Coastal Underwater Field Observer with Remote IP Access

Joe Wilinski, **Aaron Ganick,**

Alexander Clausen, Timothy Durkin, Jen Harris, Kevin Murphy, Thomas Little

CESN 2009

Supported in part by NSF #CNS-0721884

BOSTON UNIVERSITY

Synopsis

- Goal to enable long-term unattended visual observation in remote settings
- Achieve remote monitoring via IP access and pervasive Internet software tools
- Significant challenge to reconcile data rates of quality digital video streaming and network capacity
- Significant challenge to reconcile energy consumption of hardware and communications with continuous use of batteries.

Target Applications

Wide angle

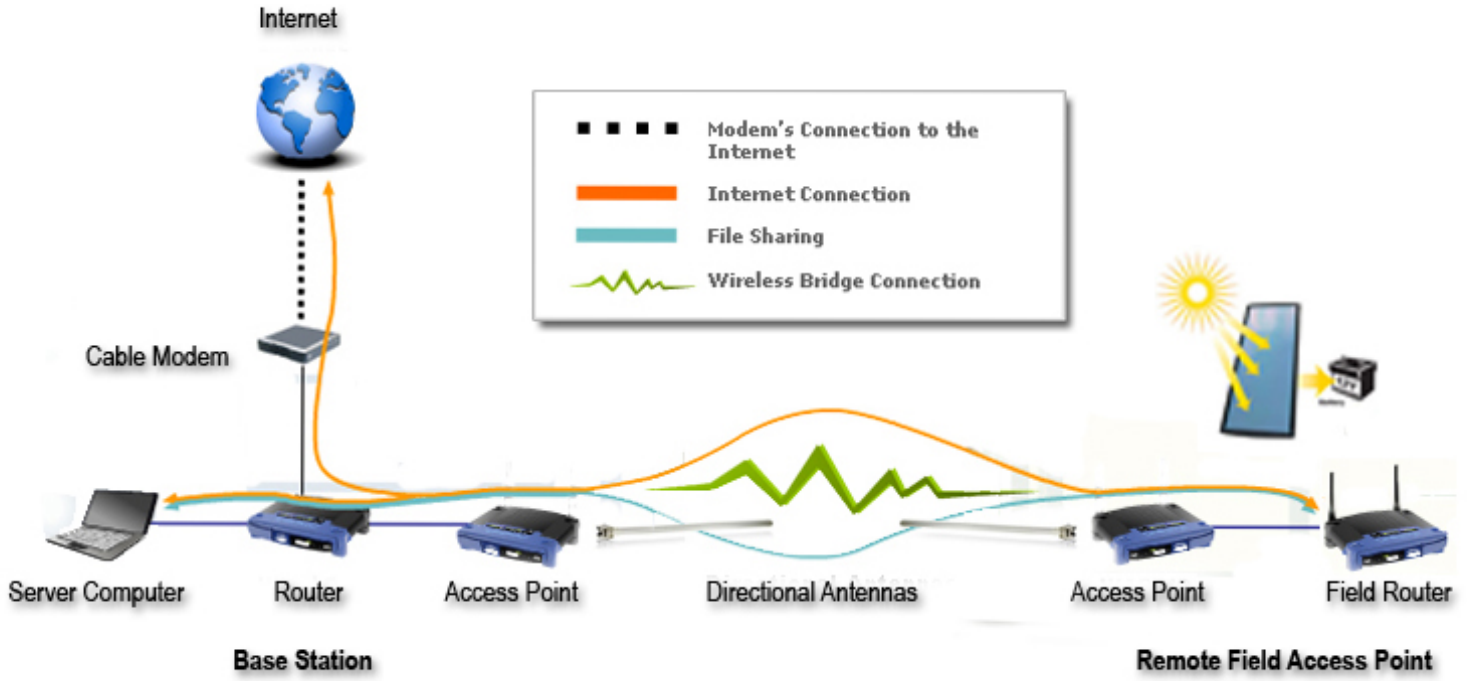
Zoom

Characterized by

- Remote location
- Devoid of infrastructure
- Linear arrangement (beach)
- Noisy background
- Harsh harsh environment (salt, sand, wind, water)
- Periods of stasis and periods of activity
- Bird droppings

- How many seals?
- What is their behavior like over extended periods?

