



Mesh Networks for Simultaneous  
Localization and Communication

# Project Proposal

Team 1961C



# Introduction / Objective

- Sailboat Regattas
  - Series of competitive boat races
- Mesh Network of radios
  - Real-time tracking, distance measurement techniques
- Nodes
  - Self contained units including radio, antennas, and electronics
  - Minimum of four nodes
- Base Station
  - One main base station, hosts web app
  - At least one other base station extender



# Key Technical Specifications

## Radio Systems

Project Element	Category	Specifications
Radio Systems	Localization	Accuracy of 7 feet or better
		Measurements every 3 seconds
	Communications	Range not less than 300 feet
		Adequate data transfer rate
		Must be able to relay messages to other nodes as needed
	Network	Operates with 1 to 12 nodes
		Operates with as little as 1 base station + extender



# Key Technical Specifications

## Base Station

Project Element	Category	Specifications
Base Station	Enclosure	No larger than 10"x6"x6", no heavier than 5 lbs
		Must be mountable to a tripod
	Antenna	Securely mounted to the enclosure (inside or out)
	Power	Must be powerable from AC power or an internal battery
		Internal battery must last 6 hours and charge in 8 hours
	Interface	Must host a wifi network for displaying node locations
		Must include settings relevant to system operation



# Key Technical Specifications

## Base Station Extender

Project Element	Category	Specifications
Base Station Extender	Enclosure	No larger than 8"x5"x5", no heavier than 3 lbs
		Must be mountable to a tripod
	Antenna	Securely mounted to the enclosure (inside or out)
	Power	Must be powerable from AC power or an internal battery
		Internal battery must last 6 hours and charge in 8 hours
	Interface	Have internal buttons/indicators as needed for operation
		Be controllable from the base station



# Key Technical Specifications

## Node

Project Element	Category	Specifications
Node	Enclosure	No larger than 8"x5"x5", no heavier than 3 lbs Water resistant to a depth of 25 feet for up to 5 minutes
	Antenna	Securely mounted to the enclosure (inside or out)
	Power	Run for up to 4 hours and charge in less than 6 hours
		Withstand temperatures between 40 °F and 130 °F
	Interface	Have internal buttons/indicators as needed for operation
		Be controllable from the base station



## Design Approach and Details



# Radio Transceiver

# Antennas

## DW1000

- Onboard ToF hardware
- Supports communication between modules

## Testing phase

- DWM1000 modules (integrated antenna) with pins broken out to a breadboard

## Final Development

- Custom PCB integrating DW1000, RF electronics, external antenna connection

## Omni-directional (node)

- Loop or Dipole

## Directional Antenna (base)

- End-fire or Yagi-Uda

## Testing phase

- DWM1000 module integrated antenna

# Power Supply

# Microcontrollers

# 18650 Battery (node)

- Thermal and volumetric efficiency
  - Higher charge cycle count (~1800)
  - Cheaper

# Sealed Lead Acid (SLA)

(base)

