Development of Self-Contained Sensing, Processing and Telemetry Systems for Undersea Applications

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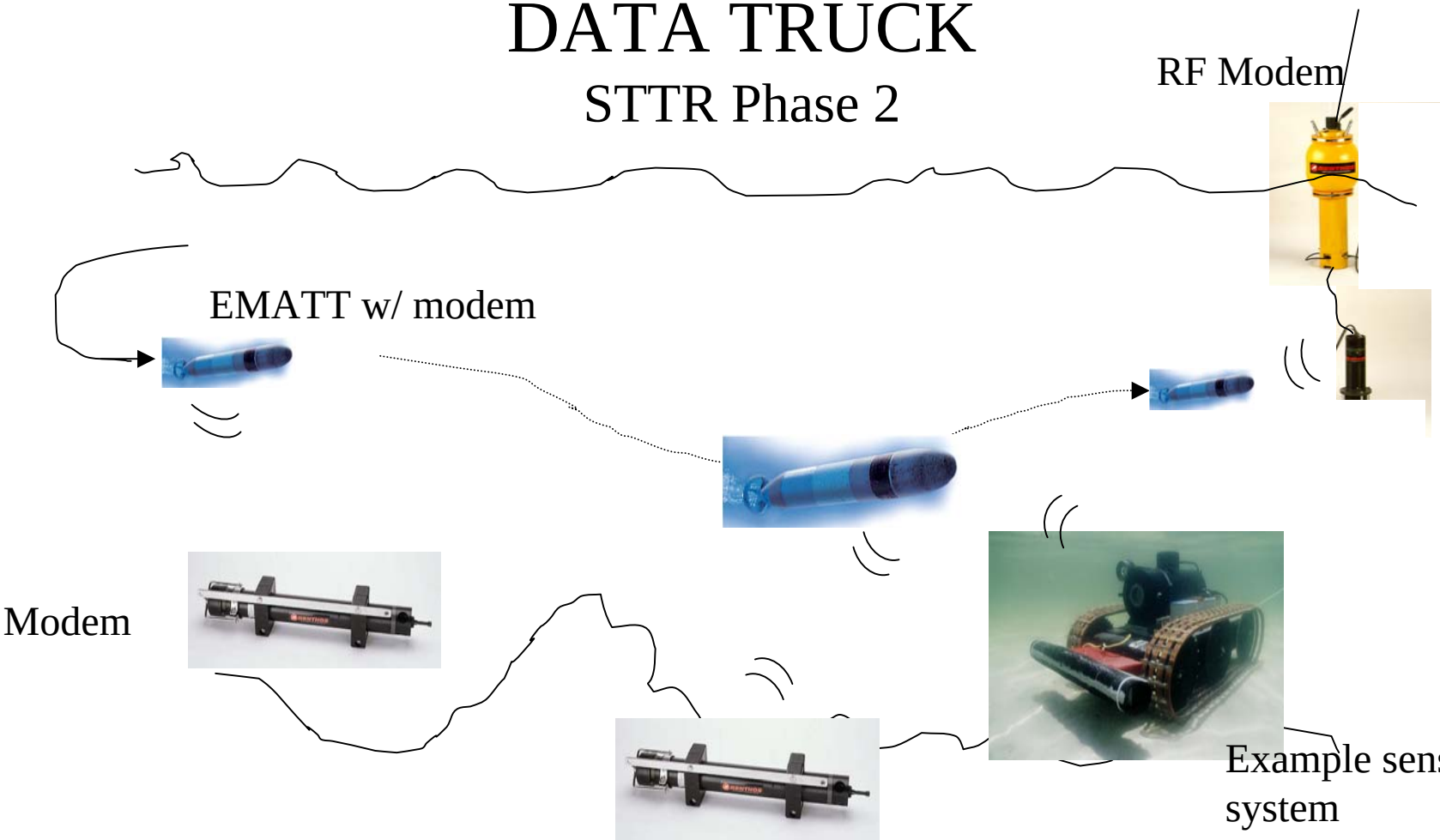
SBIR/STTR Programs