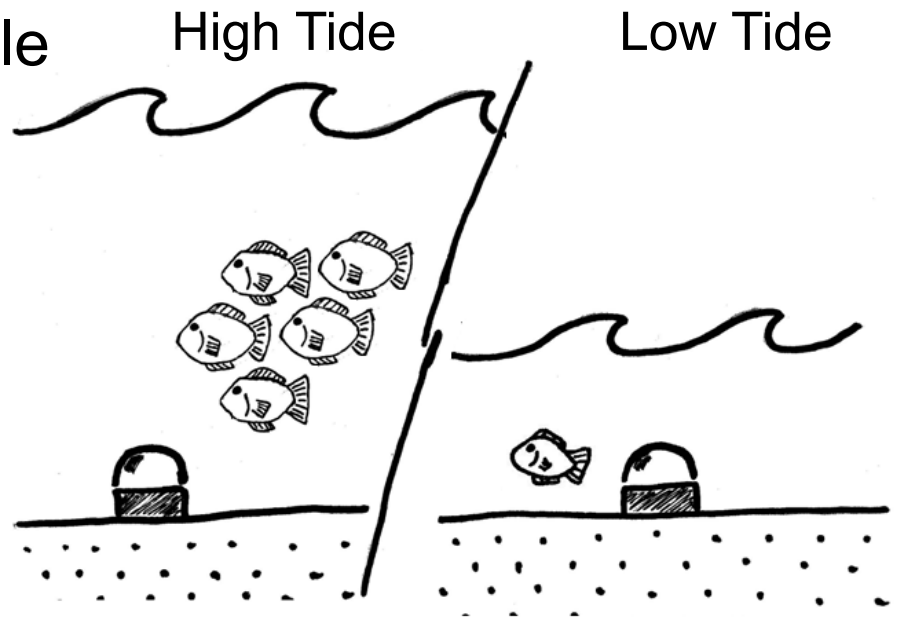
Network Overview



Under Water Field Observer

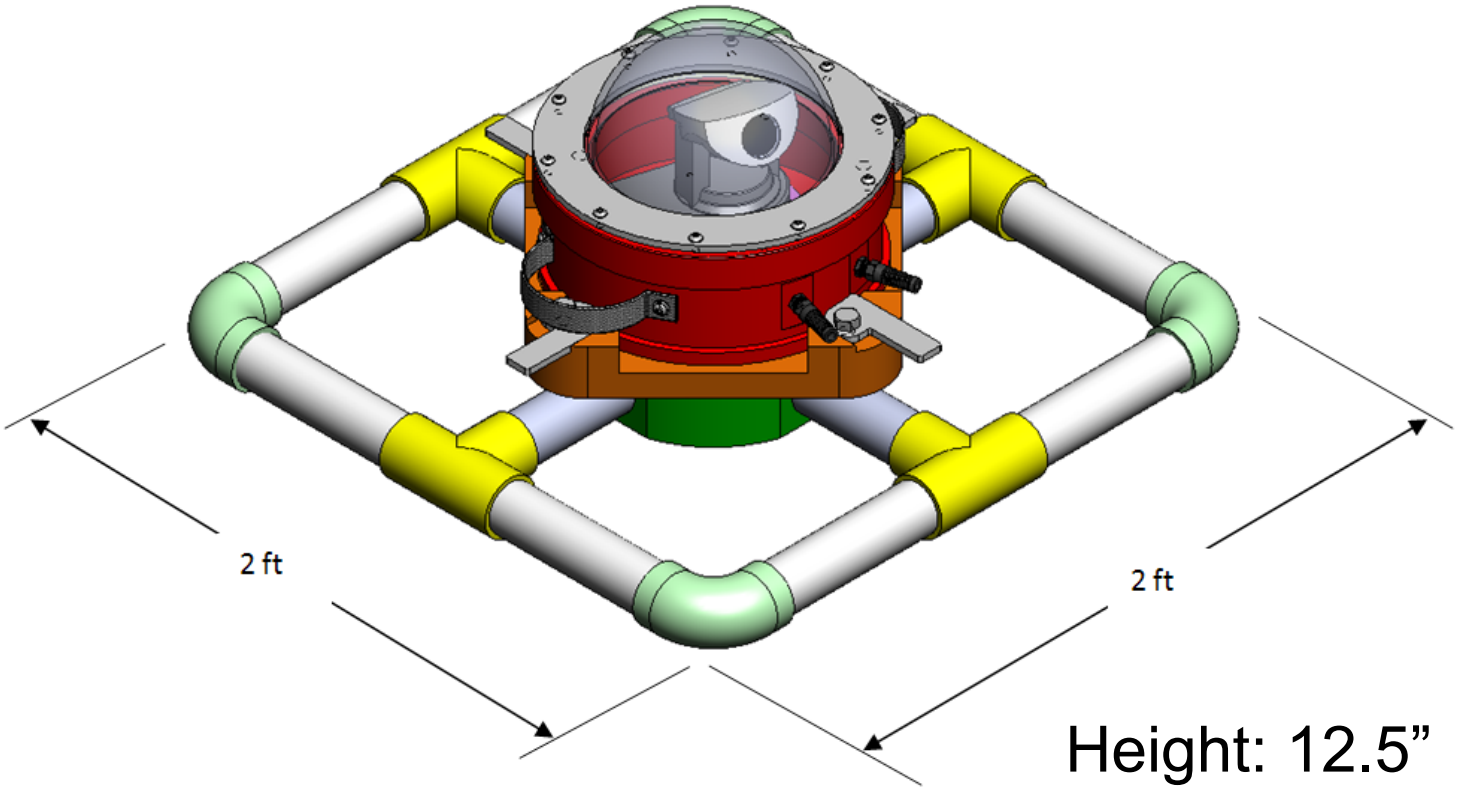
Key Enclosure Requirements

- Accommodate and Protect Camera
- Transmit/Receive Data and Power
- Watertight
- Anchored, Stationary, Stable
- Optical Clarity
- Environmentally Safe



Underwater Enclosure

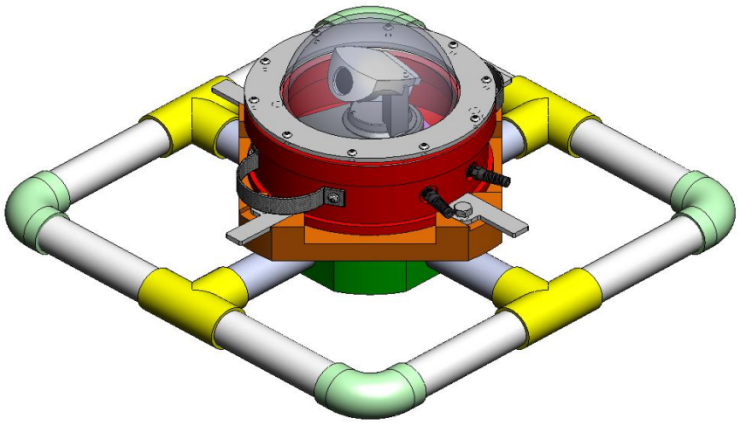
Underwater Field Observer (UFO)

