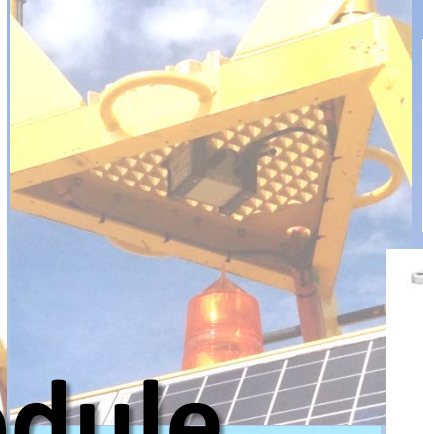
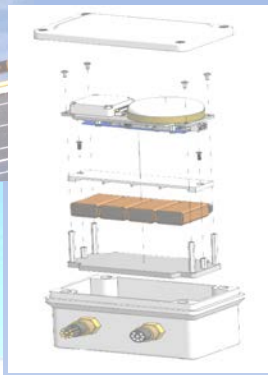
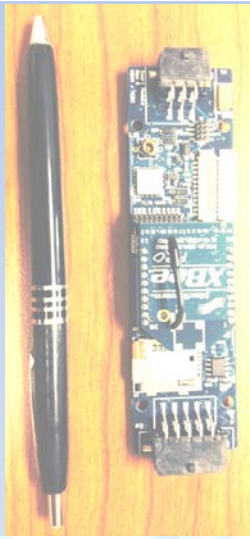
NDBC's Smart Module Applications







National Data Buoy Center

Stennis Space Center, MS.

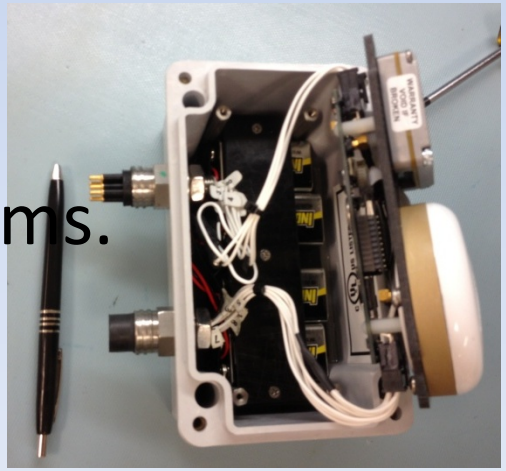
Rodney Riley

INMARTECH 2014, Corvallis Oregon

Smart Module History

- In 2008, started development to convert (dumb) analog sensors to (smart) digital sensors
  - Acquired analog data
  - Processed data
  - Provided a serial message to payload

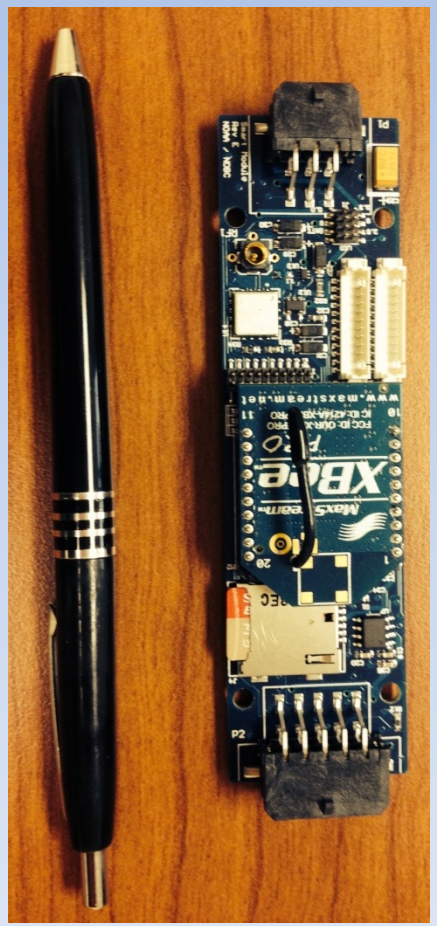
- By 2013, the development known as “Smart Module” had evolved into a building block for several NDBC systems.