- Active ONR Programs
  - Data Truck, Phase 2 STTR – Jim Valentine TPOC
  - Directional Acoustic Transponder, Phase 2 SBIR - Brian Bourgeois TPOC
  - Smart Marker, Phase 2 SBIR - Brian Bourgeois TPOC
  - Autonomous 4-D Observatory, Phase 2 SBIR – Theresa Paluszkiewicz
- Active NAVSEA Programs
  - Portable Ranges ,Phase 3 SBIRs – NUWC Keyport
  - Clandestine Underwater GPS Positioning, Phase 1 SBIR – PEO LMW
- Past and Present ONR/SPAWAR Seaweb SBIR Phase 3 programs

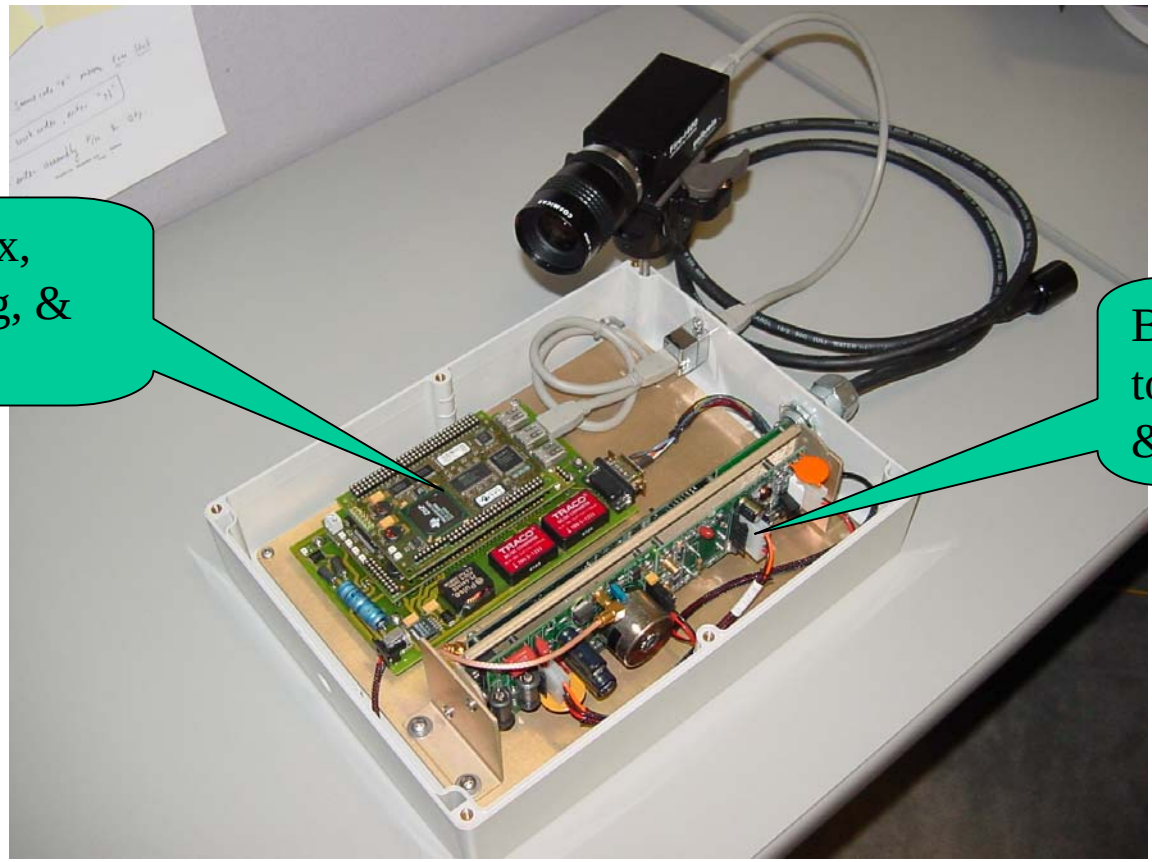
DATA TRUCK

STTR Phase 2



IMAGERY

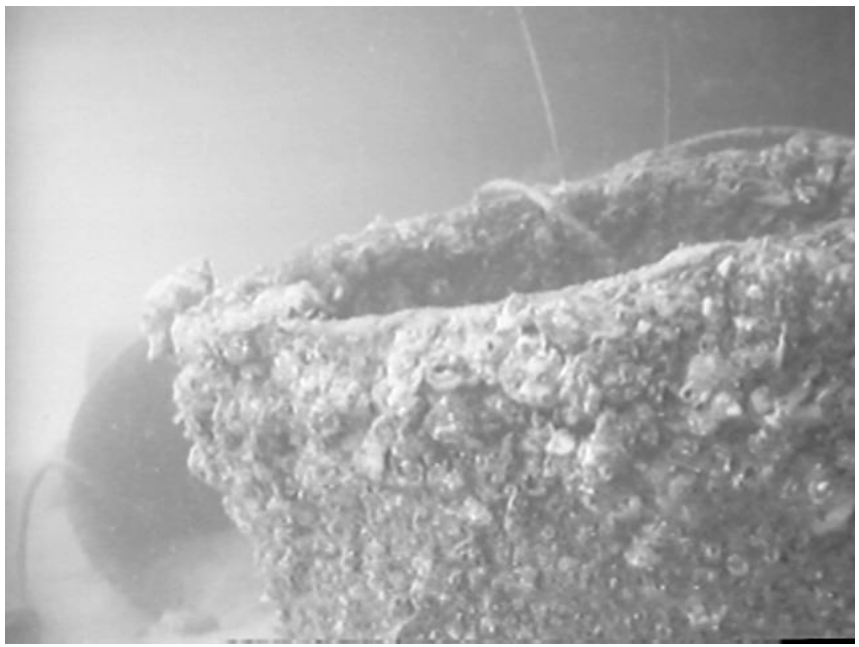
A unique integration of state-of-the-art telemetry and signal processing



Demonstration at Booth #81

Image Compression

STTR Phase 2



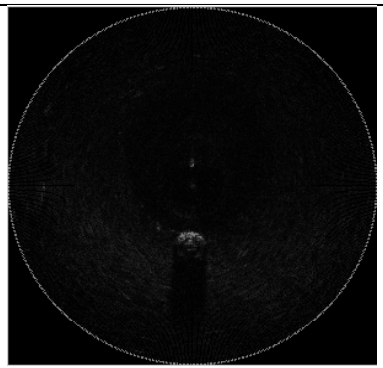
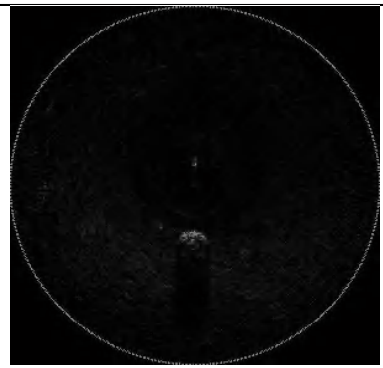
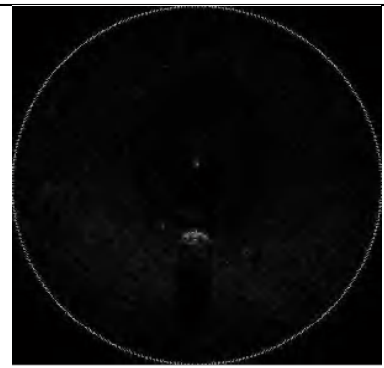
Original Image

