"The present state of In-situ Wave Data processing and real-time data transmission from seabed instrumentation"

Torstein Pedersen
Nortek AS

Real-time Systems

Real-time system =

"Robust, operational method of getting data to shore within a timeframe of validity with a reasonable interval between scheduled service visits"

"Timeframe of validity":

Winds	**5 – 30 min**
Currents	**30 – 60 min**
Waves	**60 – 180 min**

Bonus options include:

Two-way data telemetry
- **Change sampling scheme**
- **Poll instrument for data**

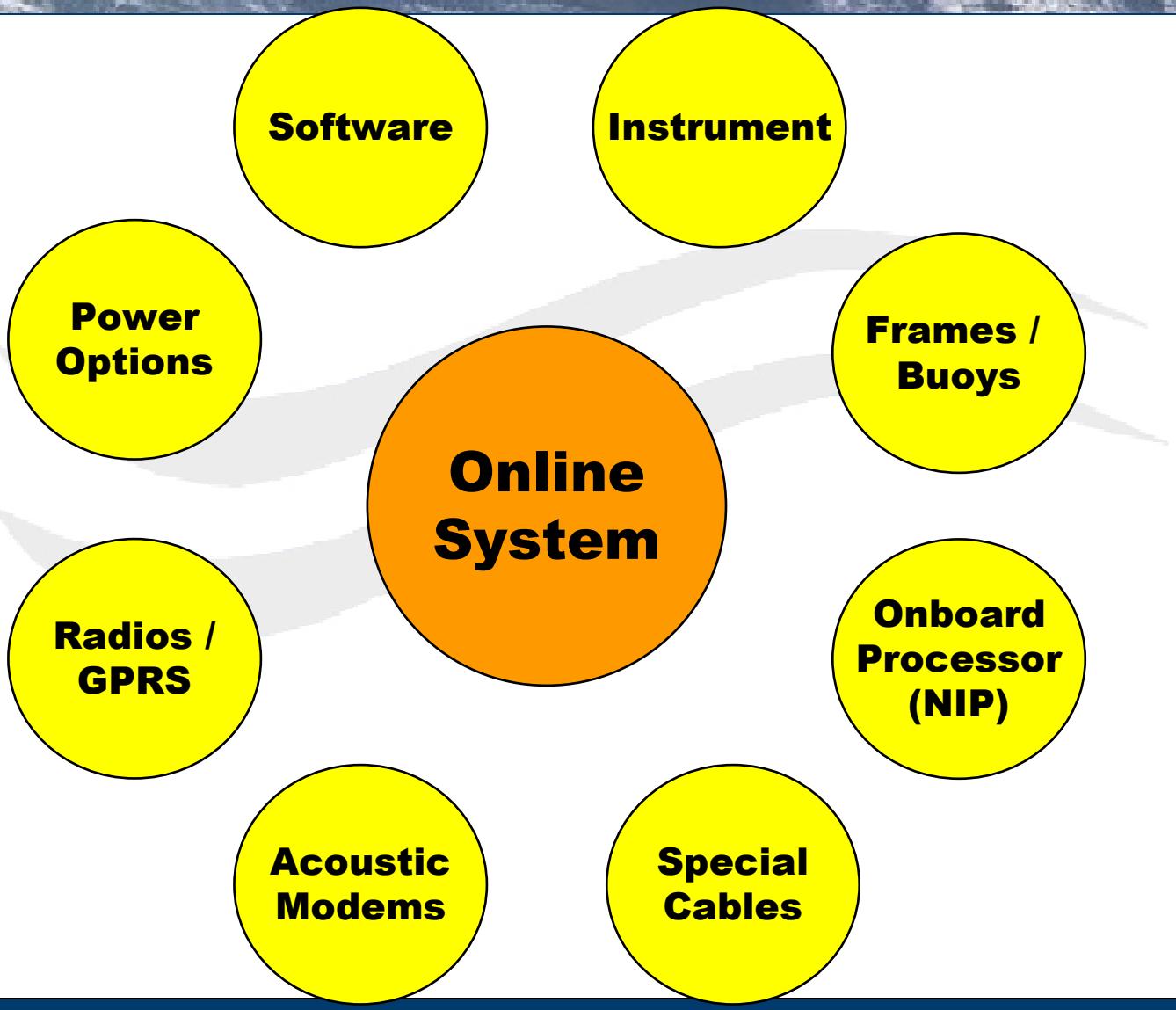
Continuous power supply
- **Direct from shore**
- **Solar, wind, etc**

Real-time Systems

Several Options Available:

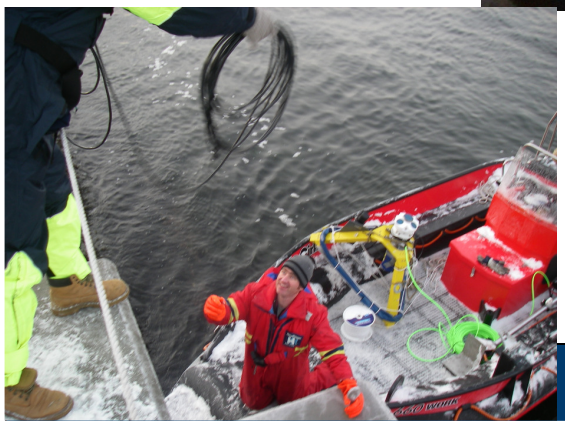
- **Cabled bottom mount**
- **Surface buoy mount**
- **Underwater modem to shore**
- **Underwater modem to tower**
- **Underwater modem to buoy**
- **Cable to buoy**
- **Subsurface buoy**
- **Platform mount on tower**

Nortek's Role



NORTEK AS

Online Group



Data Telemetry and Power

Objective is to provide an overview of available options associated benefits/limitations.

** Every locations has unique requirements

Factors defining Telemetry method:

- Fishing activity
- Surface traffic
- Range
- Hydrographic conditions
- Bathymetery
- Interference sources

Tools and possibilities for Interfacing w/ Nortek

Nortek External Power Supplies

4x

50 Wh

Small AA: alkaline/Lithium Ion

165 Wh

Lithium PulsesPlus

540 Wh

Large D: Alkaline

2x

1200 Wh

Lithium metal hydride

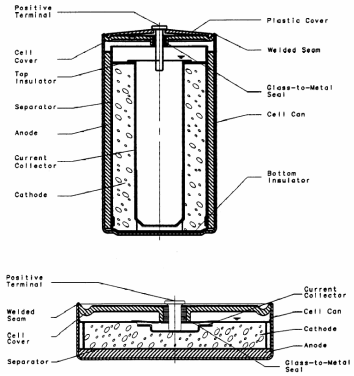
Lithium Batteries

Pulses Plus

Hybrid combines bobbin type Li/$SOCl_2$ with a capacitor

High energy denisty that allows for loads periodic high current draw or pulses

Same operating life with smaller size for use in GPSIice buoys. Oceantronics' original battery pack (left) used 380 alkaline D cells (54 kg). The new battery pack (right) uses 32 lithium thionyl chloride D cells and four hybrid layered capacitors (3.2 kg).



Doin' it yerself Power Supplies

Considerations:

Minimum voltage 8.5 V

Maximum voltage 18 V

Stiff vs. soft

DC-DC converters min 1.5-2 amp supply

Charge Systems

Solar panel

Regulator

Battery Bank

”Standard Kit”

Panel Orientation

- **Fixed: orient South**
  Vertical angle = Latitude

- **Buoy: figure 2-4X panel requirement**
  Vertical or on top of buoy

Specifying a Solar Charge System

Battery Bank

Plan for 30 days of no sun (ref. UK)

Sealed gel-cells (little to no ”gassing”)

Regulator

Avoid damaging batteries

- Disconnect panels if batteries reached max
- Disconnect load if batteries drop below critical voltage

Specifying a Solar Charge System

Panels

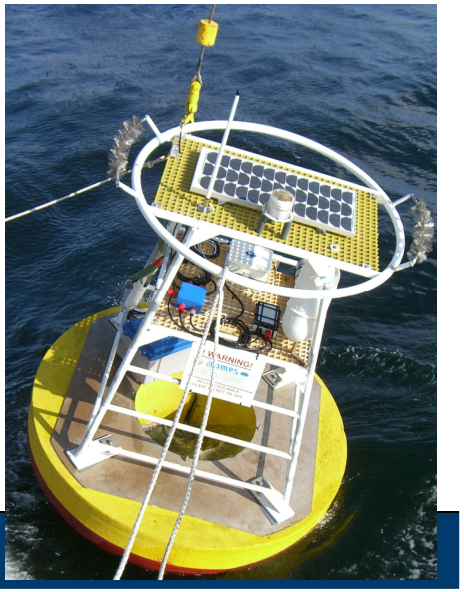
Estimate lowest Peak Power: Winter
In UK 1-2 hours/day in Jan&Feb (available from manufacturers)

Power consumption per day:
AWAC 1 wave burst/hour => 10 Wh/day
Worst case is 1 hour so 10 Watt panel (buoy 20-40 W)

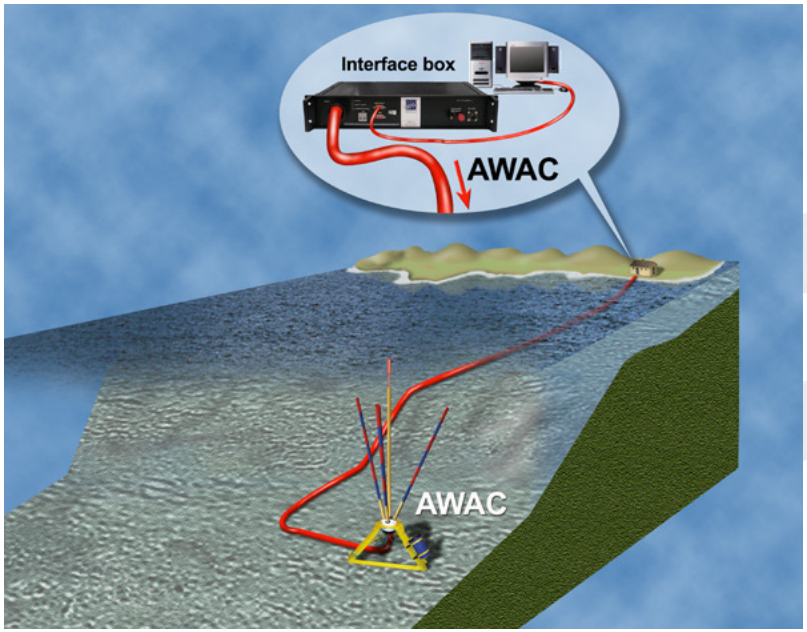
On land be careful of shading: 1/10 coverage leads to ¼ power output loss

Types:
Aluminum frame
thin SS (2X price)
Flexible (lower power, more expensive)

Siemens/Shell/BP



Cabled Bottom Mount



Advantages

- Deployment & sampling not limited by power requirements
- High bandwidth communications
- Direct communication for diagnostic and configuration changes
- Low maintenance
- Can measure waves from bottom mount

Limitations

- Concern for cable damage by recreational boating and fishing activities
- Backup battery should be in place
- Segments and break identification

Cable not without snarls

Offshore Cable

Offshore cable:

- 8 leads (RS 422)
- double jacket
- armored
- molded connectors
- Sync line for NIP on land
- $10/meter

Considerations:

- Use higher voltage (48V) DC-DC converter and backup battery
- Weight the cable
- Sements (200-500m)
- Strain relief
- Finding breaks (time domain reflectometer)