Smart Module Patent Filed

Smart Module Features

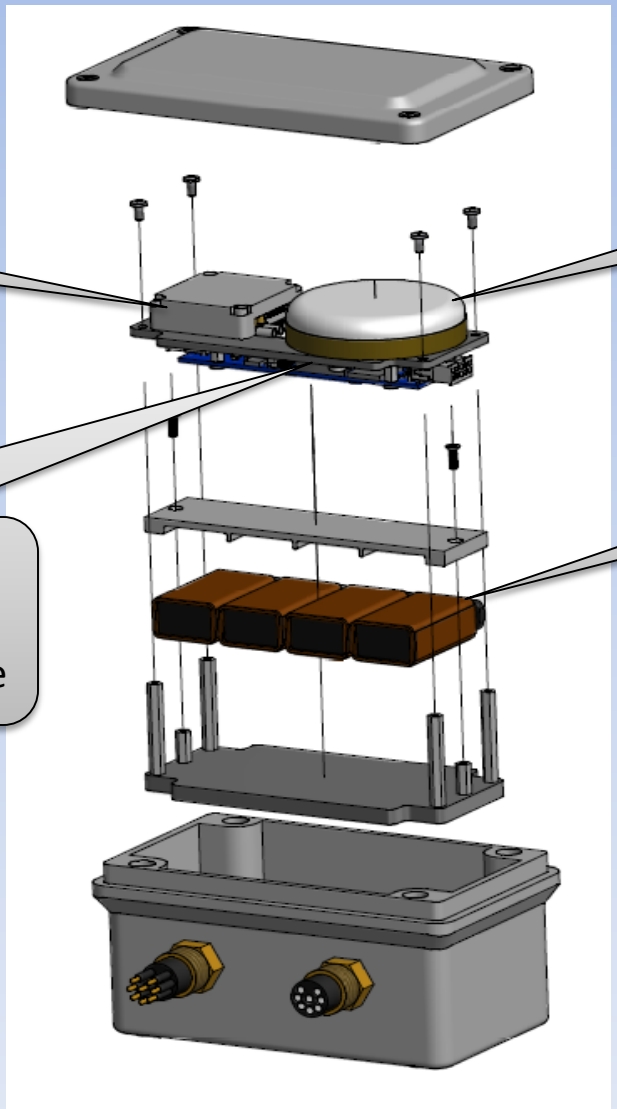
SM Board



Smart Module Patent Filed

- Very low power (12 µ Amps standby current)
- Compact (Board 10.2 x 2.8 cm & Enclosure 15.2W x 8.9D x 8.2H cm)
- Iridium short burst data (SBD) two way communications
- IEEE 802.15.4 Network (XBee wireless network)
- No exposed antennas
- GPS
- Compass with tilt and gyro correction
- 32 GB data storage
- MSP430 processor (very low power processing and control)
- Real Time Operating System (RTOS)
- Low cost (< $1K parts)
- 2 analog sensor ports with calibration function
- 1 serial sensor port (2 ports in wireless reporting mode)
- Switched Sensor Power port
- No external power switch – Always on
- Backup power for position reporting only (four, 9V batteries)

Smart Module Assembly

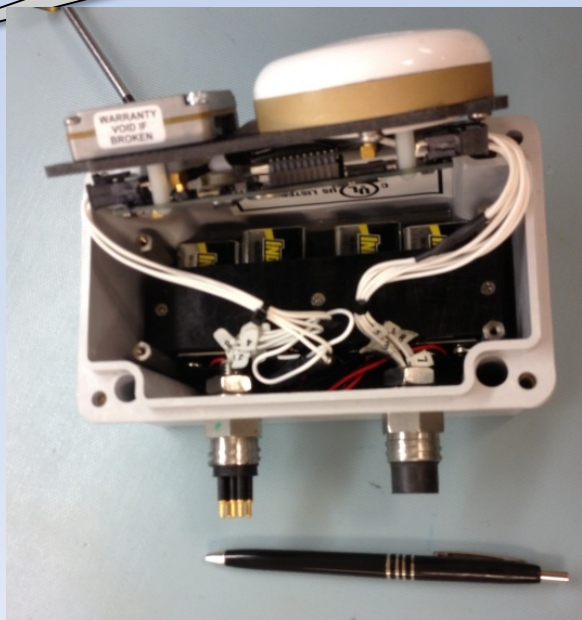


Iridium Modem

Iridium & GPS antenna

SM Circuit board with microcontroller, GPS chip, Micro SD card, & XBee wireless plug-in module