Compressed 200:1

Typical JPEG compression is 15:1

Circular Sonar Image Compression using WDR

Louise Law and Truong Nguyen
UCSD

Original Image	16:1	32:1
		

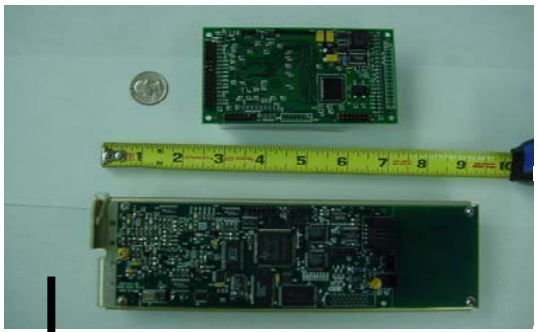
DATA TRUCK
Status

1. Modem DSP programming – complete
2. Modem Integration with EMATT – complete
   - UUV G&C Computer not integrated with modem commands
3. Altimeter integration with EMATT – complete
4. Two sea tests completed, one more planned
5. Image compression implemented in daughter board & fully integrated with modem – complete
6. Sonar imagery demonstrated - work continuing

DIRECTIONAL TRANSPONDER- How it works

Directional Transducer connected to modem

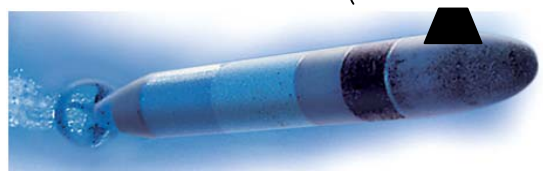
Estimate bearing in modem daughter board



Less than 0.25 deg error in bearing, down range error ≈ 0.3 m

UUV sends a range request

START HERE



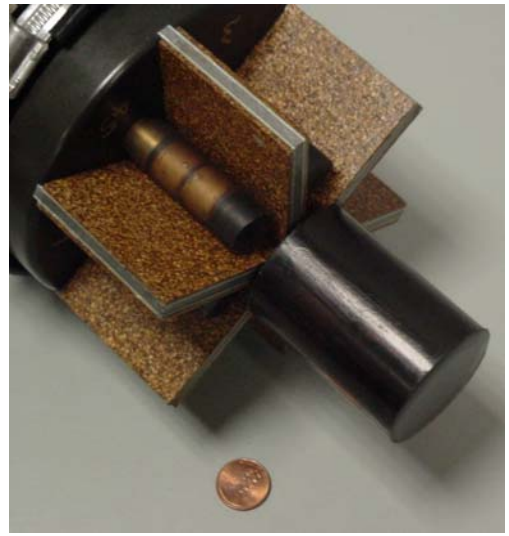
respond with bearing, range, geo-position, & time

Participants:

- Dale Green, Benthos, Dr. David Brown, UMASSD

Objectives:

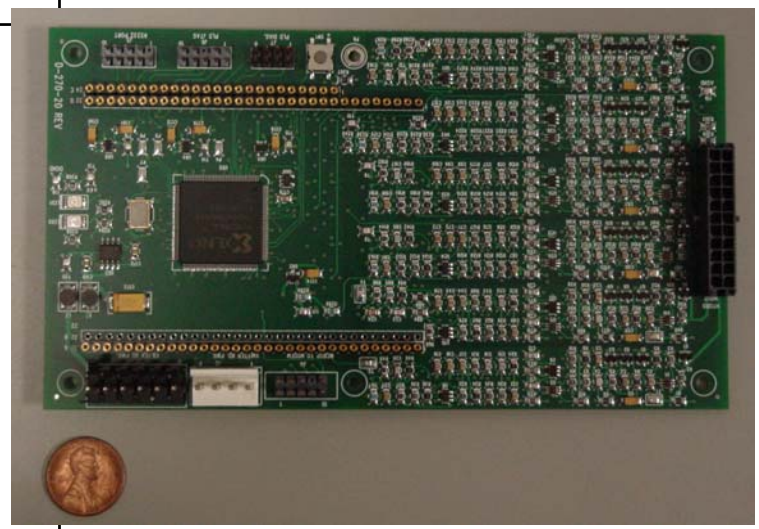
- Develop single-point reference which enables a remote UUV to determine range, bearing, &/or geo-position
- Lightweight, battery-powered
- Range resolution < 0.5 m
- Bearing resolution < 0.25 deg
- Provide full acomms modem functionality