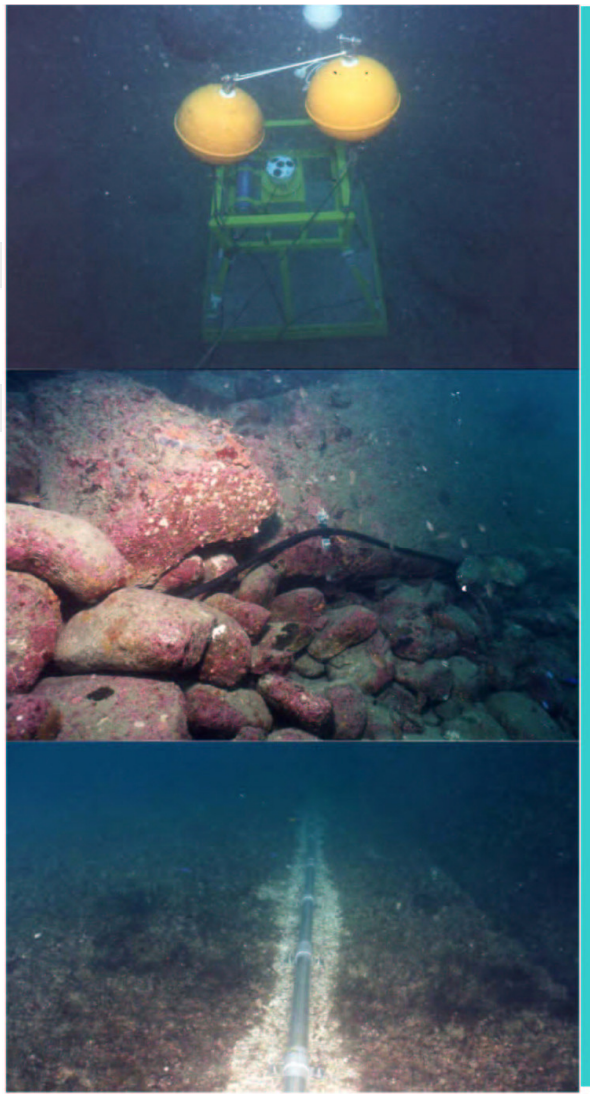
Cabled Communications

RS 232:Short distances (<50m)
- **Reference to ground**
- **High sensitivity to extern noise**

RS 422: Longer distances (<5km)
- **Reference to differential**
- **Lower noise sensitivity**

Instrument requirements:
- **Different internal harness**
- **Cable**
- **Converter at PC**

RS485:
- **Not full duplex**
- **Less expensive cables**



基隆港 AWCP 觀測站水下安裝及海底電纜固定狀況

AWAC Interface Box

Modem: GSM, RF, land

Lightning Protection

AWAC

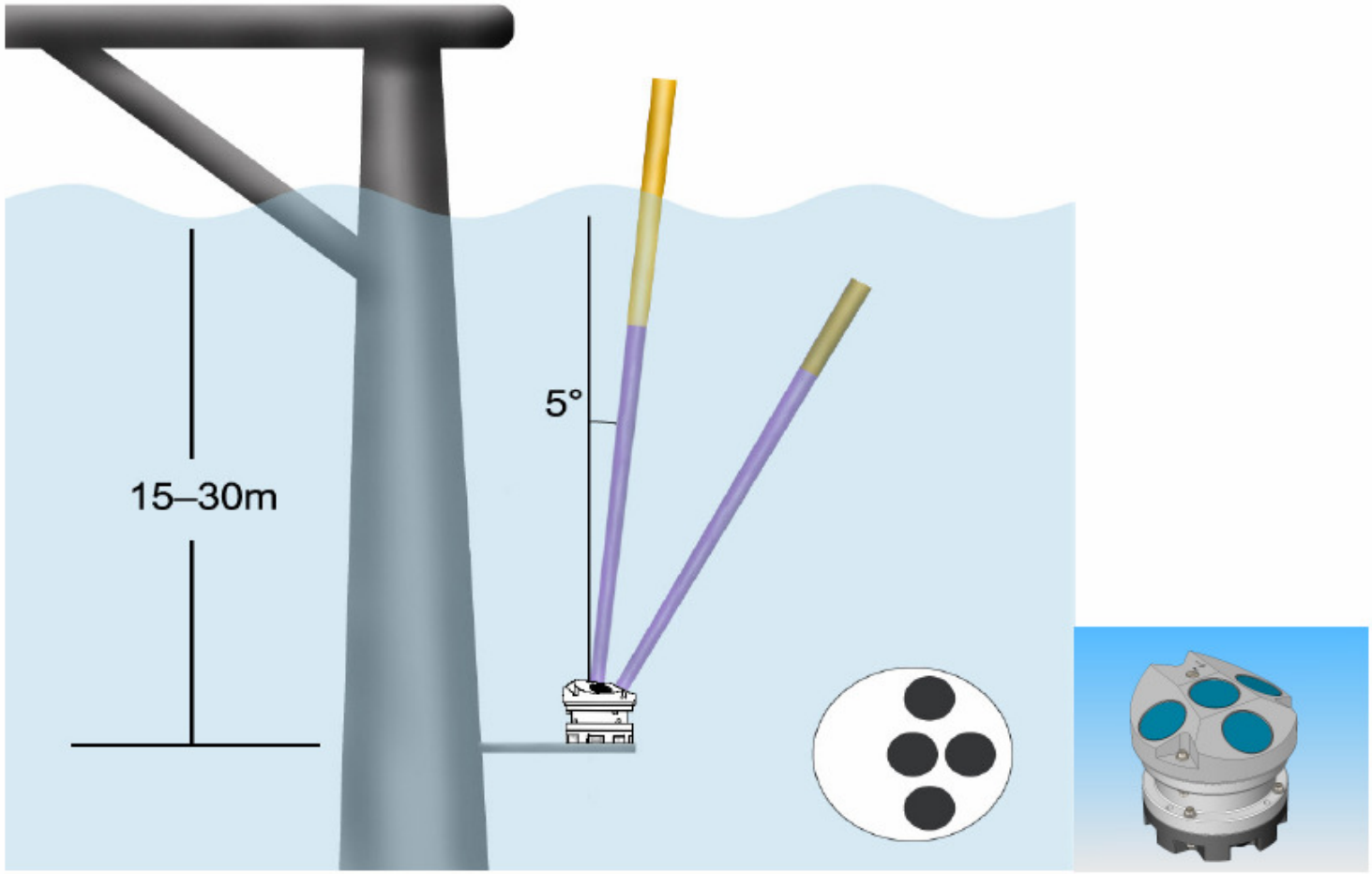
Modem

Backup Power

From AWAC

Network Power

Platform Mount - AWAC



Platform Mount - AWAC

Shell Oil
Gulf of Mexico

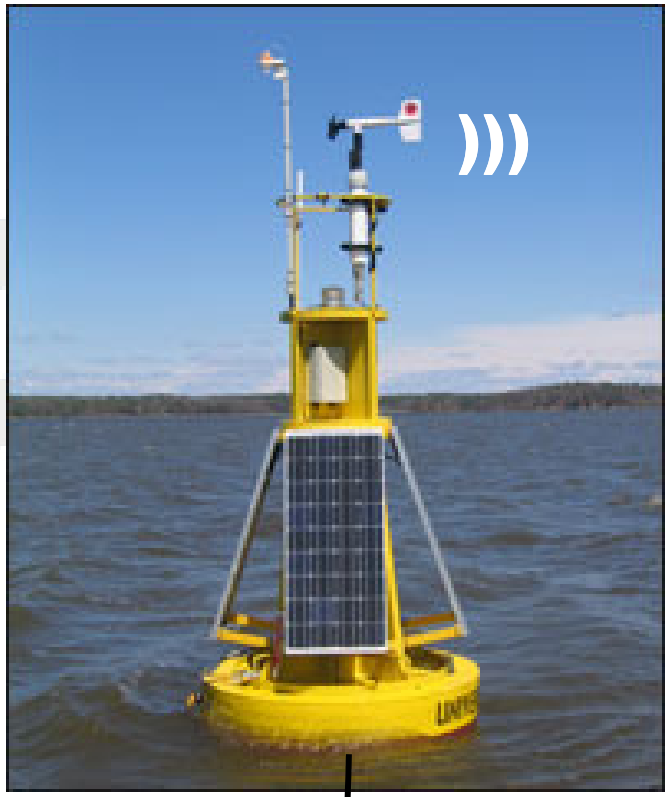
Platform Mount - AWAC

NDBC
Ambrose Light
Offshore NY Harbor

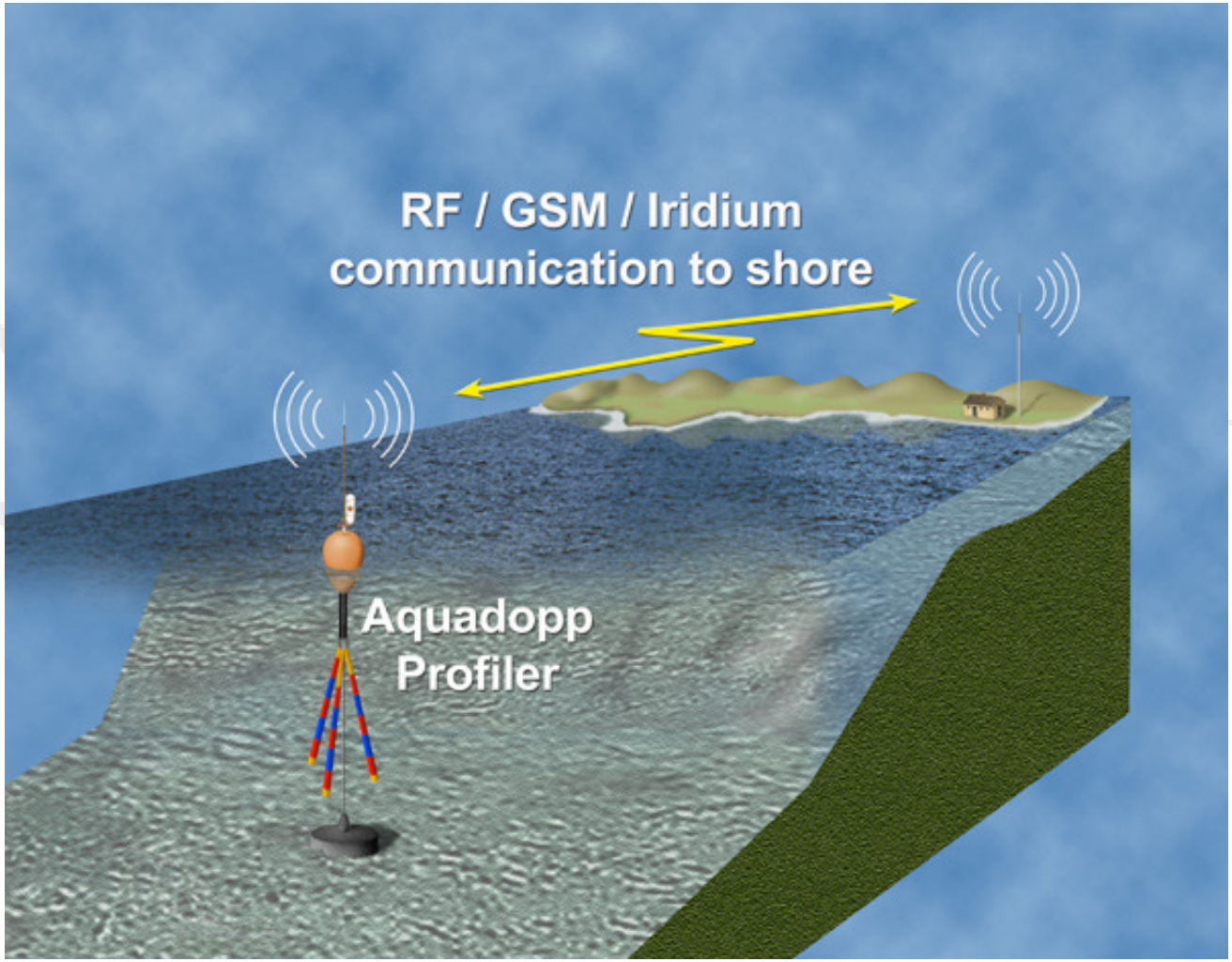
Cable to Buoy

Ru Morrison - http://www.cooa.sr.unh.edu/buoydata/buoy.jsp

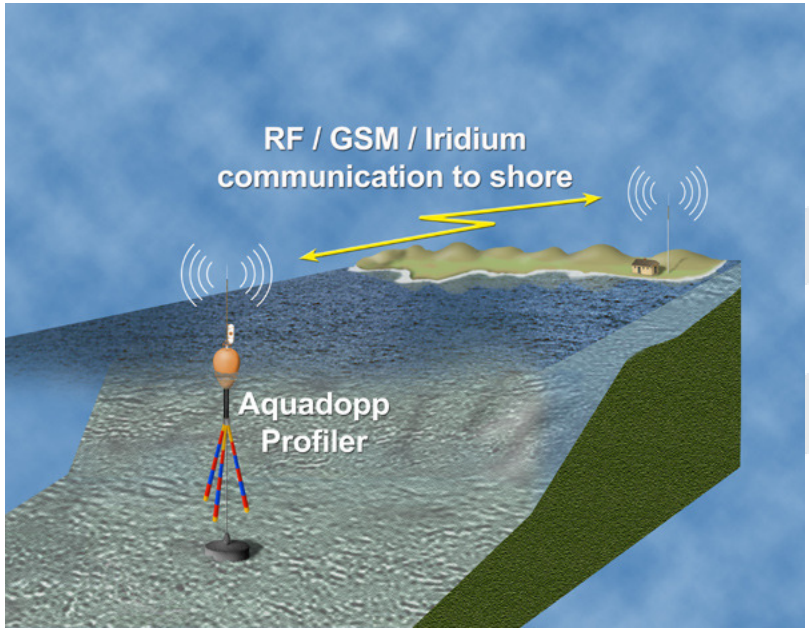
Cable provides power & data telemetry to buoy controller.