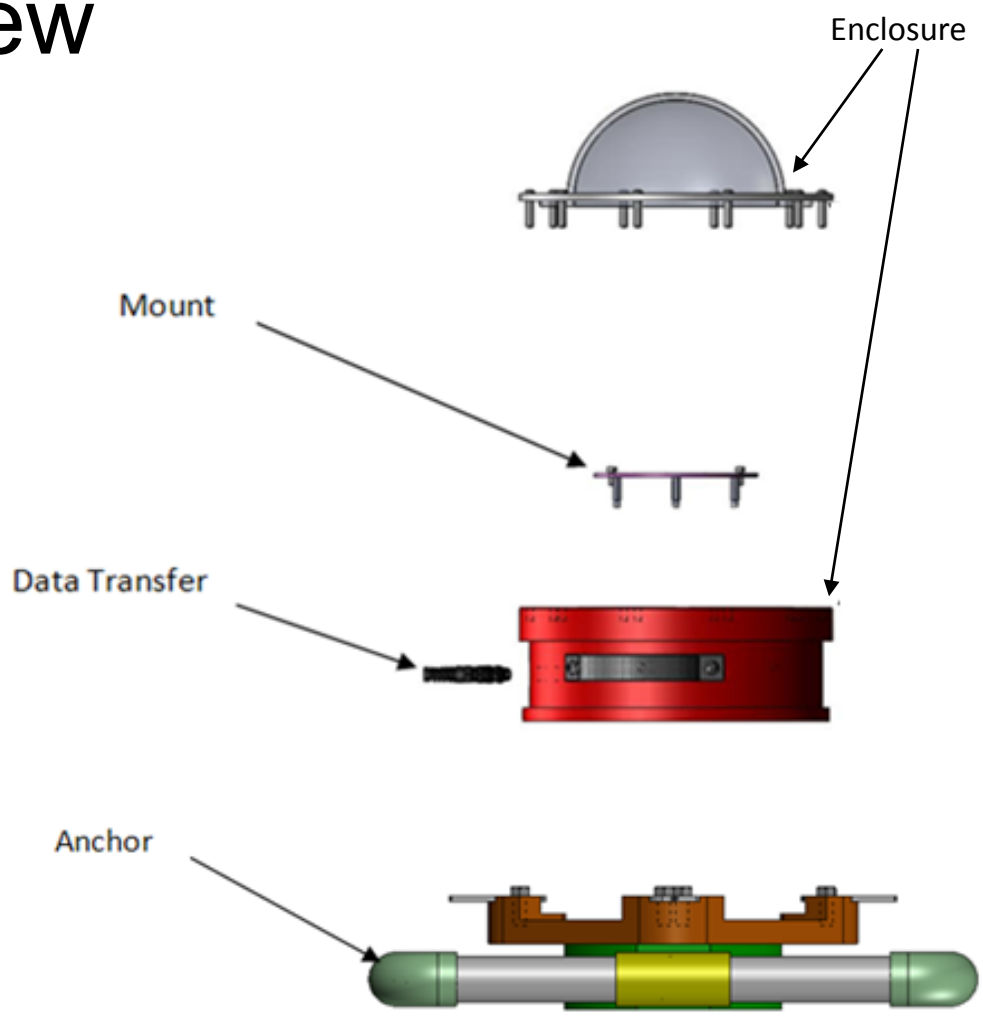


Height: 12.5”

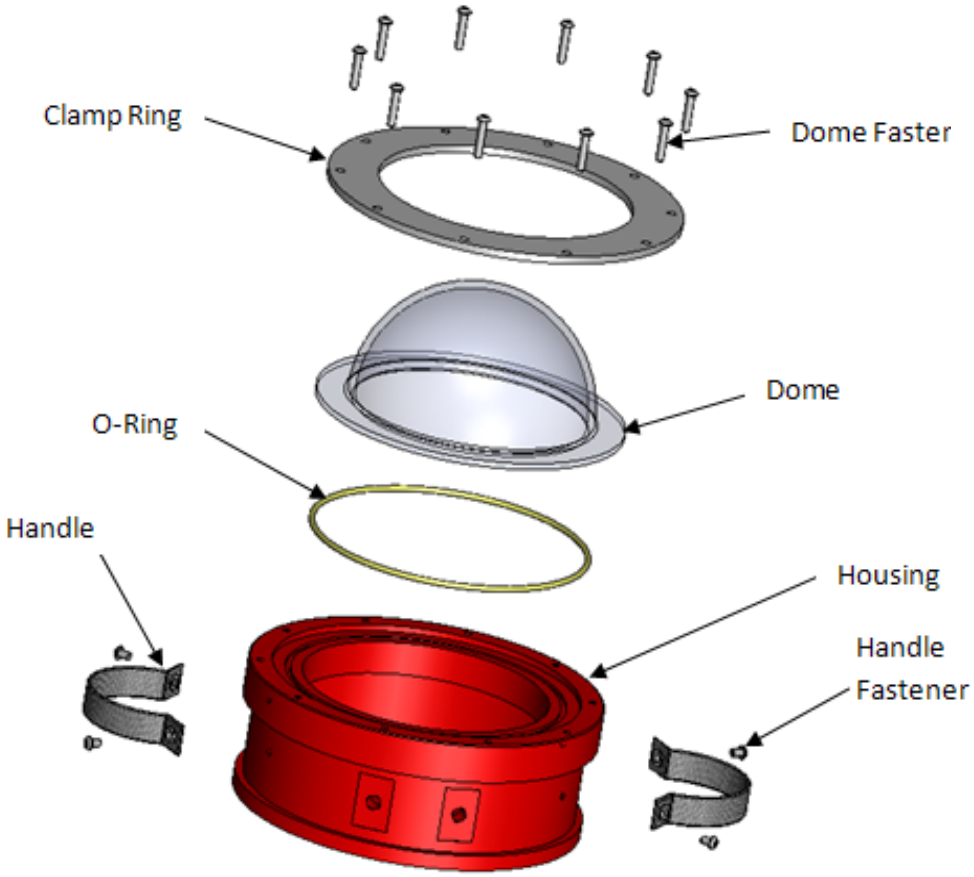
System Overview

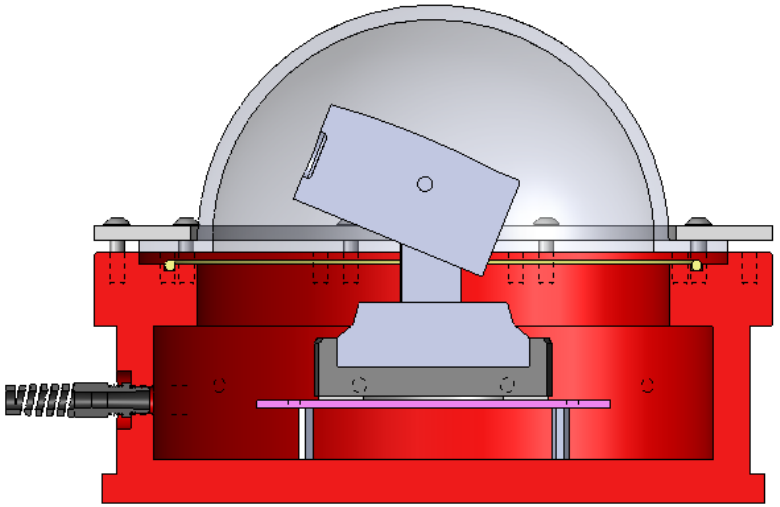
- Material Selection
- Pilot Testing
- User Friendliness
- Prototype Testing