Four, 9V batteries



Smart Module Patent Filed

Smart Module Applications

- **Special Purpose Applications**
  - Smart humidity sensor
  - 3rd party sensor interface (National Marine Fisheries, NASA, Northern Gulf Institute)
  - Standalone Weather Station

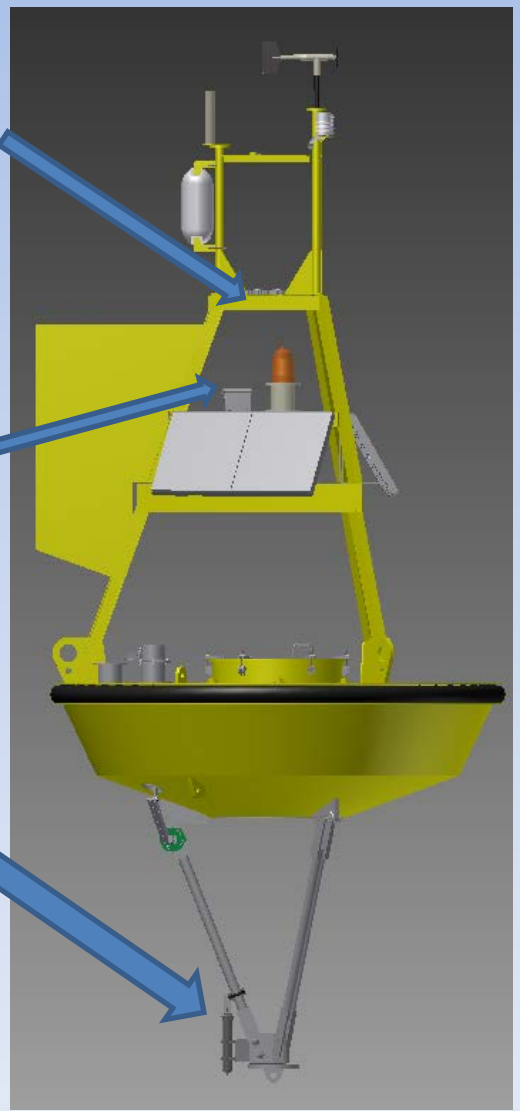
- **Operational Applications**
  - GPS position reporting (9V backup power)
  - Weather data transmission
  - ***BuoyCAM***
  - SCOOP

Smart Module Patent Filed

Fish Tracker

SMART MODULE:
- **Controls power to receiver**
- **Receives sensor RS-232 data messages**
- **Processes sensor data**
- **Transmits sensor data to shore**

NOAA's Southwest Fisheries Science Center partnered with NDBC to add a standalone system to an NDBC Weather buoy to report acoustic pings from fish tags.



Smart Module Patent Filed

Lightning Detection

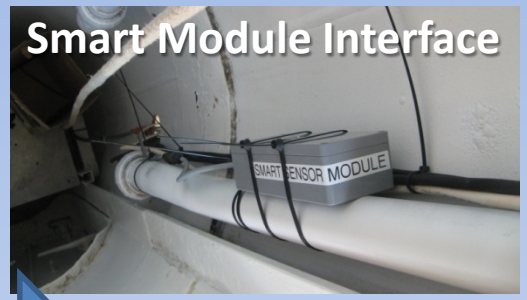
SMART MODULE:
- **Controls power to sensors**
- **Receives sensor RS-232 data messages**
- **Processes sensor data**
- **Transmits sensor data to shore**

Installed electric field sensors (lightning) on two 3-m buoys to support NASA engineers project