Surface Buoy Mount



Surface Buoy Mount



Advantages

- Does not require divers for deployment or maintenance
- Profile upper portion of water in deep-water applications
- Measure near-surface currents
- High bandwidth telemetry options
- Opportunities for charging batteries with solar or wind

Limitations

- Possible damage by ships, storms, ice & vandalism
- Cannot measure waves from buoys
- RF and GSM coverage difficult at some locations
- Compass calibration possibly necessary

Surface Buoy Options

Coastal Buoy

Buoy of Opportunity (ATON)

Offshore Buoy

Surface Velocity

Offshore Buoy

ATON Application

ATON System:

Saves cost & maintenance of own surface buoy

Puts wave & current data within navigation channels

RF Modems

What:
2.4GHz / 900 MHz license free band
Frequency hopping
spread spectrum
Different power levels

Why:
Good Range
Reasonably good bandwidth
Inexpensive

Considerations:
Power vs. range requirements
Anntena selection
Buffer size
Configurable baud rates
Sleep mode power consumption

Satel

Freewave

Maxstream

Less Expense

Range

Antennae

Antenna Gain (fixed vs. buoy)

covers 900MHz supports freq hopping

Fresnel zone/line of sight

Data rate (doubling => 30% less range)

6 dB change power => factor 2 range

Height is everything!!
10m 5x range than 2m

Vertical separation from other antennae

Yagi/Parabolic:
path study/accurate compass

GSM/GPRS/CDMA

Established network - Coverage dependent

Dependable

Reoccuring costs but low

GSM used in Taiwan & Norway
- No experience with CDMA

2-way communications

Underwater Acoustic Modem

Underwater acoustic modems provide for the advantages of bottom mounted equipment without requiring long cables for data telemetry

Limitations:

- **Low bandwidth telemetry (must use NIP for waves)**
- **Requires periodic battery replacement**
- **Robust telemetry? (horizontal, shallow water, thermoclines)**

Nortek Acoustic Modem

Benthos Technology

Features:

- Integrated with Nortek products for comms & power
- Special DC/DC converter for single power supply
- Operational & tested

Acoustic Modems

Considerations:

Vertical / horizontal transmission
Test modes – verify channel
Optimum location 1/3 from bottom

Challenges:

Background noise sources:
Sea State, shipping
low bandwidth
regular service schedule
depth/range => aspect ratio
Two way challenging - retrys
Bubbles

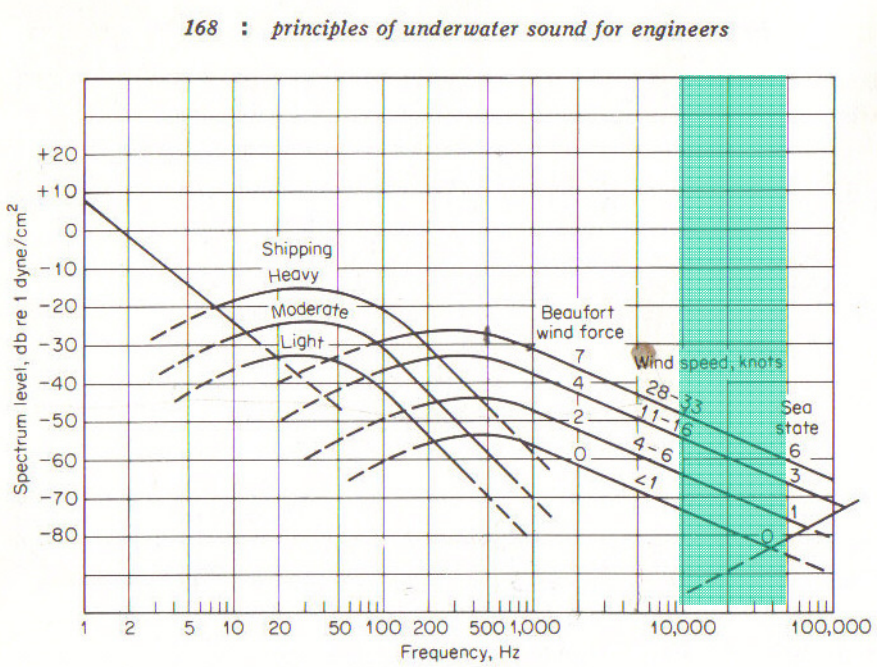
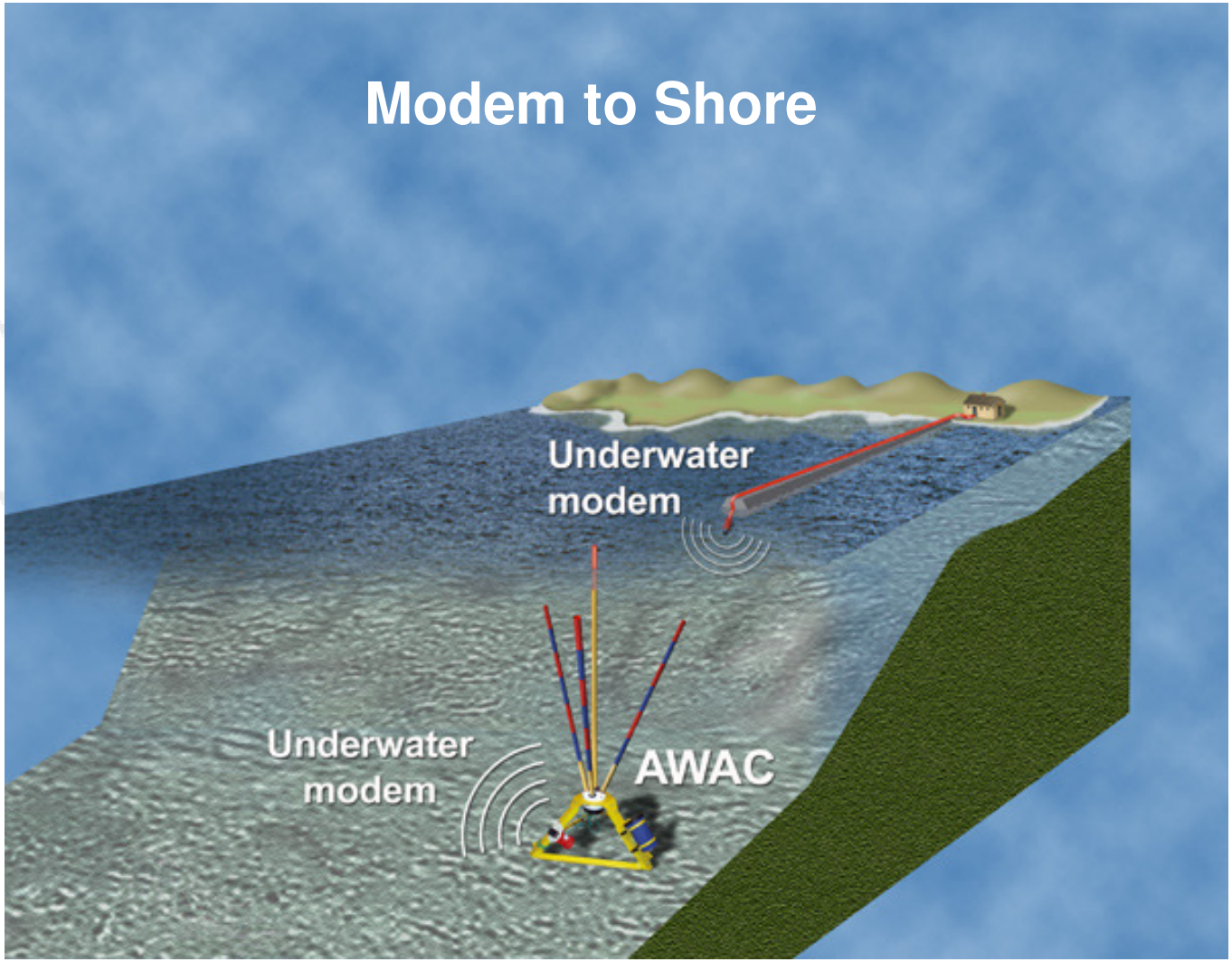


FIG. 7.5. Average deep-water ambient-noise spectra.

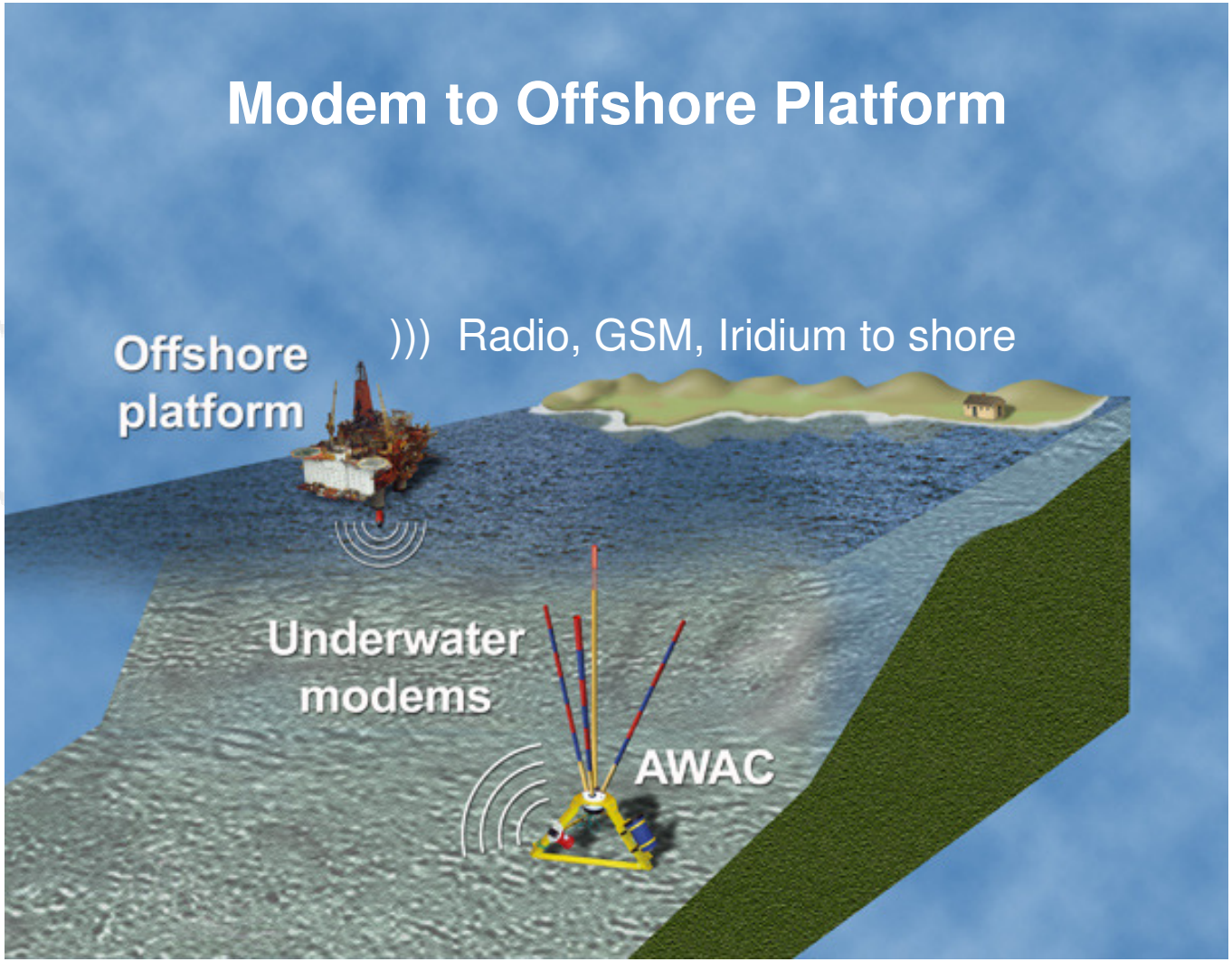
Expectations:

Baud	Range (m)
2400	800
800	1100
300	3000

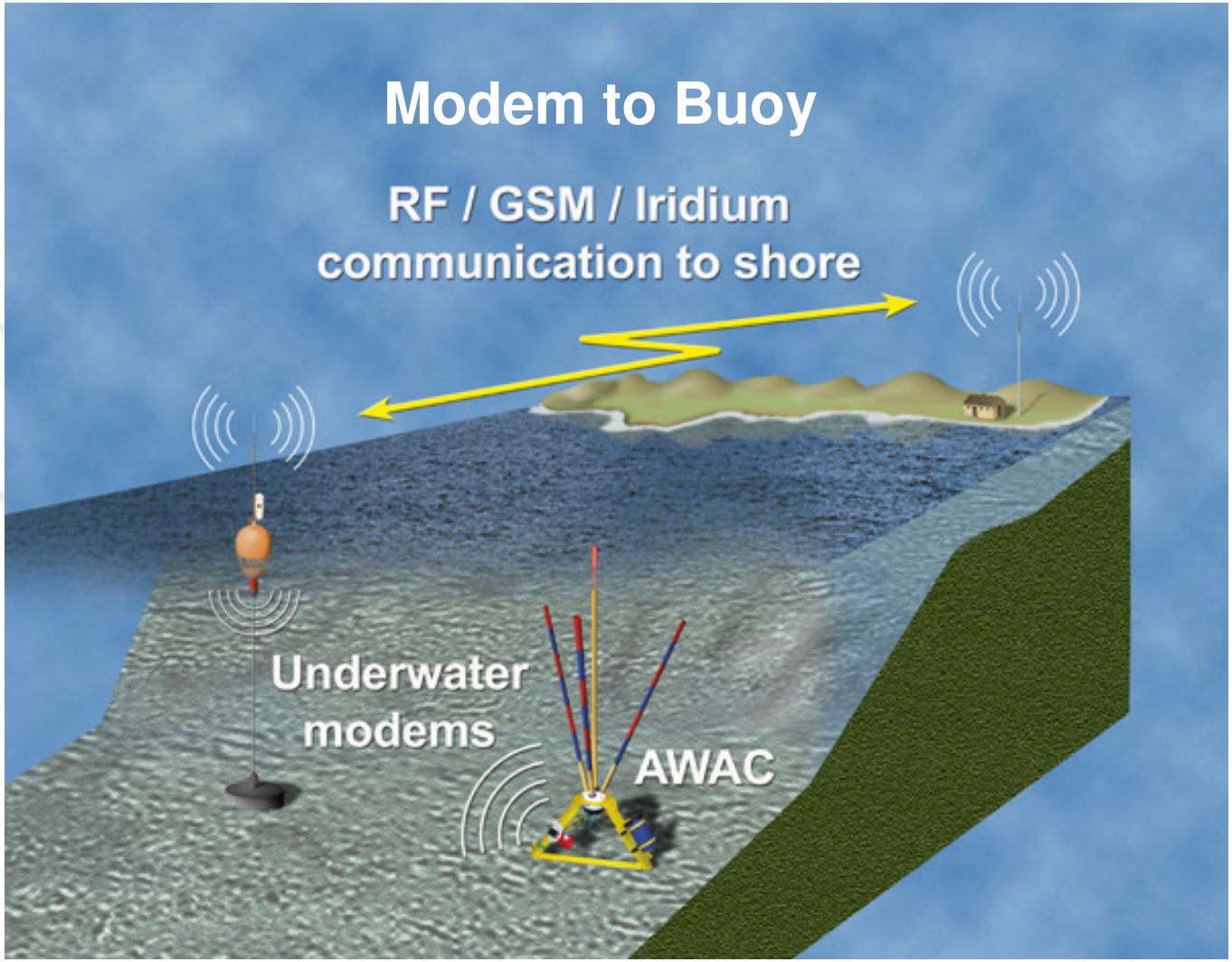
Modem Applications



Modem Applications



Modem Applications



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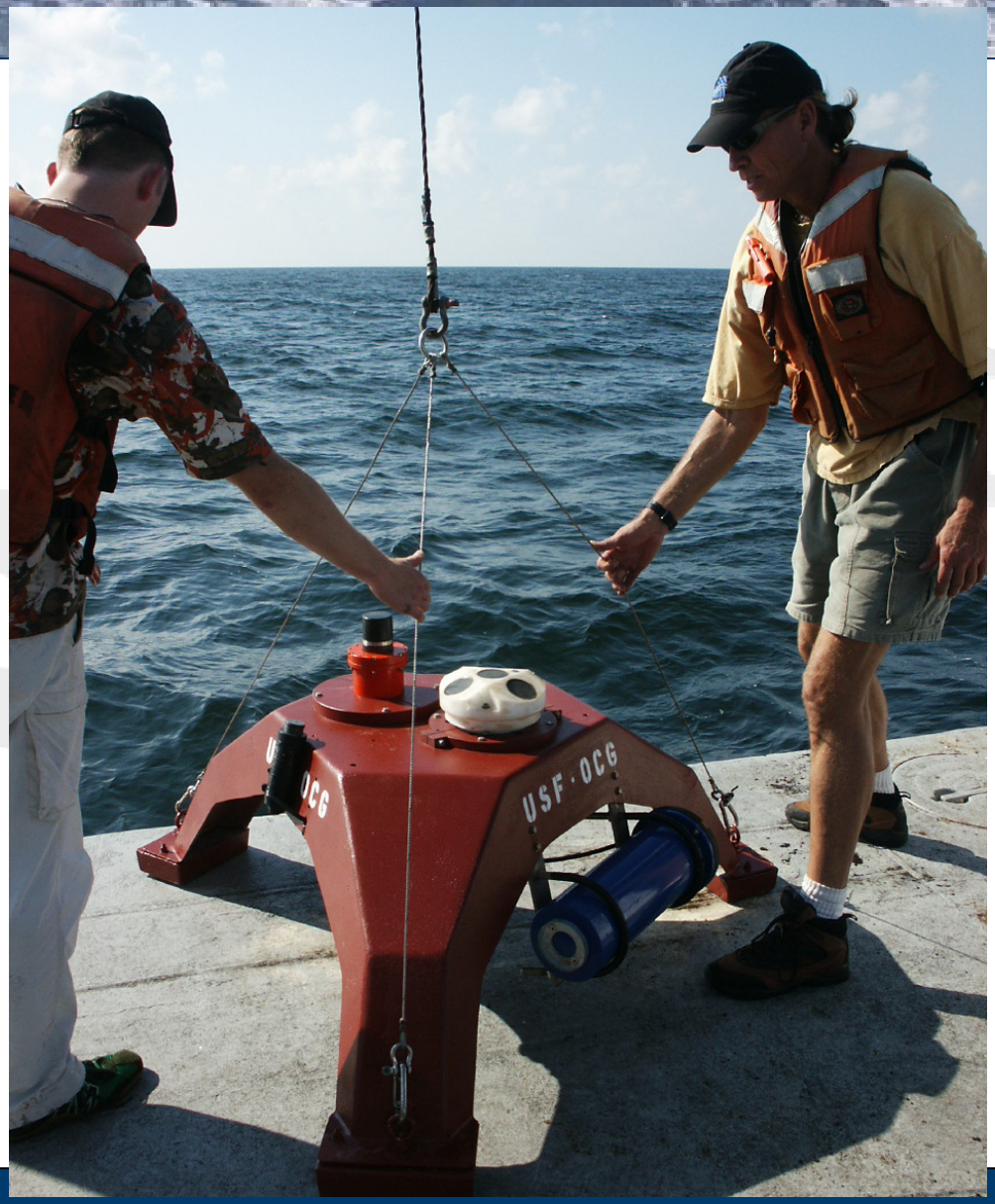
USF - SEACOOS



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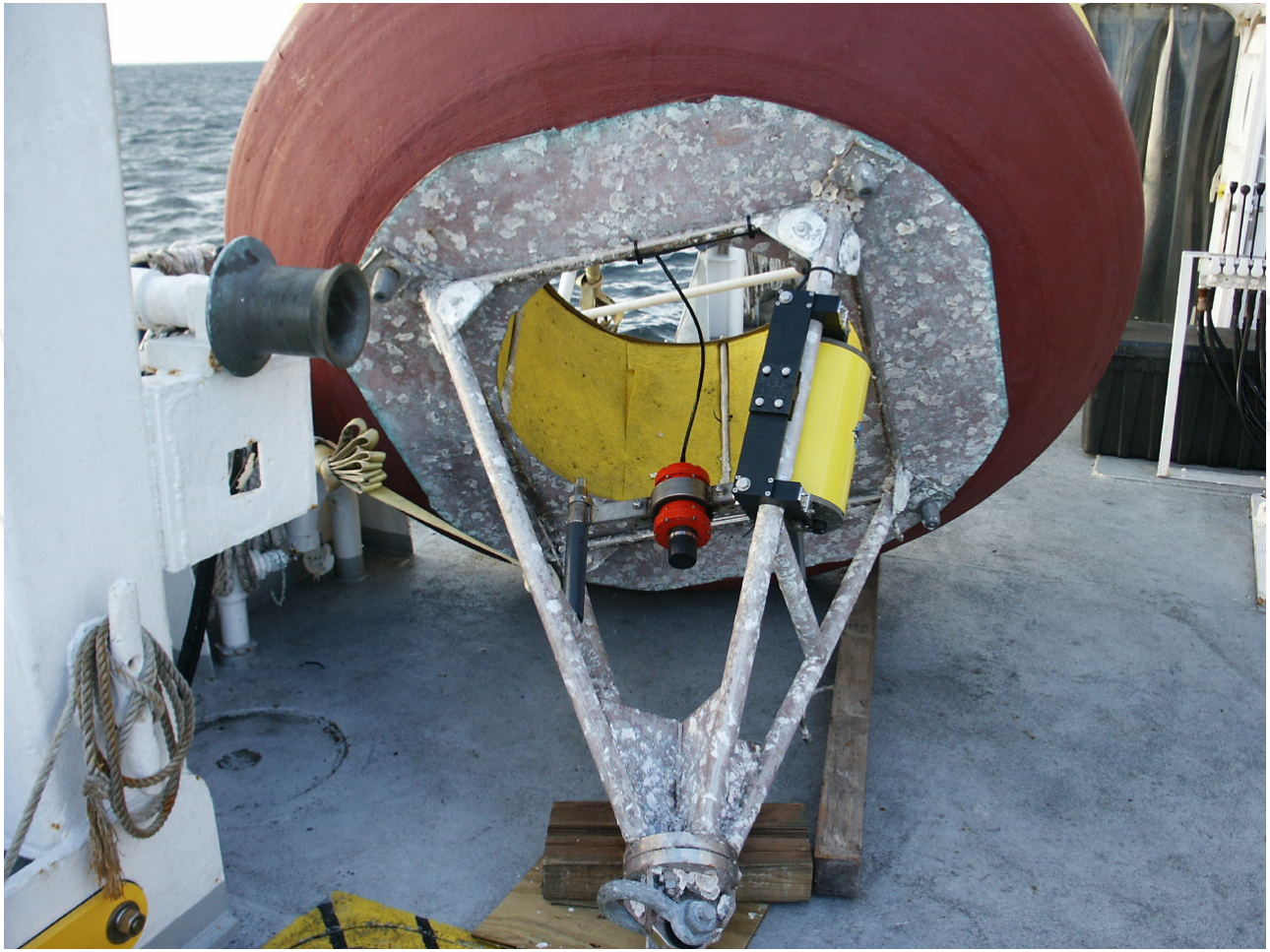