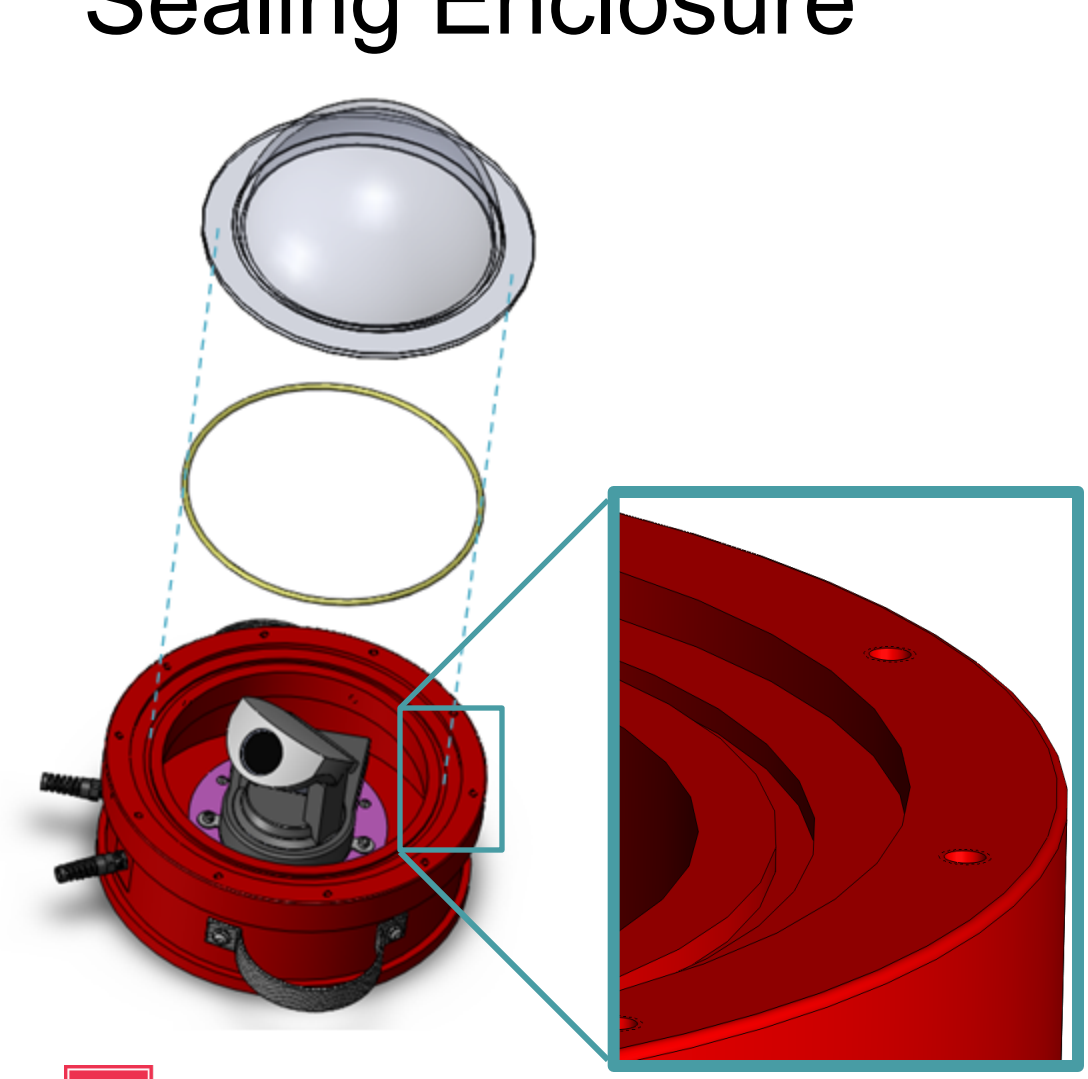
Enclosure Overview

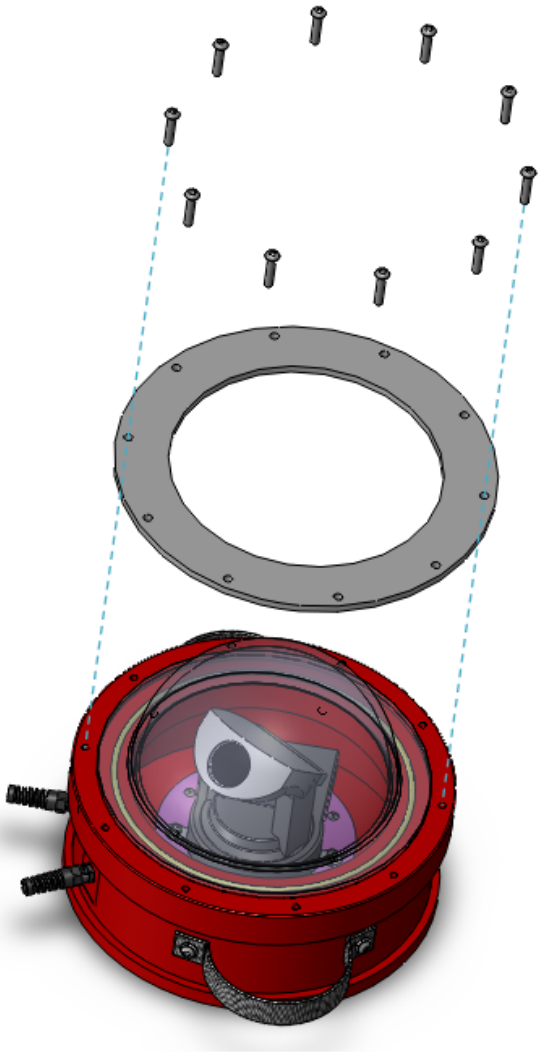




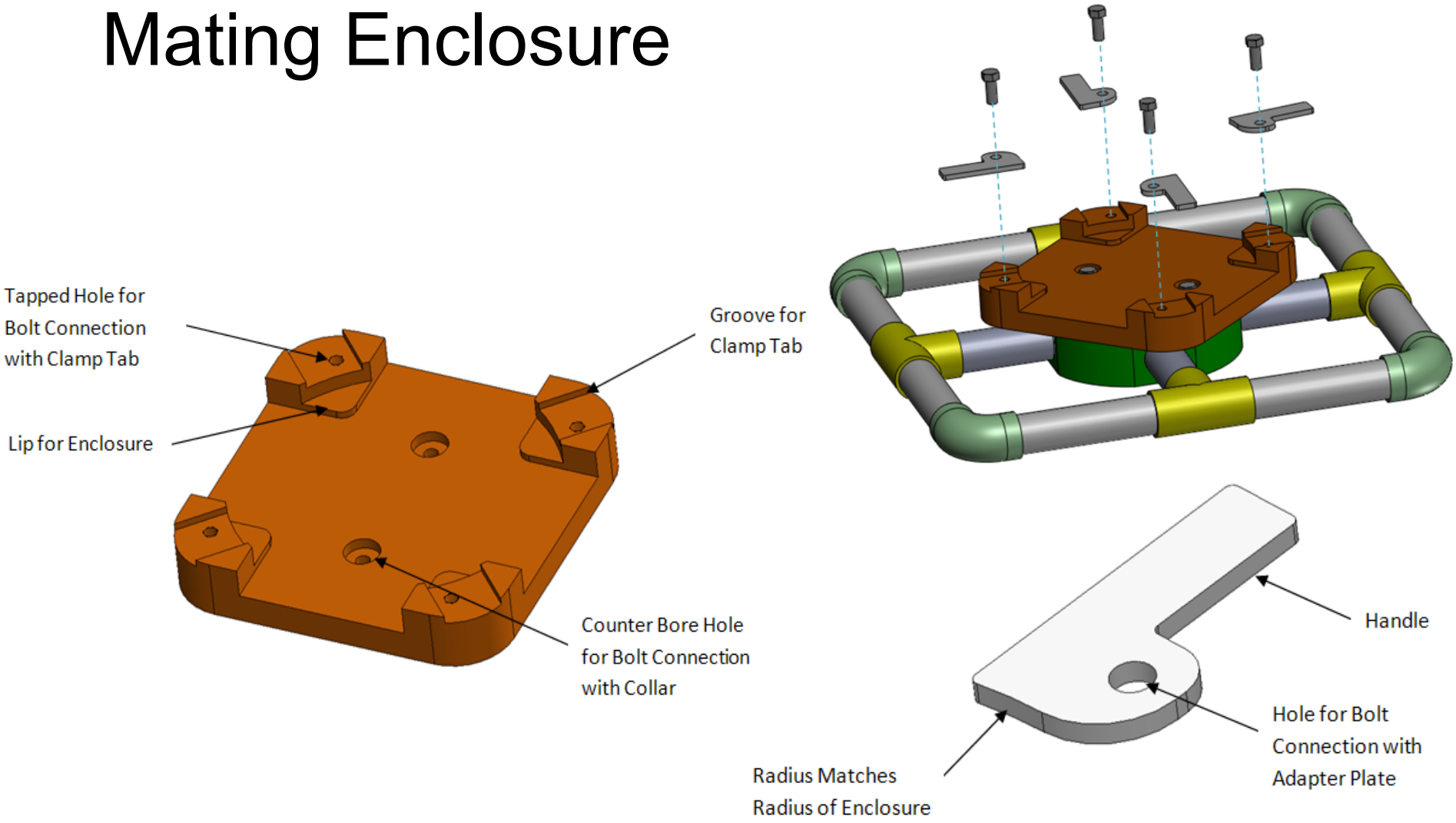
Cross Sectional View