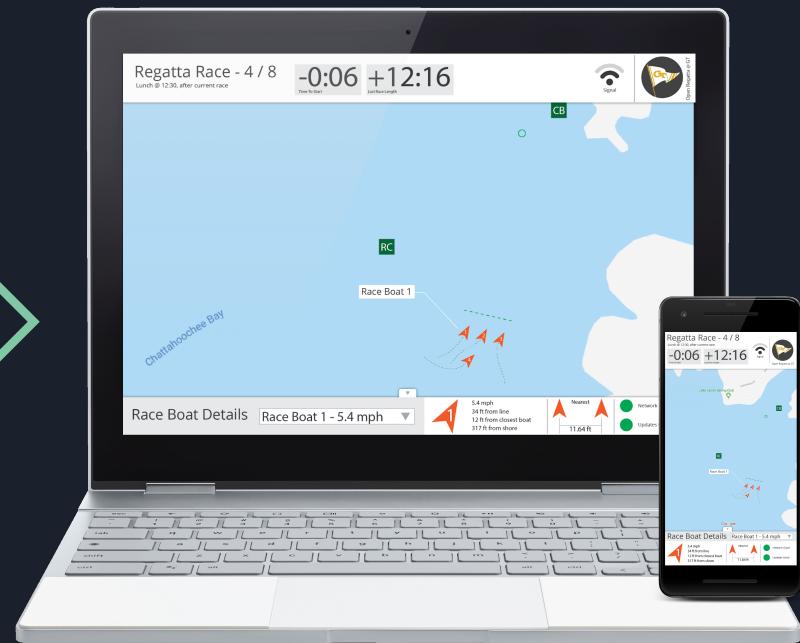
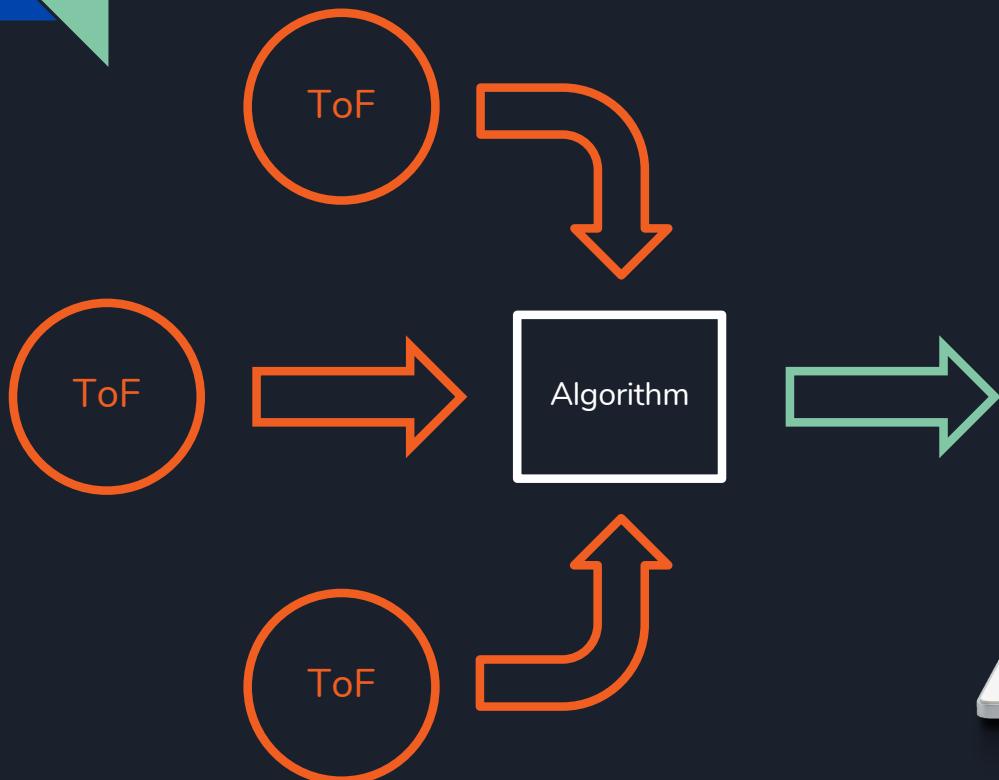
## AVR vs. ARM vs. Xtensa RISC

- Library compatibility
  - Processing speed
  - Power consumption

## Final Design Considerations

- AVR and ARM-based microcontrollers can be integrated into the PCB
  - Modules from Espressif would be soldered to the PCB as is