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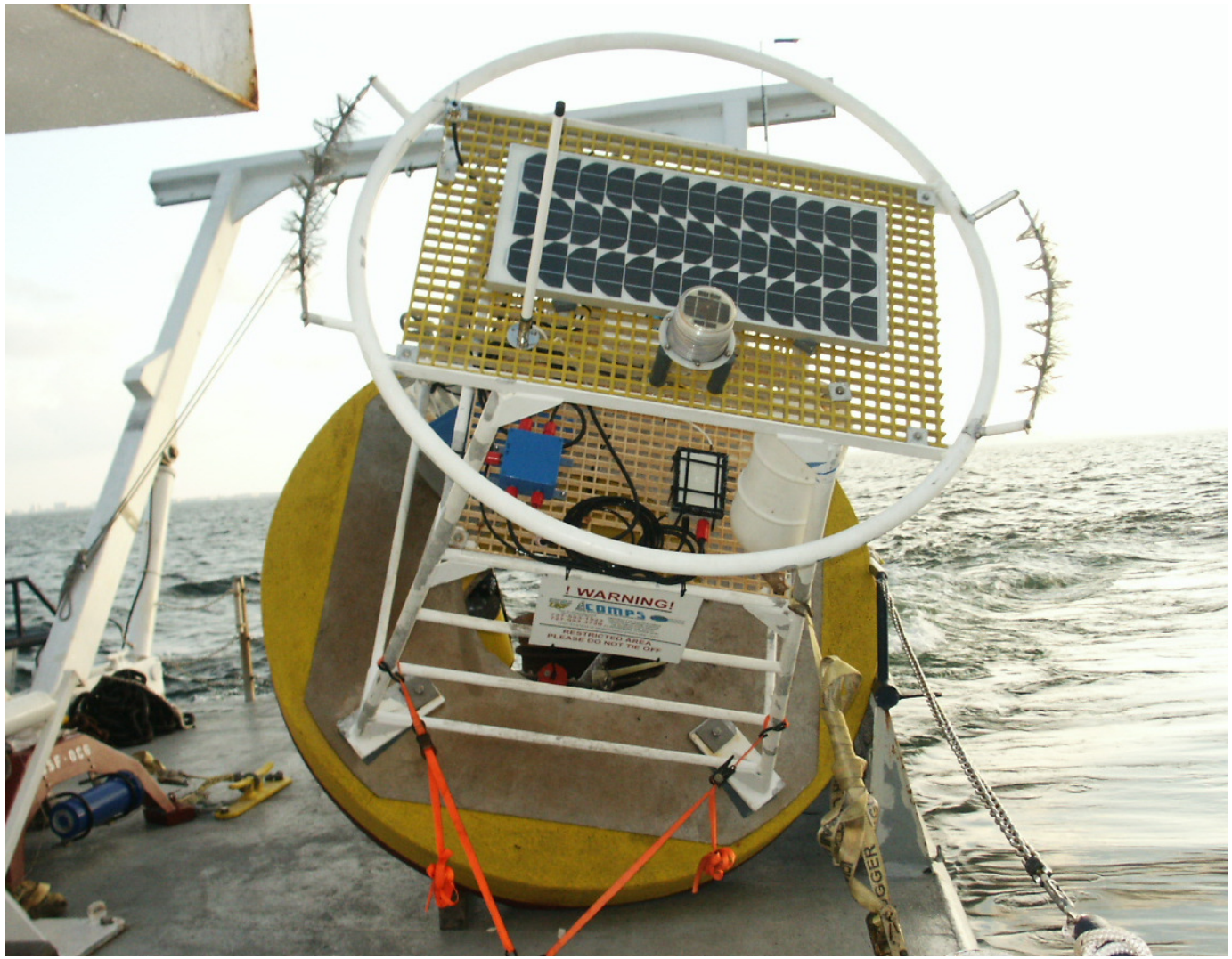
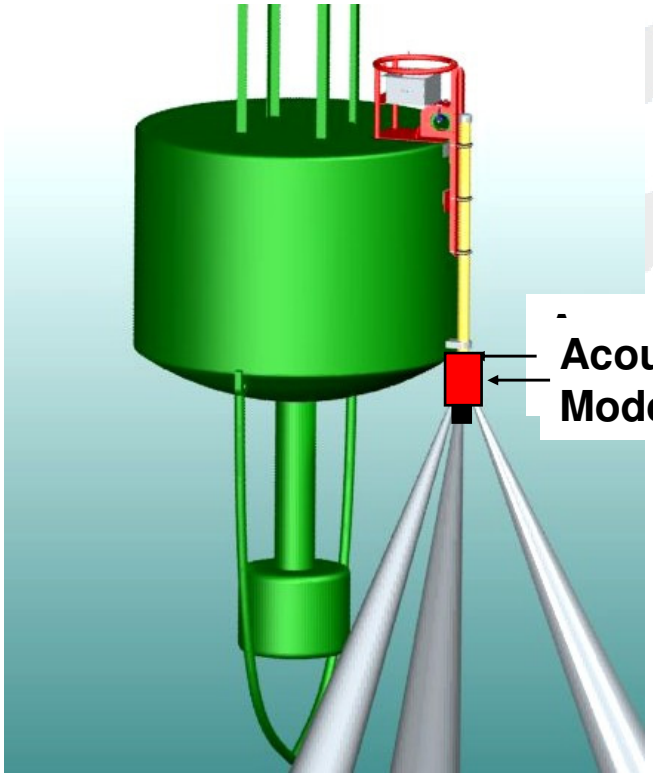


USF - SEACOOS

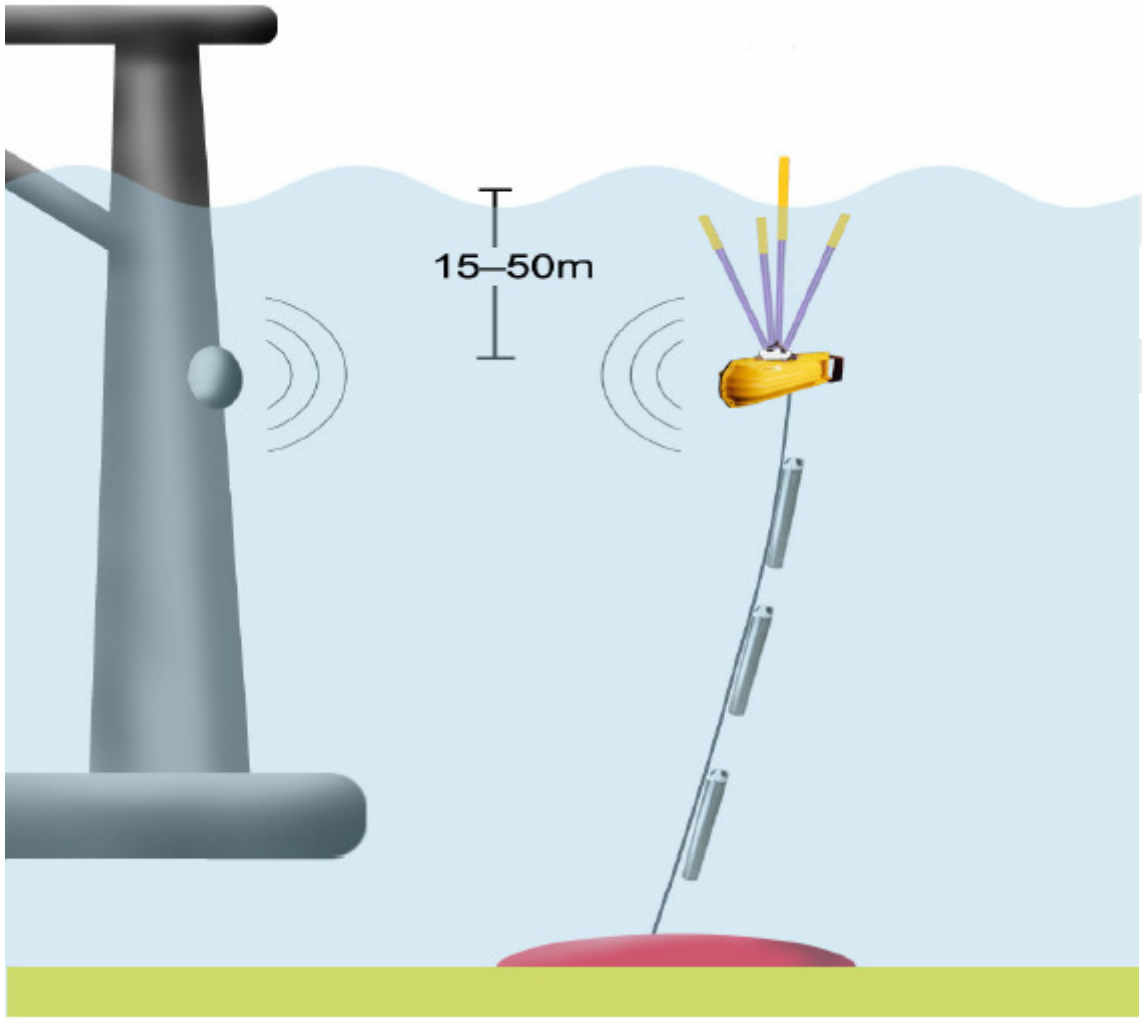
ATON Application

ATON System:

Using "Clamparatus" system on ATON buoy for underwater modem



Subsurface Buoy



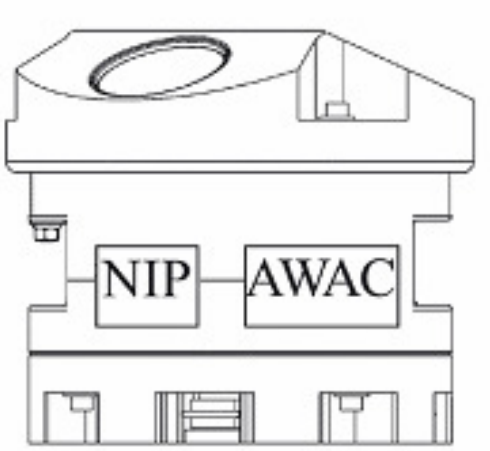
Deep water locations

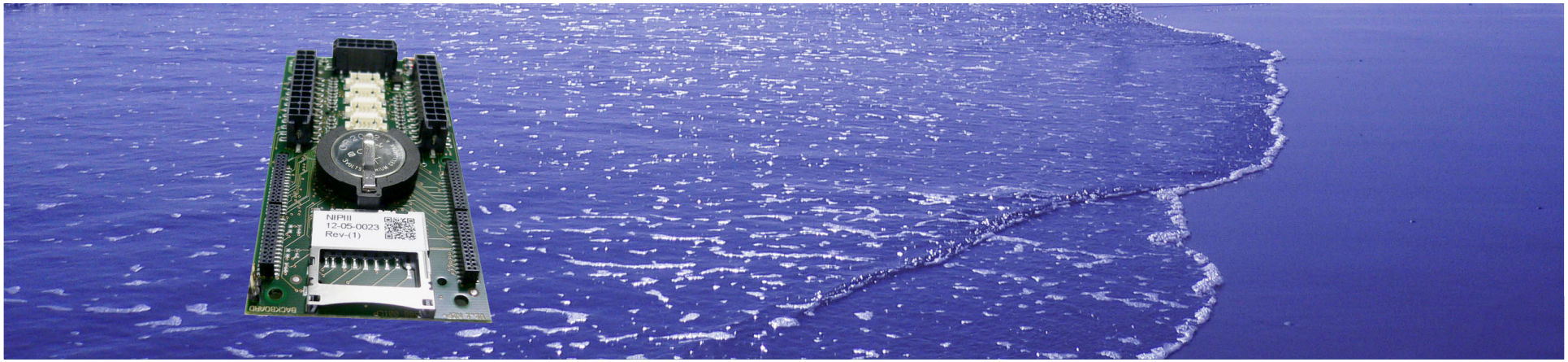
SUV processing

Data Management

NIP - Introduction

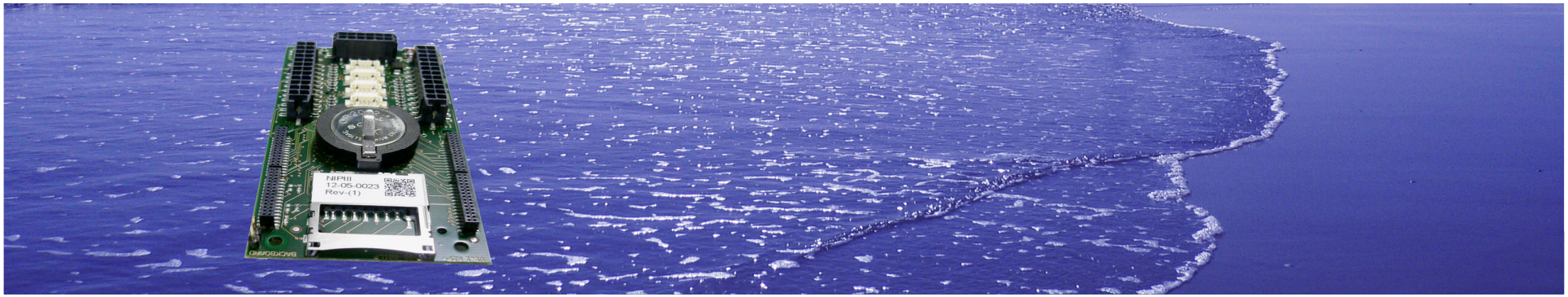
- **A wave processing module**
- **An online module**
- **Small computer**
- **Between user and AWAC electronics**





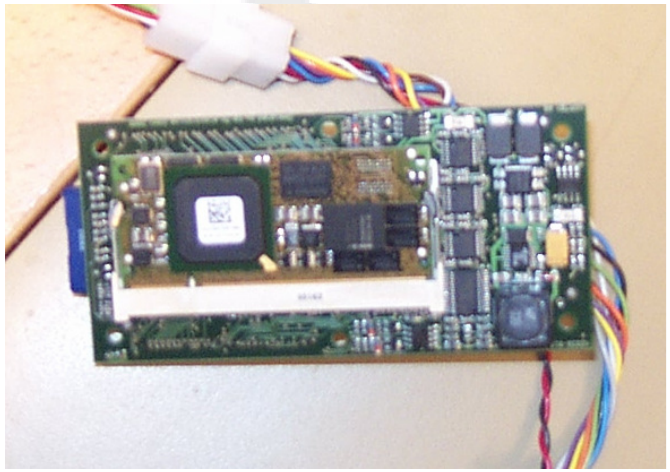
NIP: Functional Description

- **Transforms raw data to wave estimates**
- **Reducing data : ~50 kbyte to ~100 byte**
- **Available data**
  - Sensor
  - Profile
  - Wave parameters (hight, period, direction)
  - Wave spectra (energy, direction)
  - Time series
- **ASCII and binary data**
- **Polled mode or master mode**



NIP: Details

- **Small single board computer**
- **Powerfull processor**
  - Intel XScale PXA 270 at 312MHz
- **Very low power consumption**
  - Sleep : 10mW
  - Active: 650mW
  - Ultra low : 120mW
- **Support for SD-Card**
- **Extra com-port for external device.**



SeaState Software

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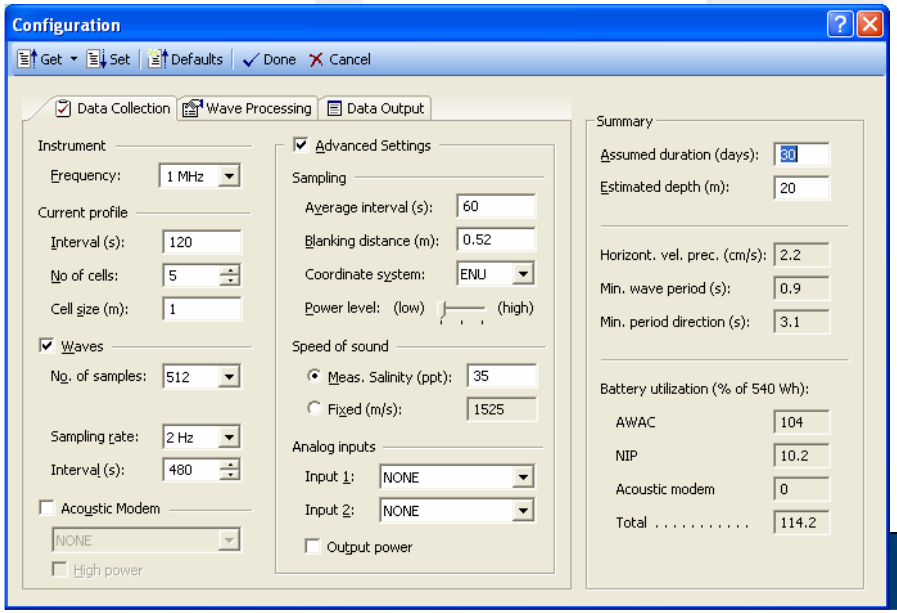
Configuration:

Direct to the AWAC – Raw data

NIP – Processed data

AWAC configuration

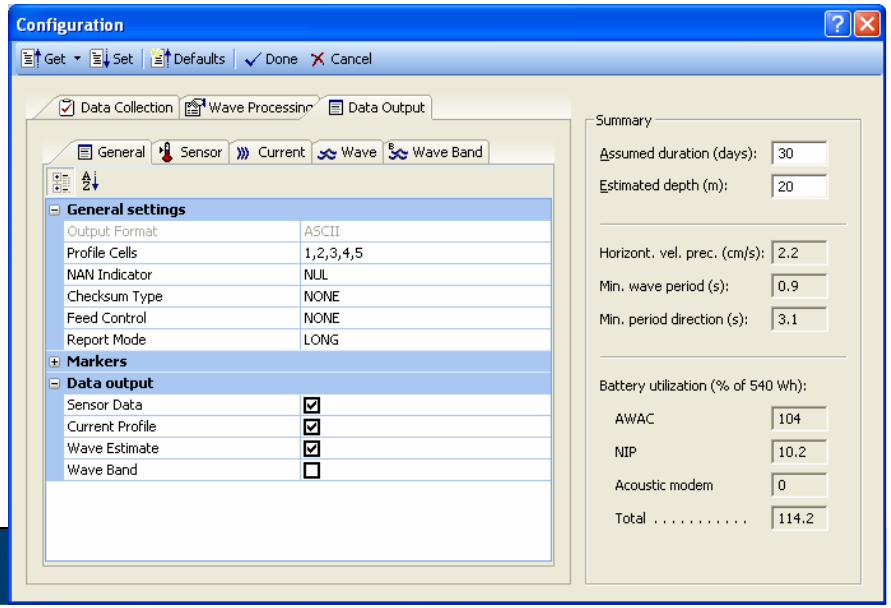


Output configuration

Data markers (c,s,w)

End markers

Delimiters



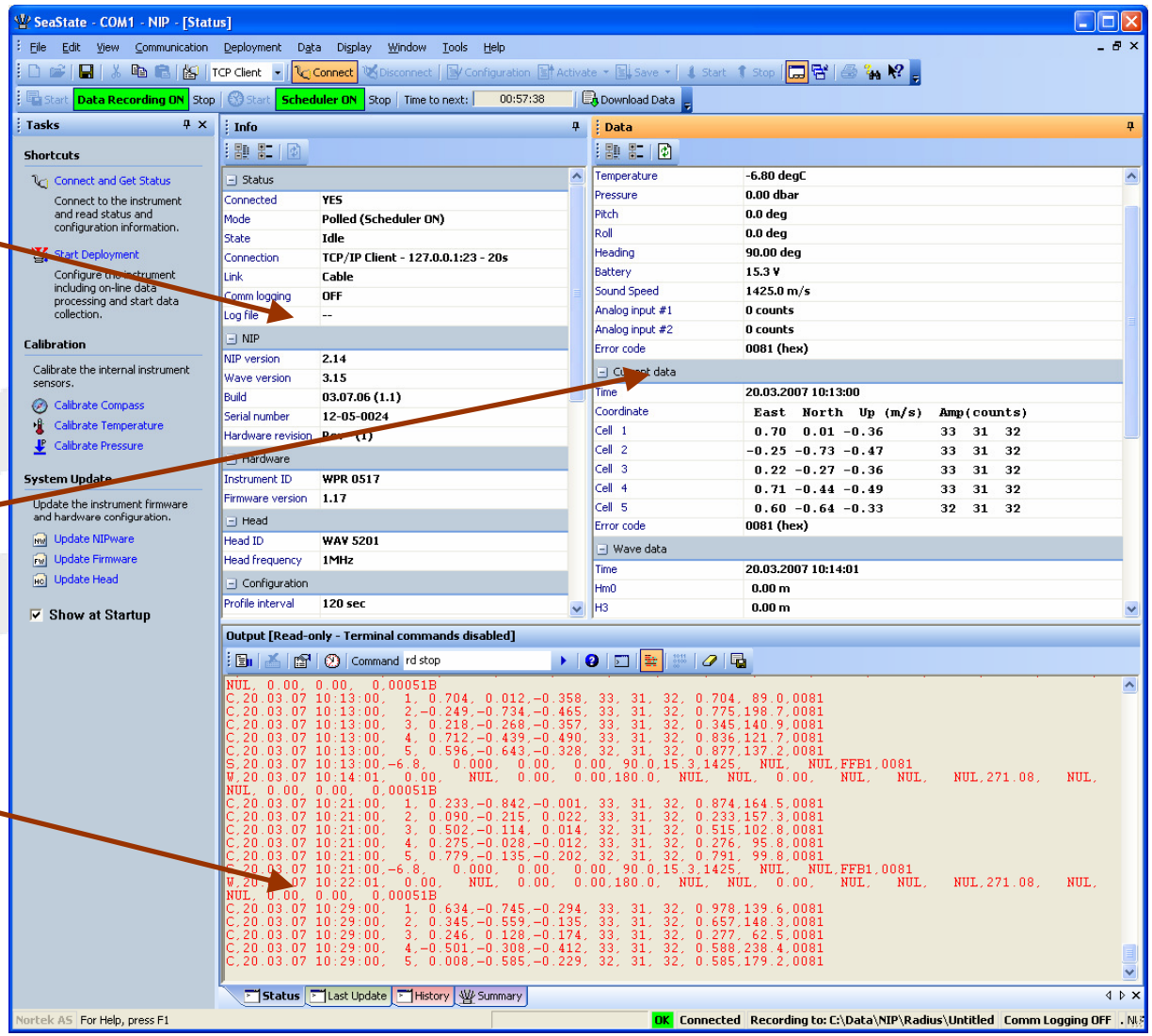
SeaState: Status

Display Setup:

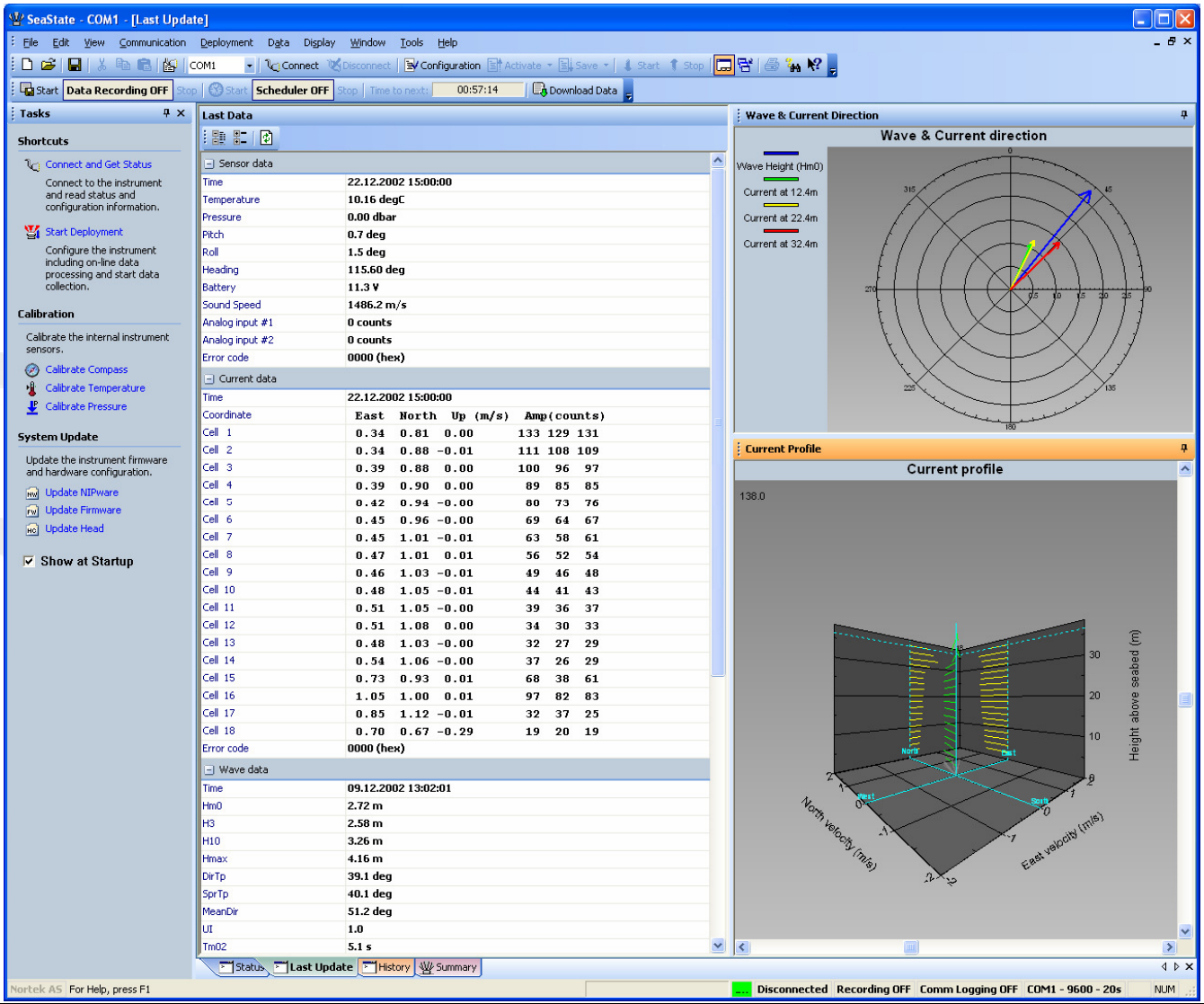
Instrument config

Last estimates

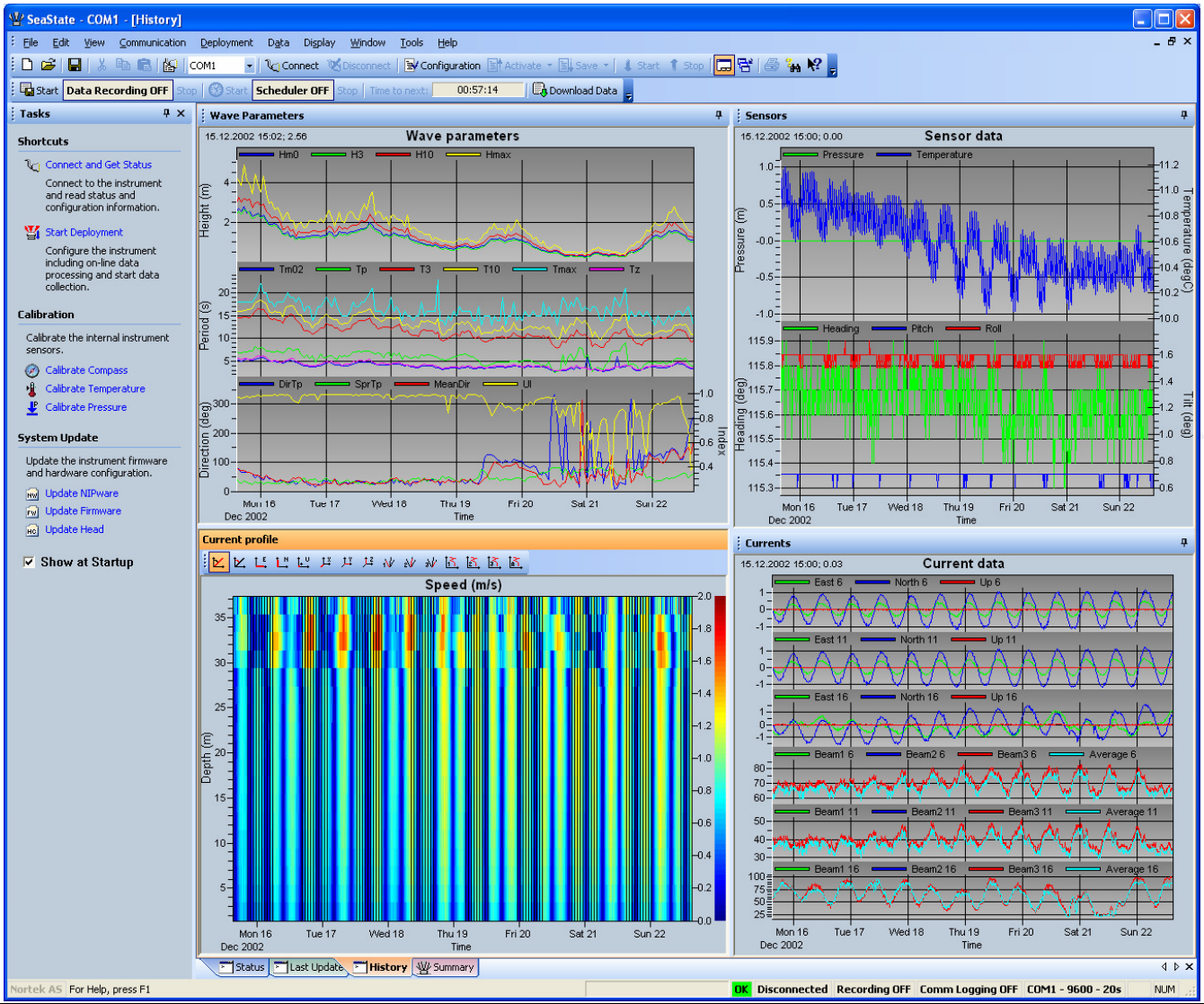
Terminal Window



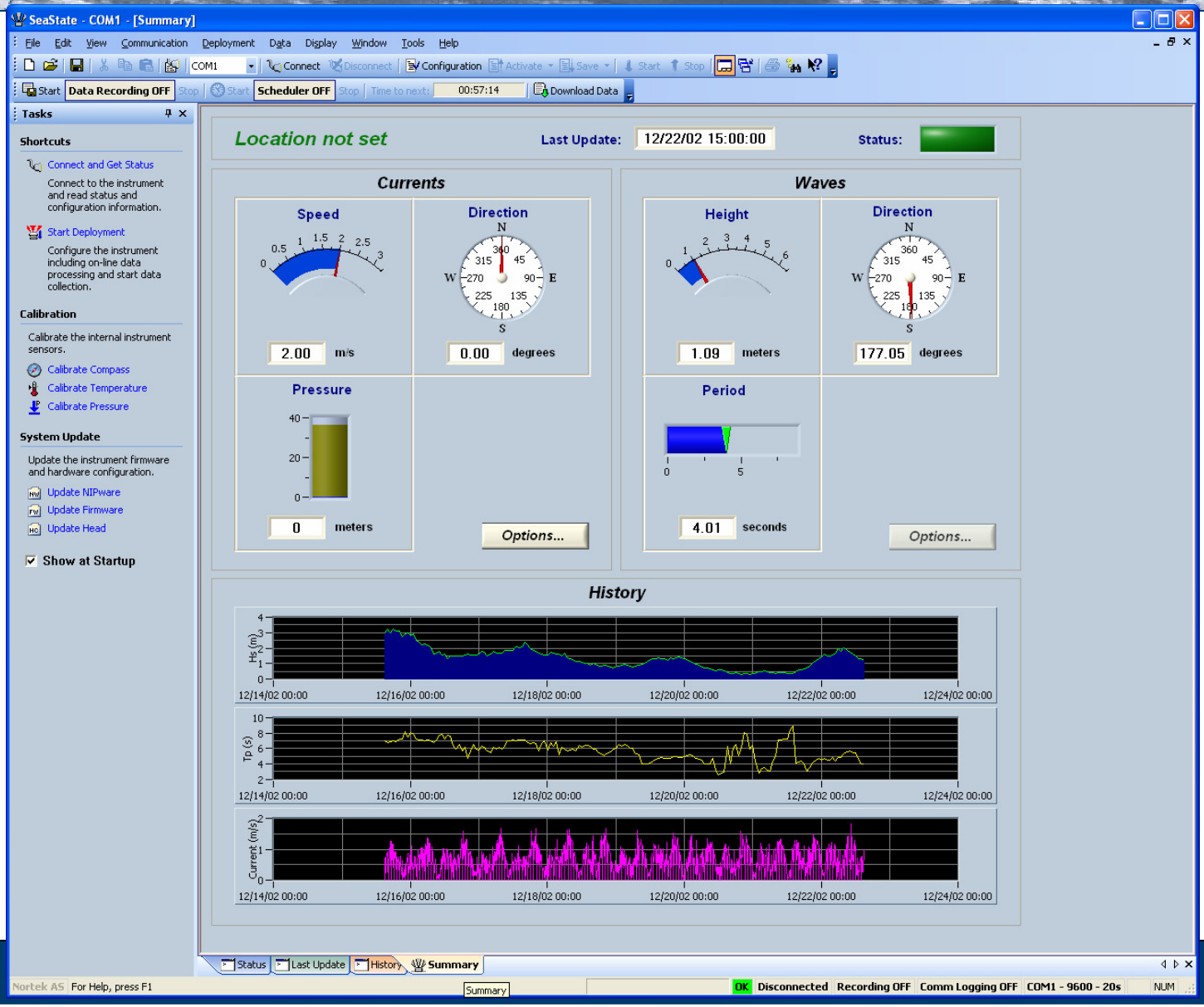
SeaState : Last Update



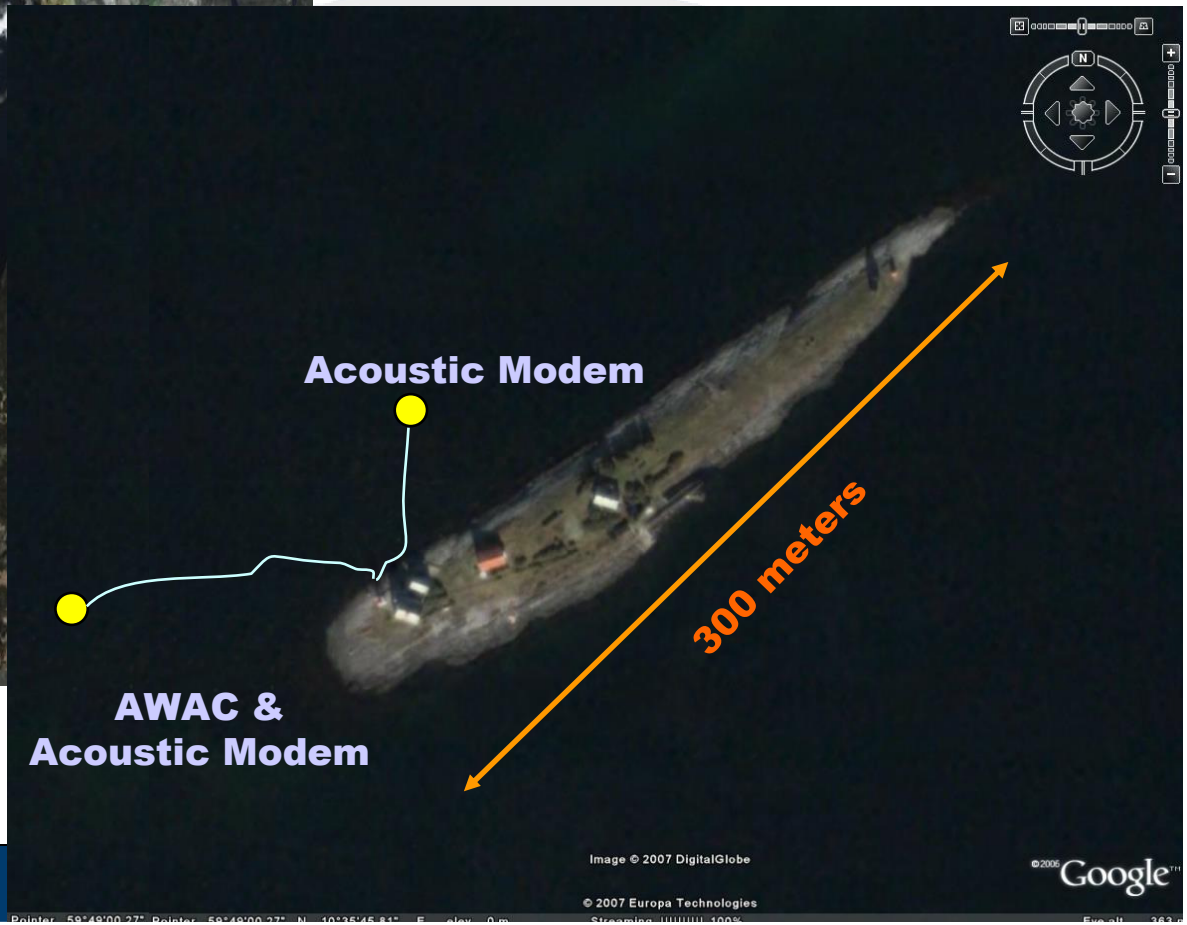
SeaState: Historic View



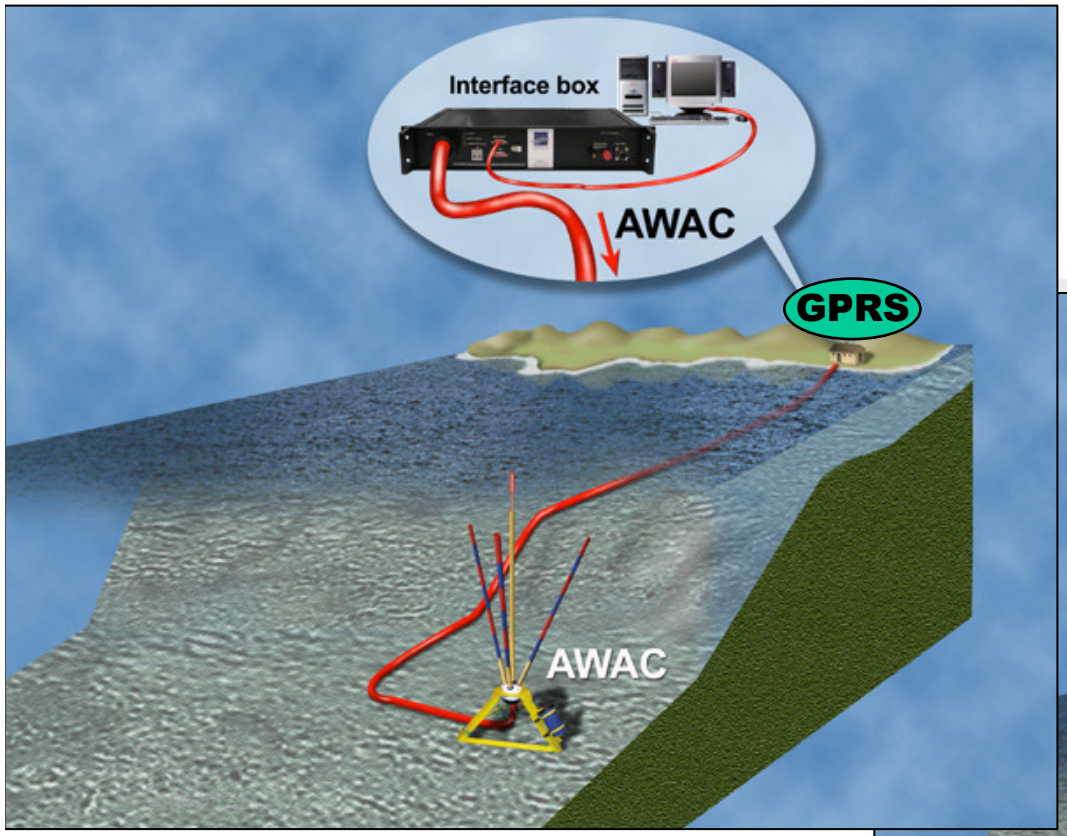