Sealing Enclosure



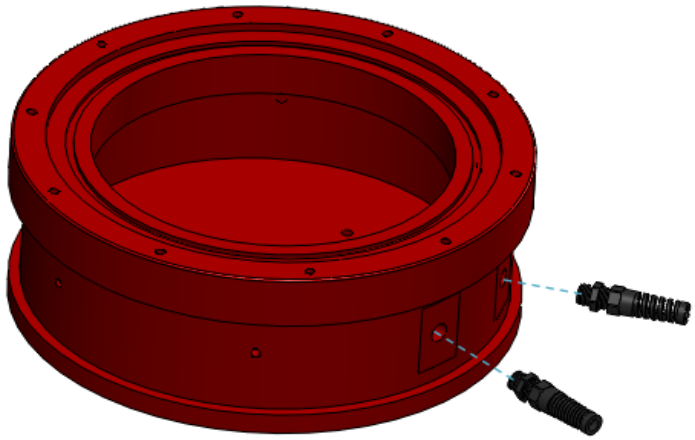


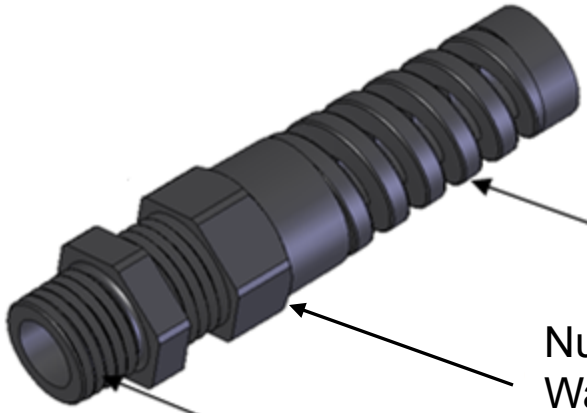
Mating Enclosure



Data Transfer

Ethernet (CAT-5) & Power (13V)