Smart Module Patent Filed

CDOM, Turbidity & Chlorophyll

Analog Sensors



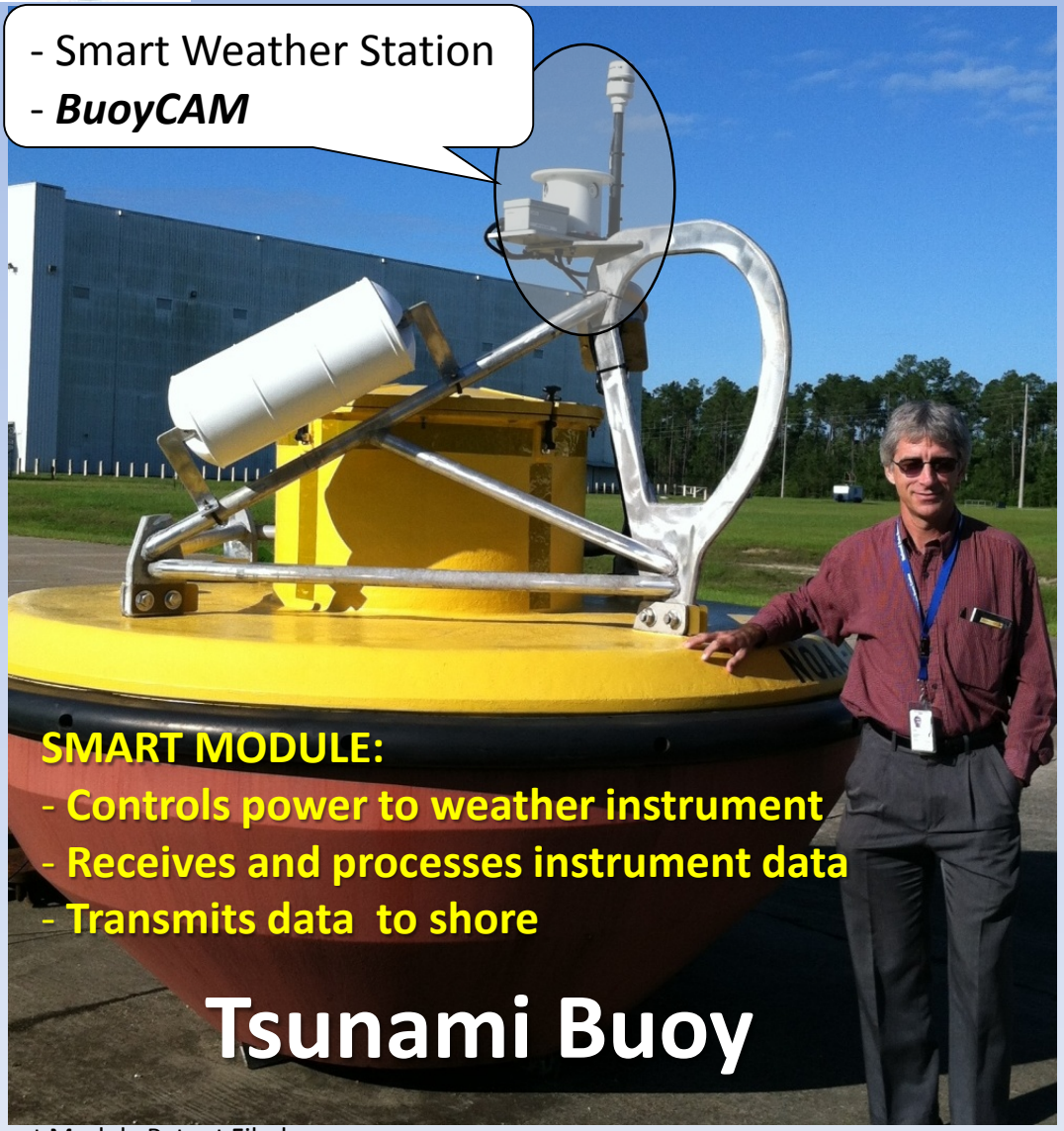
SMART MODULE:
- Controls power to sensors
- Processes sensor data
- Sends sensor data message to buoy system