SeaState: Operator View



Steilene Test Site



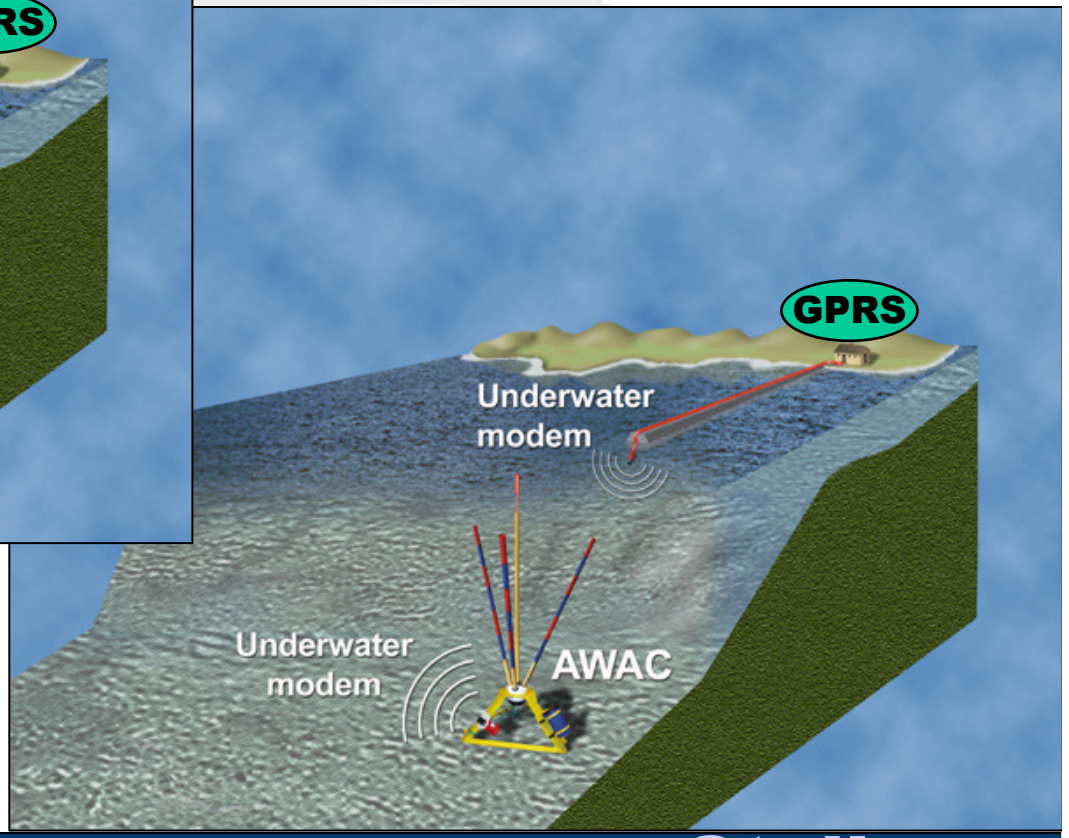
Steilene Test Site



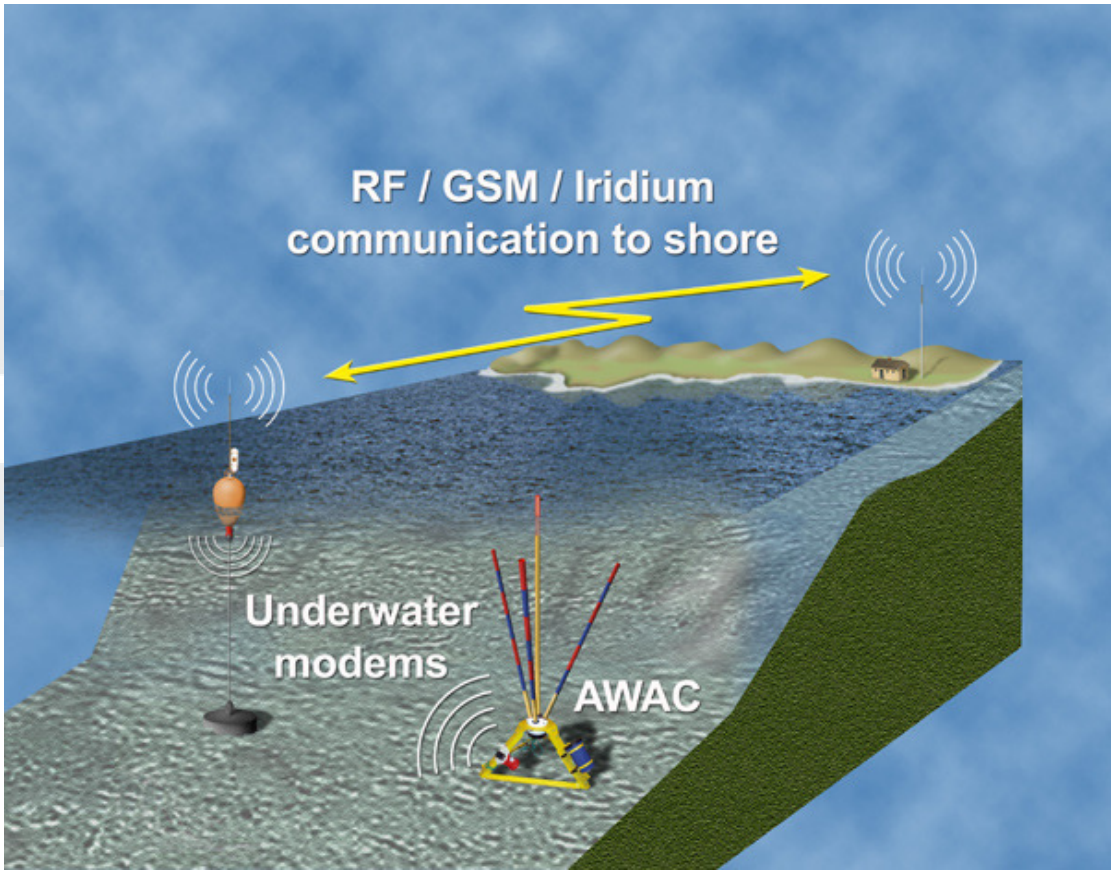
Specified IP address

Mobil Provider

GPRS



Steilene Test Site: Next Phase



Steilene

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Thank You