be the primary platform for data visualization, offering customizable dashboards and real-time monitoring features.

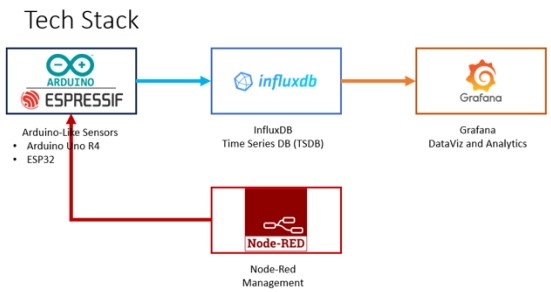
4. Linux Server: A Linux server will be employed to host and manage the framework, providing a stable and reliable environment for data processing and management.

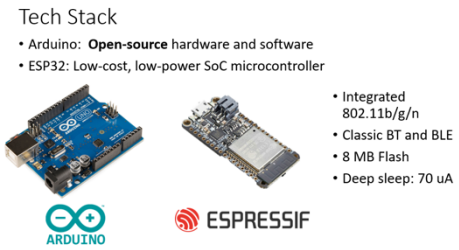
5. NODE-RED: NODE-RED will enhance the framework's capabilities by facilitating data integration, automation, and flow management, further optimizing sensor data handling and analysis.

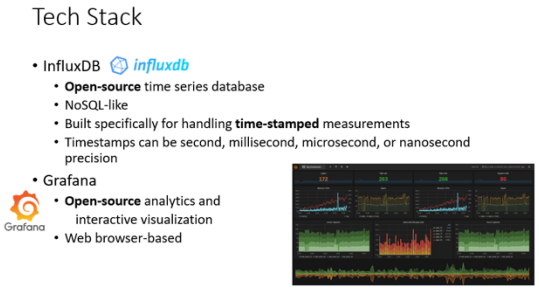
6. Sensors: (Example Sensor: Adafruit MSA311 STEMMA QT) This sensor will be utilized for detecting vibrations and structural damage, playing a crucial role in assessing structural health and ensuring early detection of issues.

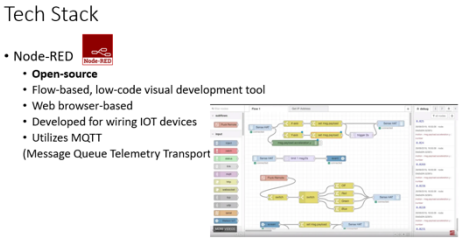
By combining these technologies, the project aims to create an open-source framework that empowers engineers, researchers, and infrastructure managers to monitor and manage the structural health of civil infrastructure cost-effectively and sustainably, while also contributing to the broader open-source community.

Design Method: Your ideas of the diagrams you will include in your design. This includes the diagrams in the software architecture and in the detailed designs. This does not include the actual design as that will be in the final design you will turn in at the end of this course.









Project Impact: The impact your project will have. This can be a description of what your sponsor will

do with the project and how useful it is to them, the impact on the students in the team in terms of learning outcomes, professional exposure, experience and so on, and any other impact your project may have.

1. Infrastructure Resilience and Cost Savings: By providing a cost-effective and open-source framework for structural health monitoring, our project could contribute to significant cost savings in infrastructure maintenance and repair. If successful, the project's impact could help the U.S. reduce the projected $10 trillion loss due to underfunding by 2039. This is a substantial contribution to the country's long-term economic stability and safety.

2. Enhanced Learning Outcomes for Students: For the students involved in the project, there are several valuable learning outcomes:

- Real-world Embedded Systems Applications: They will gain practical experience in developing and deploying embedded systems with real-world applications. This hands-on experience is invaluable in understanding how technology can address pressing issues.
- Server Management and Data Handling: Students will learn how to set up and manage servers that handle data from multiple sensors. This knowledge is transferable to a wide range of industries and is highly relevant in today's data-driven world.
- Data Visualization: Students will develop expertise in data visualization, using platforms like Grafana. This skill is in high demand across various industries, from data analytics to business intelligence.
- Research Readiness: Engagement in this project will prepare students for graduate-level research positions in software or computer science fields, as they will have worked on a complex, interdisciplinary project with practical applications.