Stress Relief

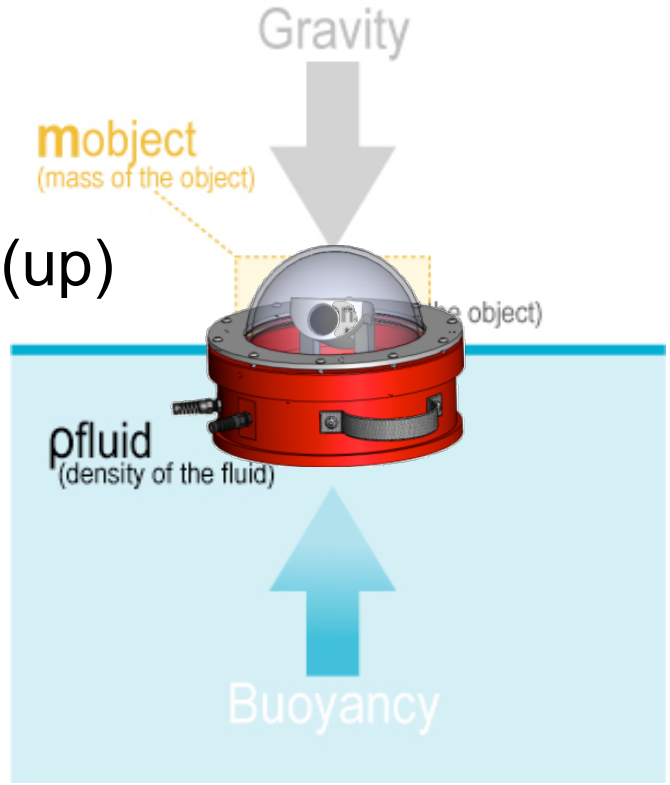
Nut Tightens for
Watertight Seal

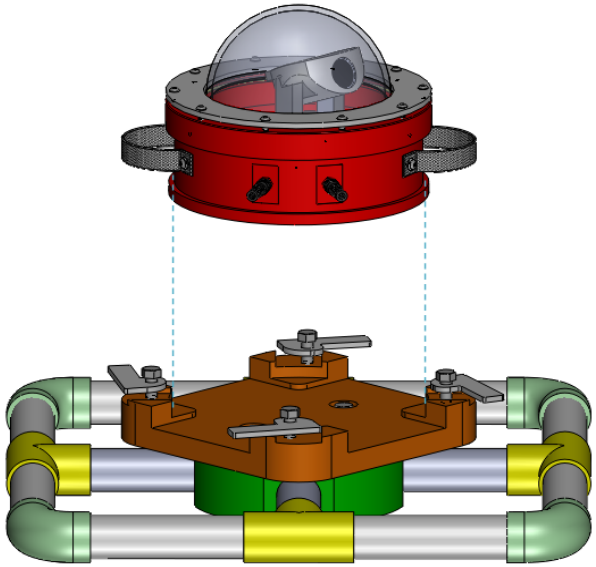
SEALCON Nylon Connector

Threaded
Connection with
Enclosure

Buoyancy - Enclosure

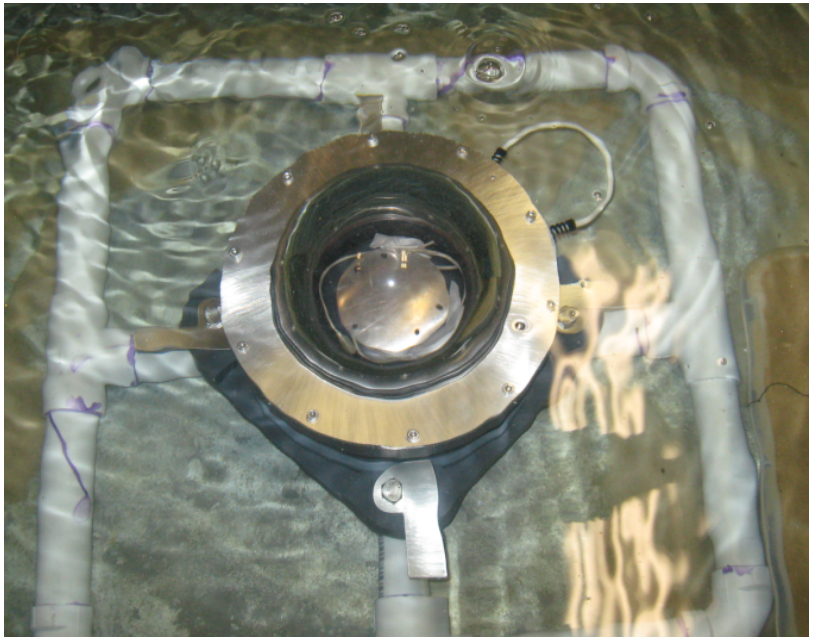
- Total above water weight: 14.1 lbf
- Volume displaced: 439.6 in^3
- Buoyancy Force: 15.8 lbf
- Effective underwater weight: -1.6 lbf (up)