Processed Data to Buoy Transmitter

Northern Gulf Institute sensors were added to 10-m buoy in Gulf Of Mexico

Standalone Weather

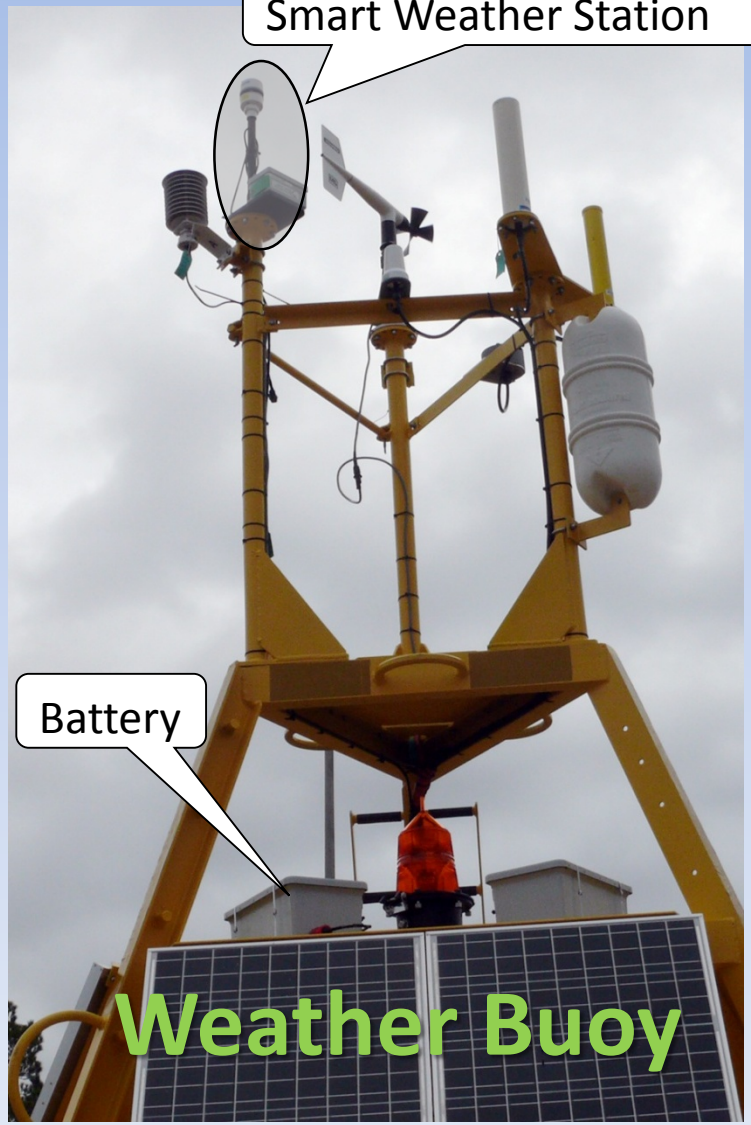
- Smart Weather Station
- ***BuoyCAM***



SMART MODULE:
- **Controls power to weather instrument**
- **Receives and processes instrument data**
- **Transmits data to shore**