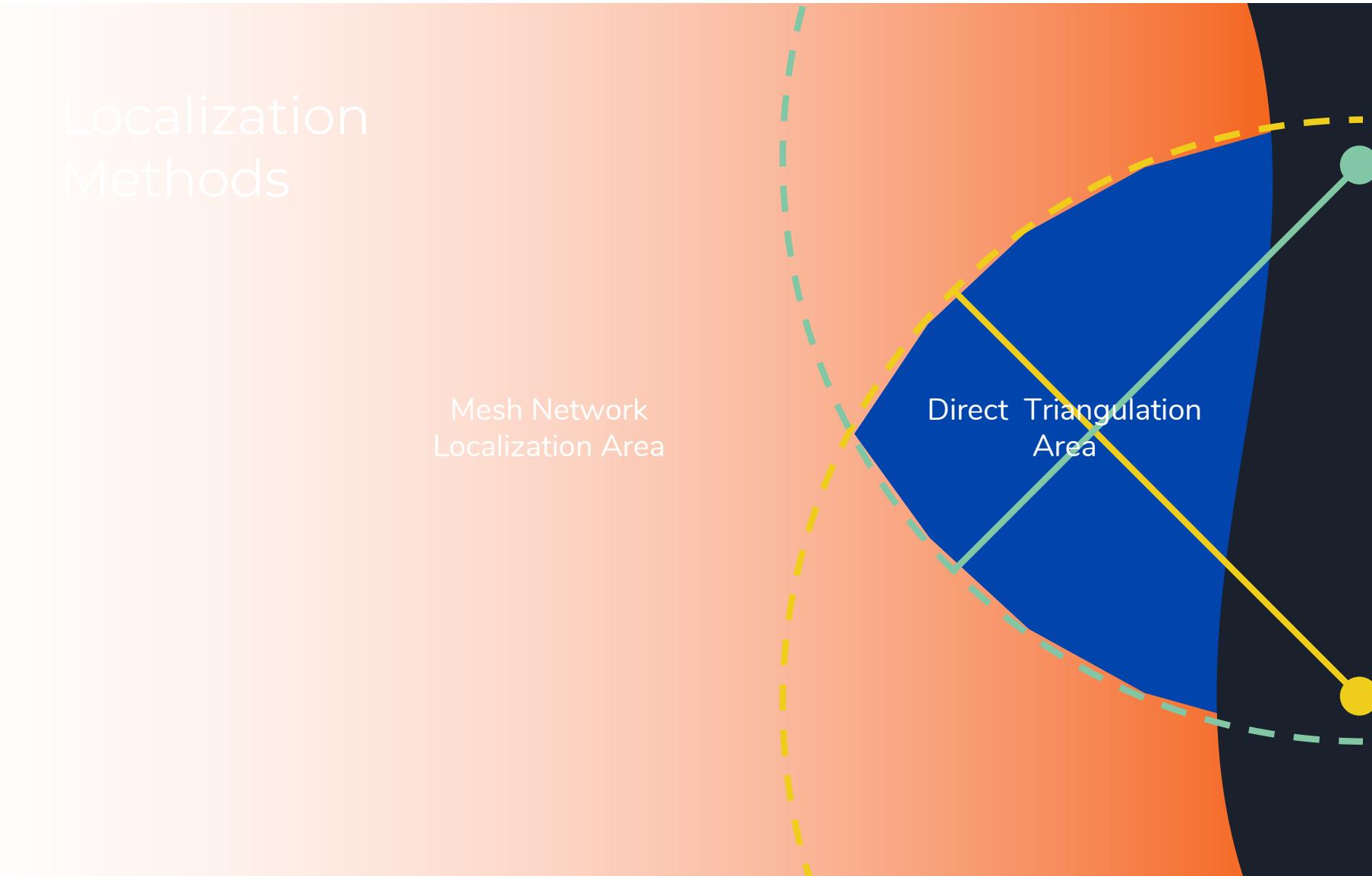
# Algorithm



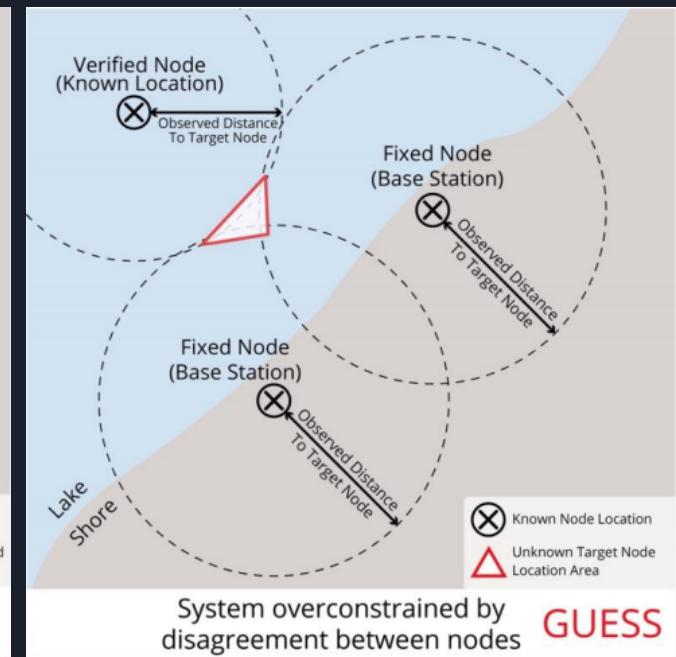