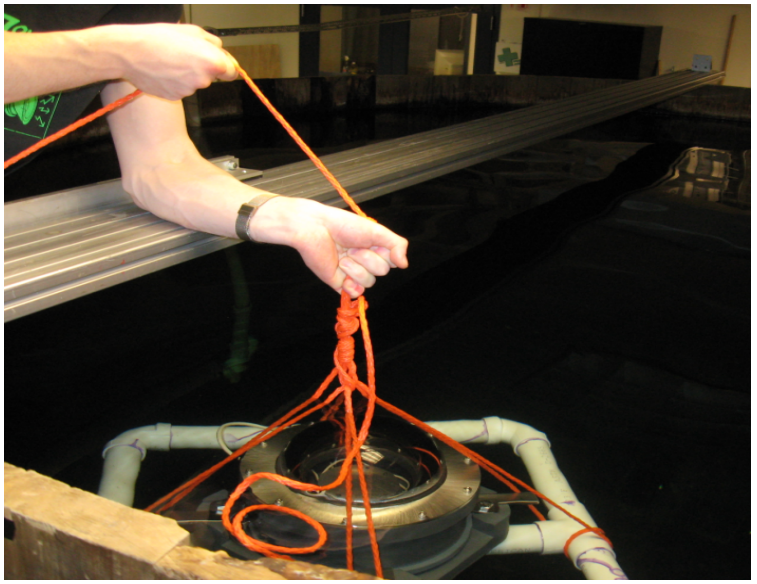


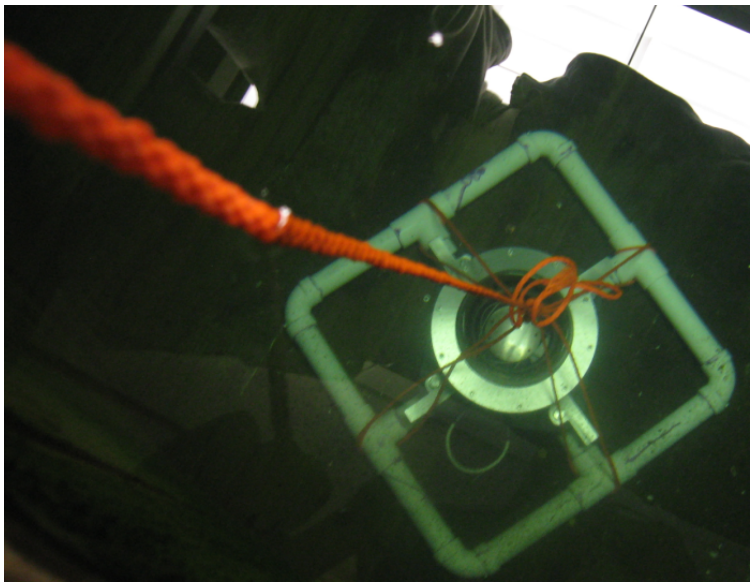
Prototype Testing

- Sealing
  - Low Tide Simulation
  - High Tide Simulation
- Result: NO Leakage



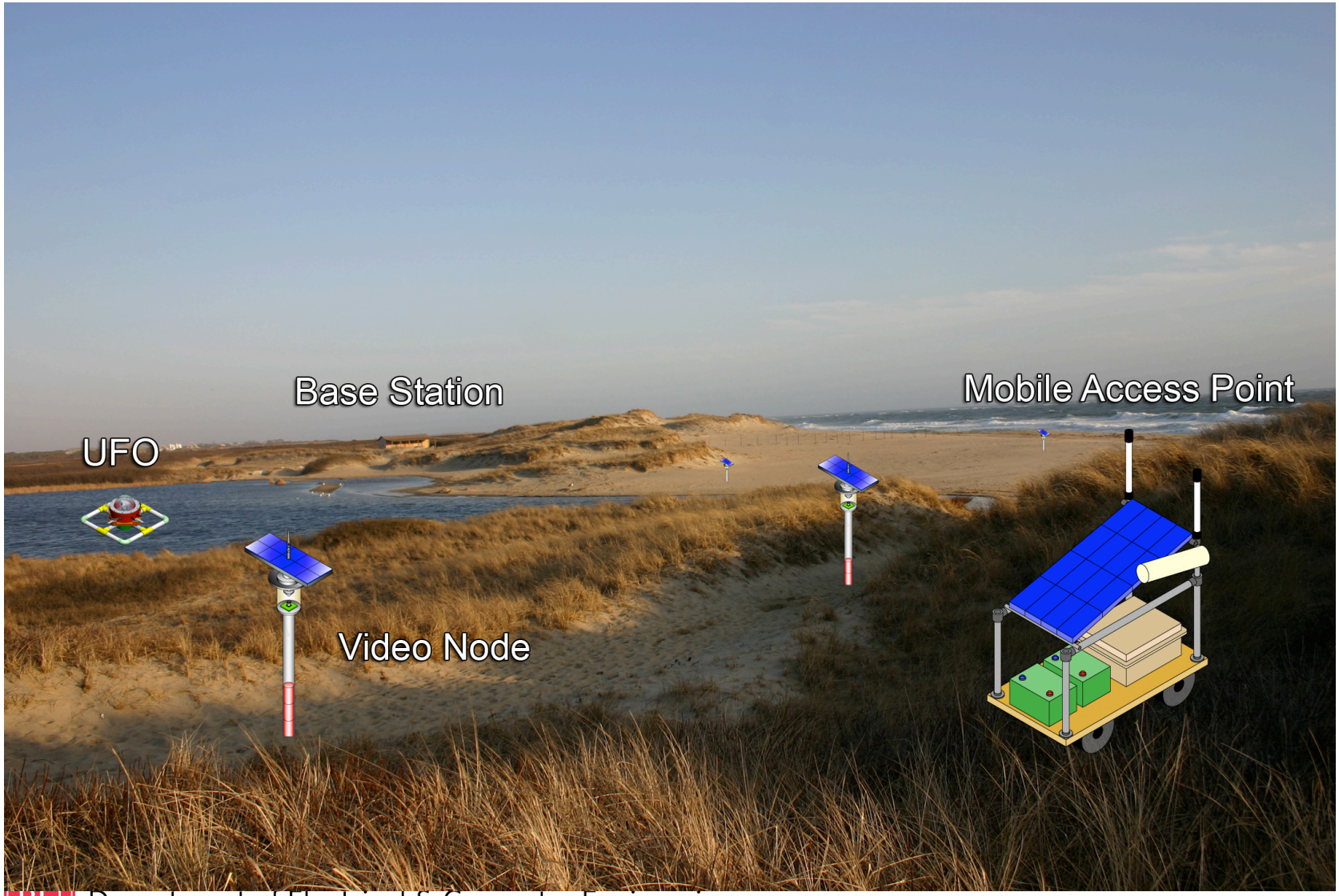
Low Tide simulation 2ft





High Tide simulation 8ft

System Overview

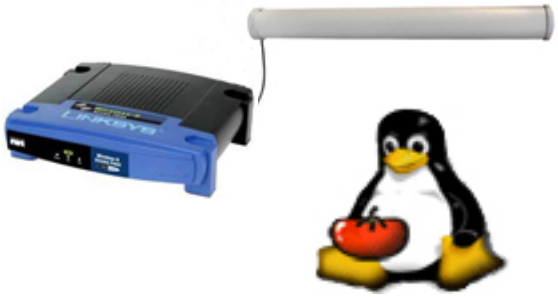


Remote IP Access Point

- Requirements
  - Powered Base Station With Remote Location of Interest
  - Internet Accessibility
  - Ethernet Bridge/Point-To-Point Network
  - Weatherproofed Hardware
- Design Considerations
  - Cart Construction (Frame/Material Selection)
  - Power Supply (Battery Selection)
  - Unit Charging (Solar Panel Sizing and Selection)
  - Power Management (Voltage Regulation, Day/Night Switching Circuit)
- Applications
  - Local Network Extender
  - Remote Viewing Access (Live Video/Still Images)
  - Network Control (IP Configuration/Sensor Management)
  - Remote Server Control (Video/Data Storage and Retrieval)

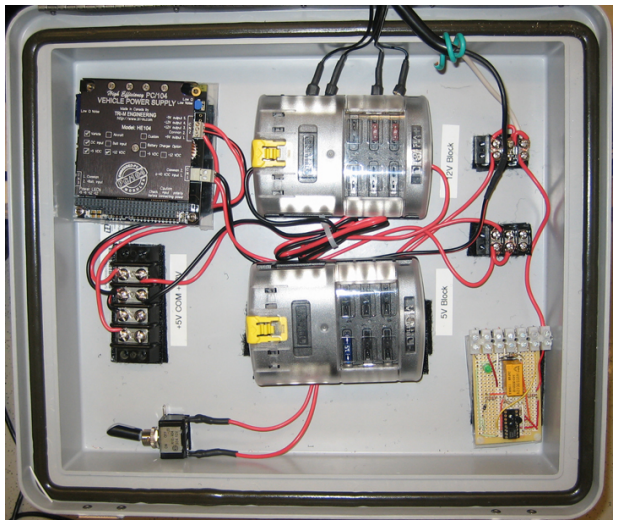
Ethernet Bridge (Point-To-Point Network)

- The bridge acts as a “virtual wire” allowing remote network access.
- Commercial point-to-point systems can range in the upwards of thousands of dollars with high voltage requirements on both ends.
- A custom bridge can consist of either two access points or routers configured to “bridge mode” running Linux firmware such as Tomato or DD-WRT.
- To obtain the required range you can then replace the stock Omni antennas with directional antennas which have line of sight.



Access Point Hardware

- Hardware must be encased in a weatherproofed enclosure
- Battery output voltage must be regulated; 12V or 5V DC
- Solar charge controller needed
- All equipment must be fused
- Short length pigtails should connect to the antennas
- Cart should be secure, accessible, and cleanly wired
- Hardware shown: Linksys router/ access point, charge controller, voltage regulator, fuse boxes, bypass switch, and light sensing circuit