Tsunami Buoy

Smart Weather Station

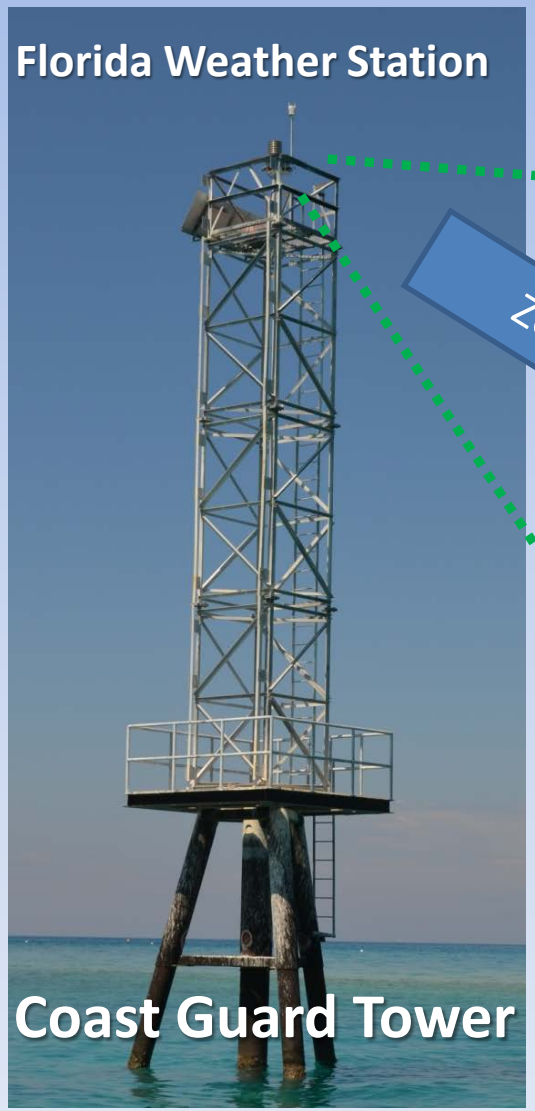


Battery

Weather Buoy

Smart Module Patent Filed

Standalone Weather



ZOOM

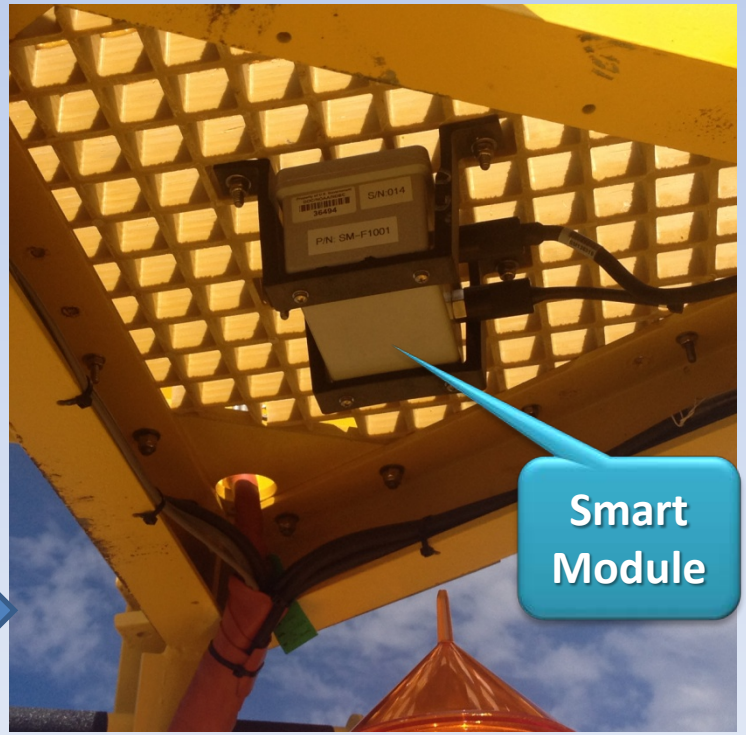
Smart Module Patent Filed

Transmitter Application

- ✓ Backup GPS position reporting (internal 9V)
- ✓ Backup weather data reporting
- ✓ Mounted in protected area