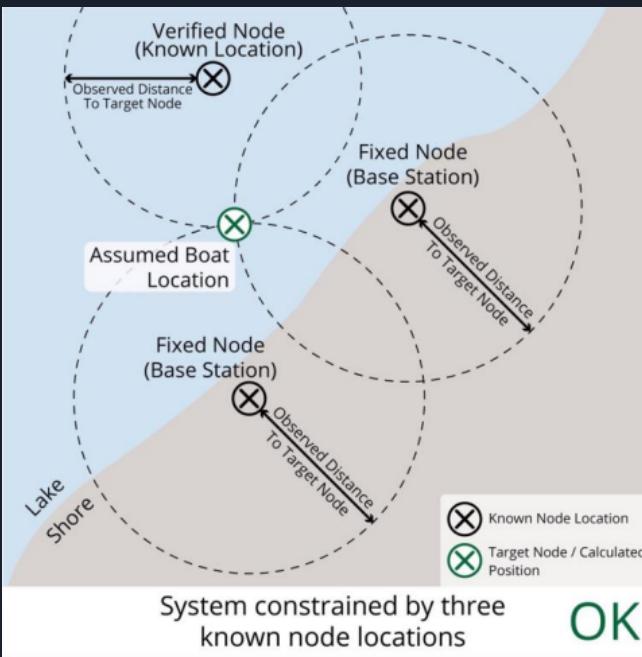
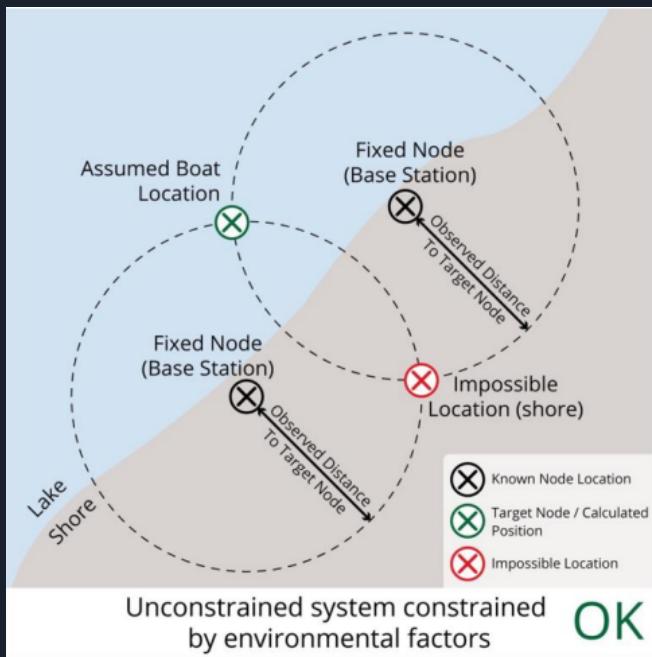
# Localization Methods