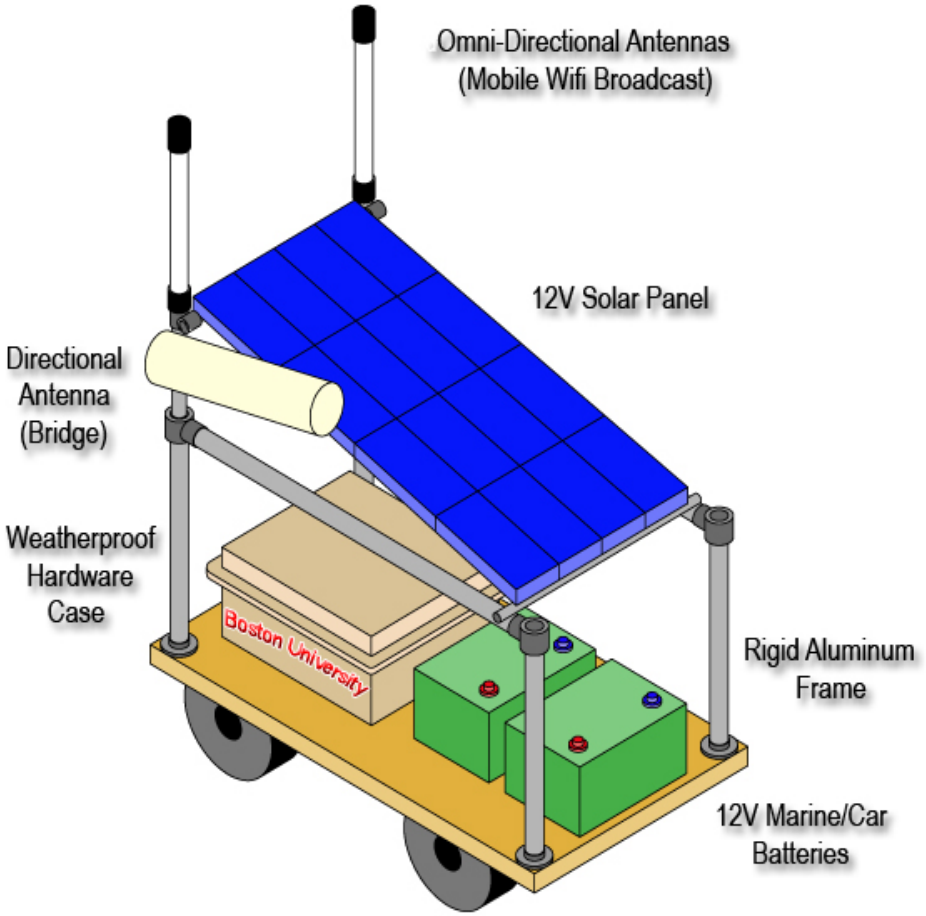


Enclosure Lid

Enclosure Base

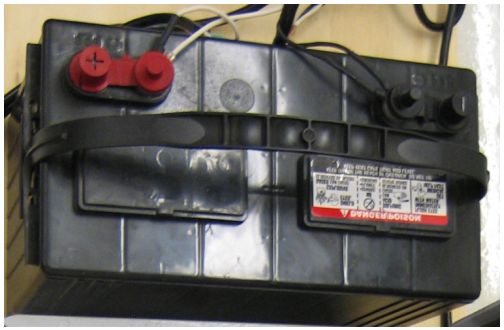
Cart Construction

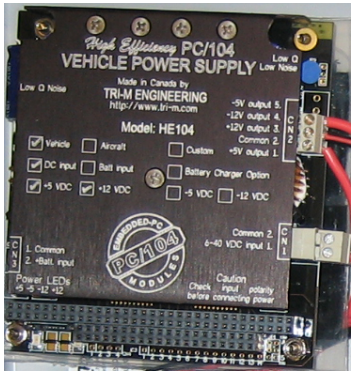
- Frame should be rigid, non-corrosive, and secure
- Base large enough to accommodate hardware and batteries
- Mobile base for easy transportation
- Directional antenna mounted for line of sight with base station
- One or two omni-directional antennas to provide access to local network
- Lockable weatherproof housing for network equipment and fuses

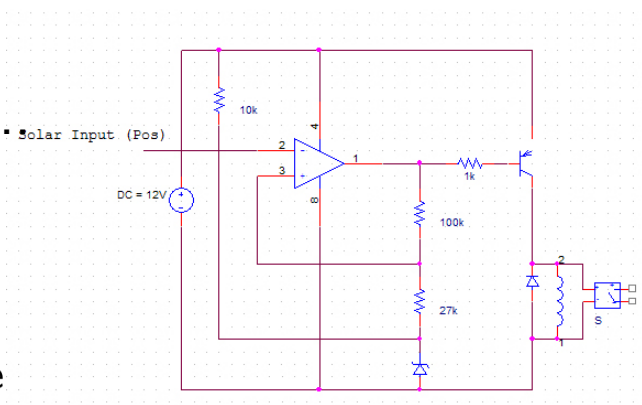


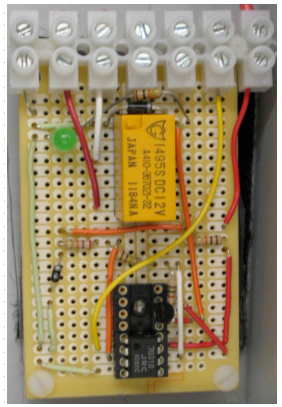
Power Management

- Cart must be sustained solely by a 12V battery with solar charger
- Use of a high efficiency voltage regulator to protect against dangerous spikes
- A charge controller is used to prevent overcharging of the battery
- A switching circuit (as shown below) could be used to turn off the cart at night; an automatic power save mode
- Total field longevity? To be tested…



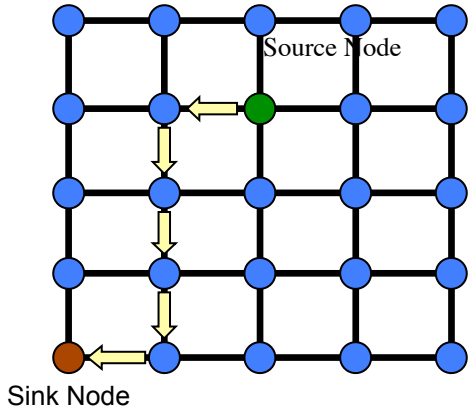


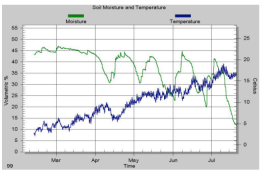


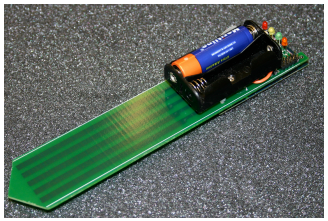


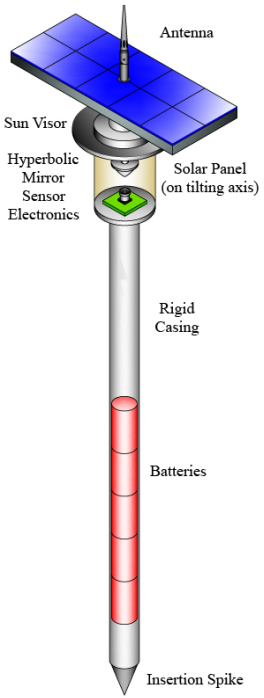
Further Applications?

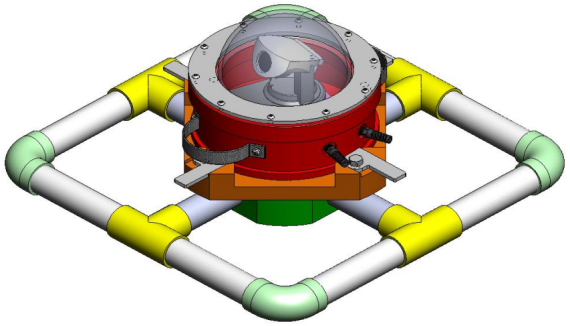
- Video sensor network control
- Allows remote access to testbeds
- Multi video-sensor control
- Extends sensor connectivity range to monitor larger areas
- Http:// access to view live video streams, manage servers, and network management











Deployment Plans

- Deployment at NFS in August 2009
  - Estuary location
  - Multi-camera (above-water) observation
- Use for outreach activities
- Use to enable observation by FS staff and visiting biologists

Summary and Conclusion

- Designed and developed a portable remote access point for enabling video recording and internet access
- Created a waterproof camera enclosure for use in the tidal zone
- Deployment summer 2009

Thank you for your time and attention.

Joe Wilinski, Aaron Ganick