3. Open-Source Collaboration: By contributing to an open-source framework, our project will foster collaboration among developers, researchers, and organizations interested in structural health monitoring. This open and collaborative approach can lead to continuous improvements in sensor design, cost reduction, and expanded use cases.

4. Sustainability and Green Energy: If your project incorporates green energy components such as solar panels, it can contribute to a more sustainable approach to infrastructure monitoring. This aligns with the global push for eco-friendly solutions and showcases the potential for integrating renewable energy sources into existing systems.

In summary, our project has the potential to make a substantial impact on infrastructure resilience, cost savings, student education and readiness for research roles, open-source collaboration, and sustainability efforts. It addresses a critical need and has far-reaching implications for both the immediate and long-term well-being of society and the economy.

Deliverables: The list of deliverables including software, hardware if any, designs etc. that your sponsor expects at the end of the project.

Phase	Milestone	Task	2023 Sep	Oct	Nov	Dec	2024 Jan	Feb	Mar	Apr	May
Phase 1 Preparation and Setup	1	Acquire necessary hardware, including ESP32 devices. Establish a development environment for ESP32 programming.									
	2	Begin programming ESP32 devices for basic functionality. Research and choose appropriate sensors for data generation.									
Phase 2 Sensor Development and Preliminary Data Generation	3	Continue programming ESP32 devices for slow-rate data (humidity, temperature) generation. *Develop code for precise timestamping using GPS.*									
	4	*Program ESP32 devices for fast-rate data (wind speed, acceleration) generation.* Ensure data is transmitted to the internet over WiFi.									
	5	Set up InfluxDB on the chosen platform (AWS or local server). Implement the database schema for storing slow-rate and fast-rate sensor data. Configure ESP32 devices to send data to InfluxDB.									
Phase 3 Data Visualization Research and Implementation	6	Set up Grafana on the chosen platform (AWS or local server). Connect Grafana to InfluxDB. Create initial slow-rate and fast-rate data visualizations.									
	7	Research and experiment with real-time data visualization techniques and tools. Begin implementing data visualization features in Grafana.									
Phase 4 System Optimization and Feature Development	8	Set up Node-RED on the chosen platform (AWS or local server). Gain a deep understanding of the MQTT model for sensor communication.									
	9	Implement remote start/stop functionality for ESP32 devices via Node-RED. Develop sensor quality monitoring features within Node-RED.									
	10	Refine and optimize all components of the system. Conduct thorough testing and debugging.									
Phase 5 Final Presentation and Project Closure	11	Deliver the final presentation. Demonstrate the system's functionality and capabilities. Discuss the project's outcomes, challenges, and lessons learned.									

Resources: Breakdown of the resources such as any material, information, computers, or human resources your team will need. Indicate any cost involved and who will pay for these costs.

The only physical materials are the ESP32 boards and the Linux server in Holmes 429; human resources are the student senior project members, and Dr. Ali. FGCU covers all costs.

Statement of Work: Approximate timetable. Breakdown of the project among the team members clearly showing each task and who will perform each task.

Needs of the project vary greatly week to week, and students are expected to fill in where needed, but below this paragraph is the general division of work. Timetable requirements are as follows: Mondays 2:45-4:45 students are expected to meet and work together on the needs of that week, Thursdays 1:00-2:00 students are expected to bring forth findings, progress, and discuss our next course of action. Students are also expected to work independently when possible. Progress does not need to be met every week since students have jobs and classes, but the bare minimum is progress every other week. All tasks and assignment of tasks will be tracked on Thursday meetings. We will follow an Agile development methodology.

Jordan Kooyman: Arduino & Embedded System
Andrew Holm: Grafana Data Visualization
Andrew Bryan: Linux Server
Lucas Wilkerson & Andrew Holm: Node Red & MQTT
Lucas Wilkerson: Documentation

Sponsorship Agreement: Name of sponsor's contact person and any established agreements with them such as any nondisclosure agreements or waiver of intellectual property rights. You do not need to include the agreement itself. I just need to know what you have agreed to.

Only agreement made is that this project is open source.

PowerPoint for additional information: Senior Design Project.pptx