ZOOM

ZOOM

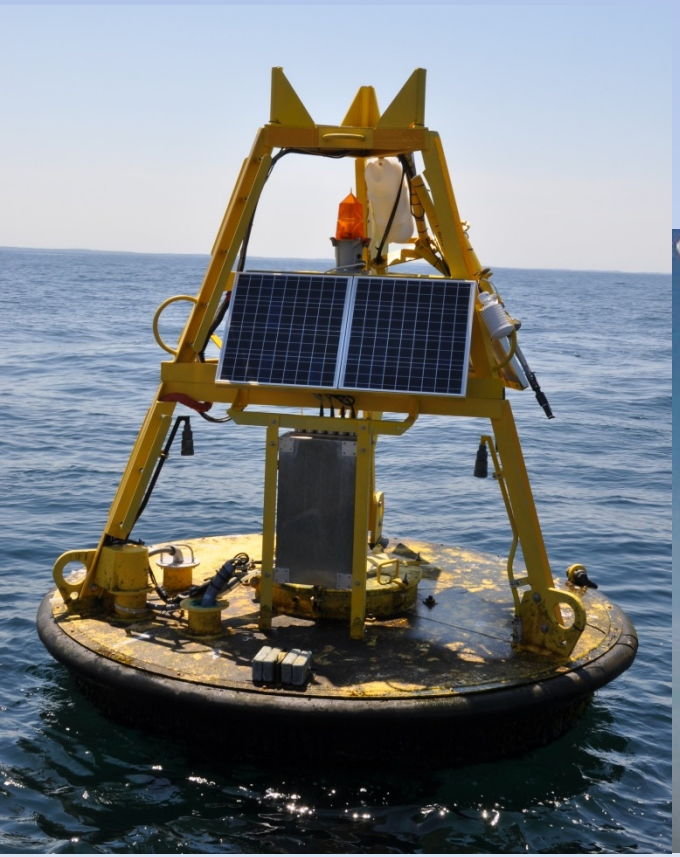


3 Meter Weather Buoy Application

Smart Module Patent Filed

Transmitter Placement Matters

Storms & Ships can be rough on buoys



Smart Module Patent Filed

44013

46011

42007

Backup Transmitter

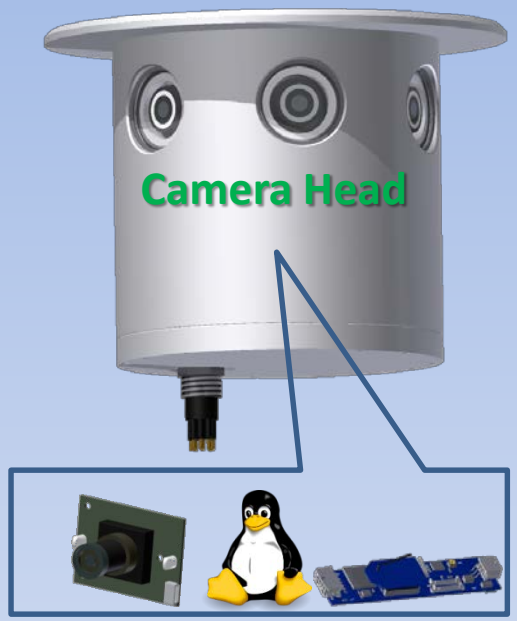
Backup transmitter on Florida CMAN station has provided weather data after primary GOES transmitter system failed

Smart Module Patent Filed

BuoyCAM

CAMERA HEAD

- 5 cameras
- Ocean environment enclosure & lens
- Embedded Linux processor
- ***Smart Module***: Controls power and housekeeping



TRANSMITTER & BATTERY

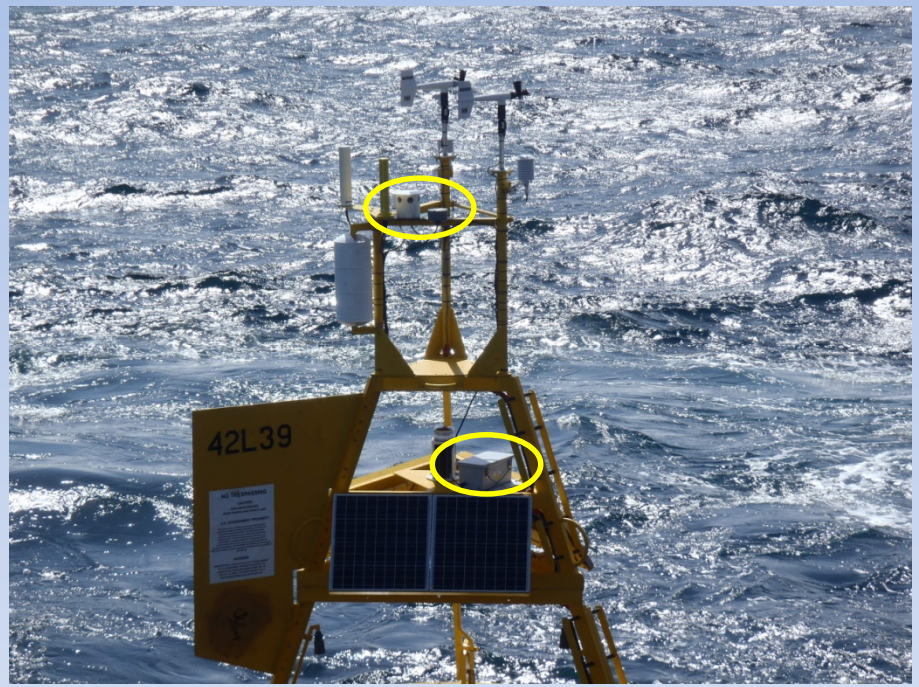
- ***Smart Module***:
  - Transfers pictures from Linux system using off-the-shelf "XBee" Wi-Fi module
  - Controls Iridium RUDICS modem to transmit pictures to shore