Mesh Network  
Localization Area

Direct Triangulation  
Area



# Challenge - Overconstrained Localization

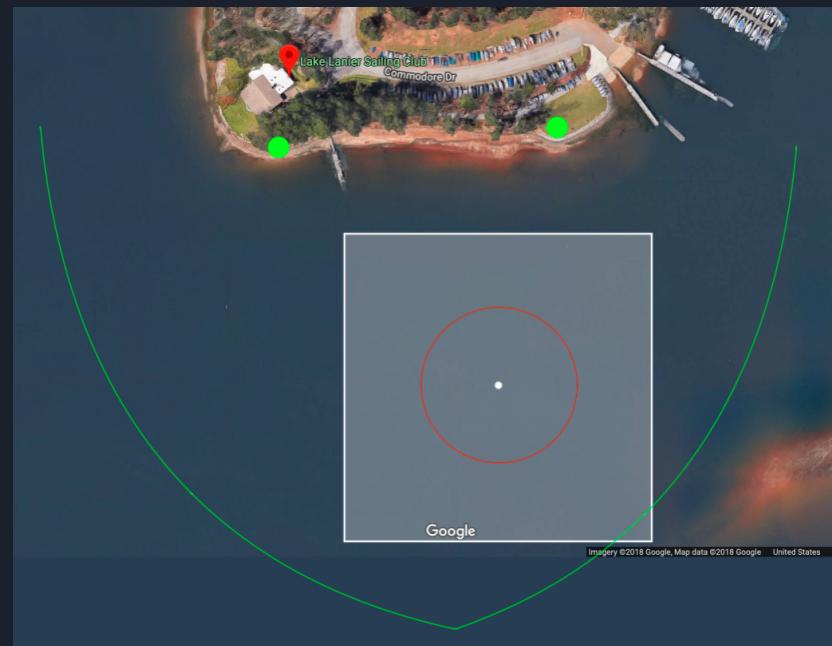


# Schedule, Tasks, and Milestones

# Project Demonstration

We will coordinate with the Georgia Tech Sailing Club for use of their boats

- Nodes will be placed on C420 sailboats
- One base station + extender pair will be placed on shore (green dots)



# Cost Analysis

Node

Item	Cost
Radio	\$24.40
Antenna	\$5.99
Microcontroller	\$1.59
Power Supply	\$5.00
Total	\$36.98

Base

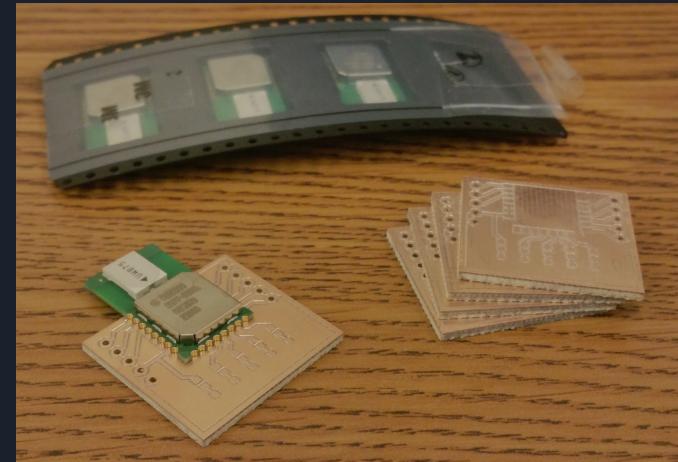
Item	Cost
Antenna	\$30.00
Microcontroller	\$6.95
Power Supply	\$30.00
Total	\$66.95

Misc.

Item	Cost
Wiring	\$10.00
Packaging	\$15.00
Extras	\$100
System Total (4 node, 2 bases)	\$406.82

# Current Status

- Acquired test hardware
  - 4x DWM1000
  - Various MCUs
- DWM1000 Breakout PCBs
  - Designed and fabricated
- Currently testing microcontrollers
  - Arduino
  - Teensy
  - ESP8266





## Next Steps

- Design initial hardware (PCBs, enclosures, mounts) Jan  
28th
- Test enclosed units for shock/water resistance Feb 2nd
- Program MCUs for distance measurement, communication. Feb 18th
- Conduct initial real-world tests (Lake Lanier) Feb 25th

# Questions?

