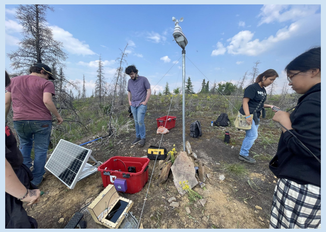
PULSE - Powering and Unifying Long-range Sensor Ecosystems

Hailey Hodgins & Petie Deveer
Project Mentor: Dayne Broderson

Background



High school students deploy a weather station at Chena Hot Springs during the 2024 summer program

The deployment of sensor systems, such as weather stations, in remote locations presents both power and network challenges. These challenges require flexible & adaptable solutions which can be modified as needed on-site. In the context of teaching and learning, these solutions must also be easy to implement and clearly documented.

The Teaching Through Technology (T3) program offers STEM education activities to high school students across AK, and has worked with remote sensor systems in the past. However, students consistently run into problems that prevent them from maintaining their systems long-term. During the 2024 summer program, students created a weather station at Chena Hot Springs Resort, but due to unreliable cell connection and issues with their power system, they were unable to leave the station running.

Consistent and reliable remote sensor systems provide

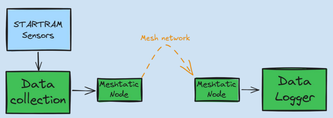
- Valuable data for organizations like GLOBE (Global Learning and Observations to Benefit the Environment)
- Greater access to weather station projects for rural communities
- Opportunities for participation in citizen science
- Educational experiences with data handling

Technology Used

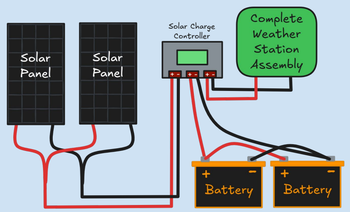
This project focuses on data transmission and logging, and, secondarily, on building a functioning power system. We are working with another project, STARTRAM, whose goal is to evaluate the sensors themselves.
We chose to use an open source, long-range radio (LoRa) mesh network protocol called Meshtastic to transmit data. Benefits include being well documented, easy to use, and not requiring internet or cell connection.

Other technologies used include:

- Raspberry Pi 4
- Heltec V3 LoRa development board
- RTL-Software Defined Radio
- Solar panels, batteries, charge controllers
- NodeRED, Python, Bash scripting



Original plan for system



Power system wiring diagram

Deliverables

Upon completion of this project, we will:

- Demonstrate a successful remote sensor station
- Provide a qualitative report to our T3 partners, including
  - A bill of materials for final selected system components
  - Detailed documentation for building the system
  - Outline of ways to use system for student activities
  - Recommendations for next steps & improvements
- Release PULSEtastic, an open source toolkit for transmitting data over Meshtastic, on Github

Student Engagement

To ground our feasibility assessment of these technologies within a T3/classroom environment, we held a hands-on learning event at North Pole High School on 02/06/25. Participants were T3 students who had previous exposure to Raspberry Pi's and basic programming. Some students learned to intake data from sensors via an RTL-SDR and parse the data in NodeRED, while others setup Meshtastic nodes and sent messages.

This event revealed valuable lessons, from technical problems, to better ways in which we can engage students in the project. It also provides a foundation for further work at North Pole - the NPHS T3 classroom was left with several Meshtastic nodes so that students can explore these concepts independently.

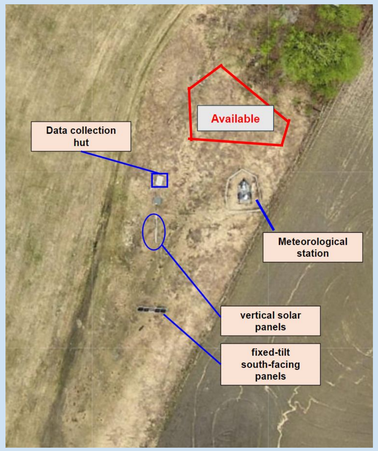
Top Left & Right: Adrian Burke (STARTRAM) demonstrates data collection from atmospheric sensors at NPHS
Bottom Left & Right: Hailey Hodgins (PULSE) supervises setup of Meshtastic nodes using RPi's at NPHS

Future Efforts

In the next phase of our project, we aim to wrap up the technological evaluation process and move towards documentation and collaboration with partners. Our goals are as follows:

- Deploy test system at solar test site
- Refine PULSEtastic for broader applicability
- Troubleshoot compatibility with currently used T3 technology
- Continue collaboration with T3 students
- Consider additional grants and partnerships for future development
- Seek development for formal curriculum to maximize students' learning potential

PULSE and STARTRAM Teams visiting the Solar Test Site with Henry Toal, Research Engineer



Target Deployment Area at Solar Test Site

Acknowledgements

The broad applicability and direct relevance to multiple research and education efforts has allowed this work to be supported by the **URSA program**, along with programs at **ACEP** and UAF College of Engineering and Mines (CEM):

- **UAF Upward Bound Program**, funded by the Dept. of Education;
- **ARCTIC Program**, funded by the Department of the Navy, Office of Naval Research under ONR award number N00014-22-1-2049
- **Project STORM**, funded by National Science Foundation EPSCoR (RII Track-2 FEC) award number 2316402

Thanks to the Undergraduate Research and Scholarly Activity (URSA) program, the University of Alaska Fairbanks Teaching Through Technology (T3) and Upward Bound Programs, the Alaska Regional Collaboration for Technology Innovation and Commercialization (ARCTIC) Program, Project STORM (Data-Driven Approaches for Secure Electric Grids in Communities Disproportionately Impacted by Climate Change), and the Alaska Center for Energy and Power (ACEP).