- Lithium battery supply

Smart Module Patent Filed

BuoyCAM

Weather Buoy Installation



TAO Installation

Sample Pictures

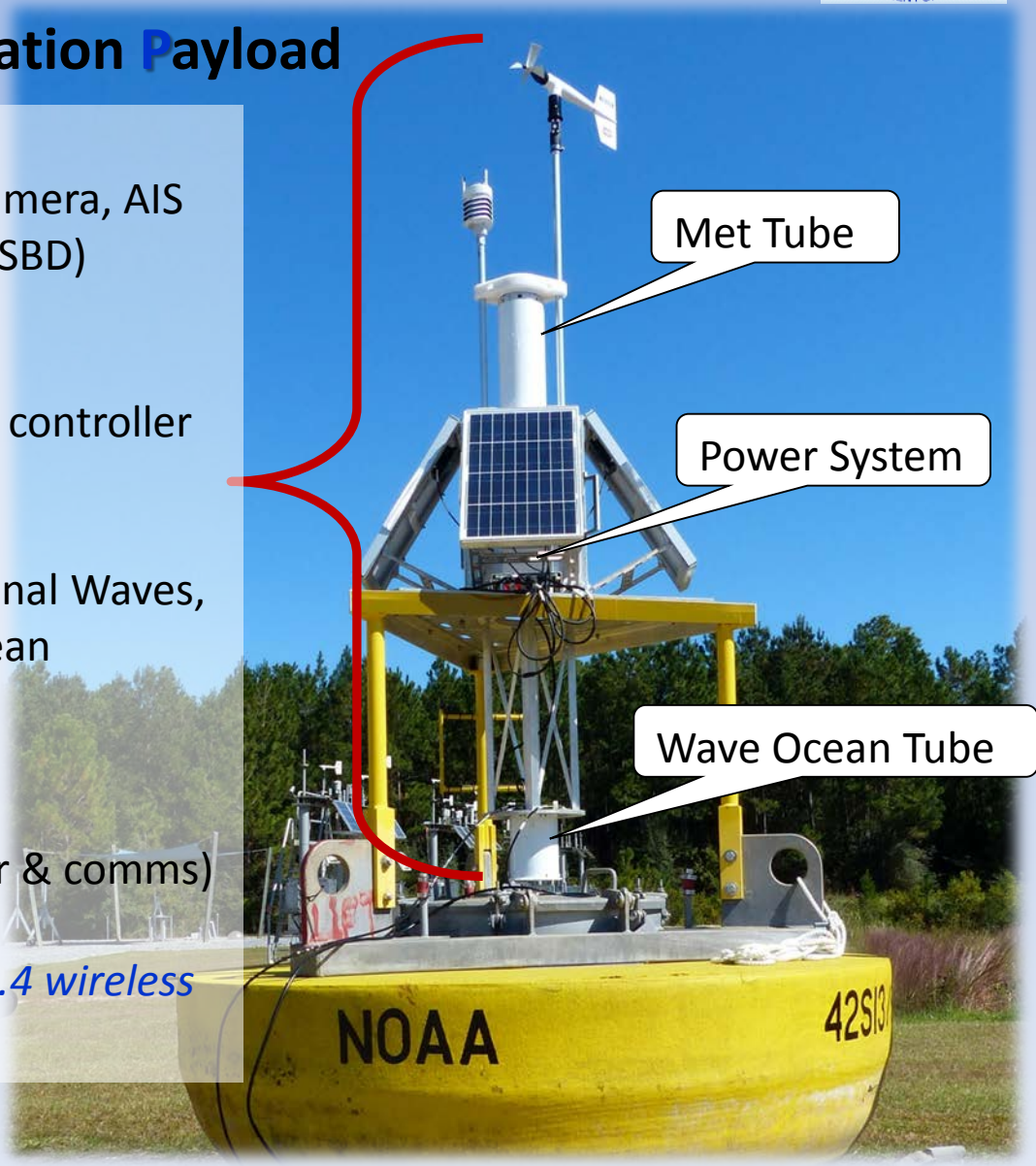



SCOOP

Self-Contained Ocean Observation Payload

- MET Tube
  - 5 SM's control & interface MET, Camera, AIS Rx'er, Iridium modems (RUDICS & SBD)
- POWER
  - 1 SM interfaces to a smart battery controller
- WAVE & OCEAN
  - 2 SM's control & interface Directional Waves, Sea Surface Temperature, and Ocean Temperature profile (9 depths)
- Auxiliary Tube - NOT SHOWN
  - 1 SM for 3rd party interface (power & comms)

All SM's communicate on a IEEE 802.15.4 wireless network



Smart Module Patent Filed

Smart Module Benefits to NDBC

- Less cost than present backup data transmission & position reporting systems
- Increased reliability of NDBC data reporting
- Less risk to NDBC mission critical systems for 3rd party sensor Interfaces
- Building block for different applications (i.e., re-usable)
- Less development effort than larger more complicated NDBC devices

Smart Module Patent Filed

THANKS !!!

Smart Module Patent Filed