Angled view of the physical transducer

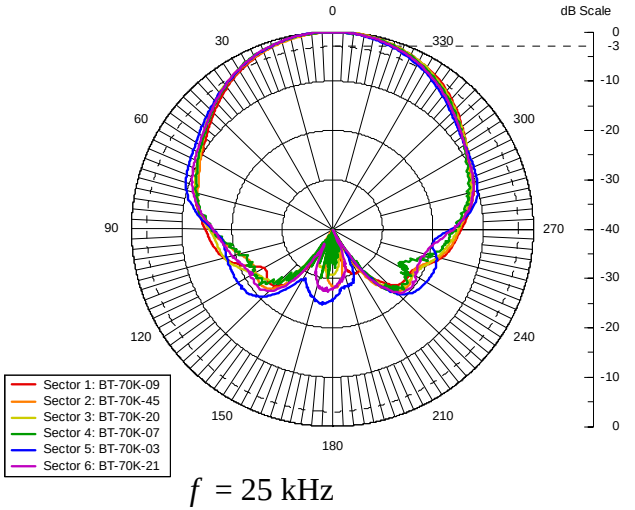
Approach:

- Design an appropriate 6-Pack multi-hydrophone receiver
- Integrate 6-Pack with existing acomms modem
- Develop specialized signaling
- Investigate clandestine signaling
- Experimentation and demonstration



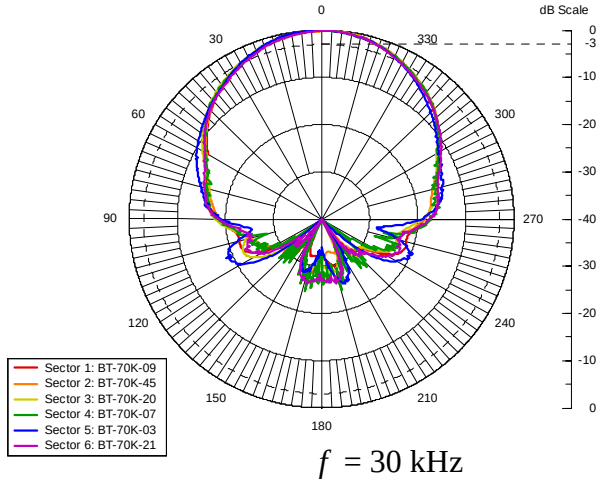
Front side of the 6-channel signal conditioning board

Directional Acoustic transponder
Measured Beam Patterns (BTech)



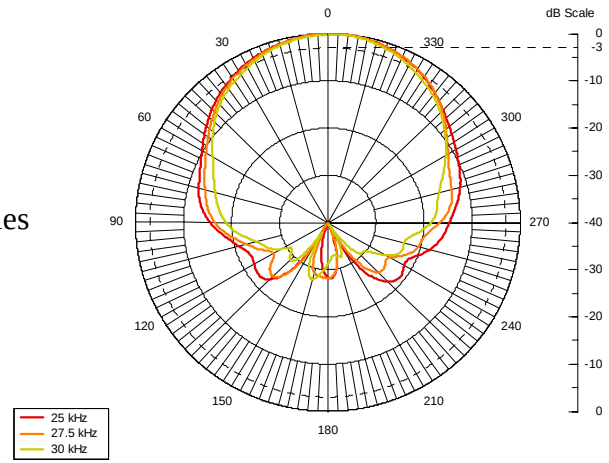
f = 25 kHz

Overlay of 6 hydrophones



f = 30 kHz

1 hydrophone at 3 different frequencies

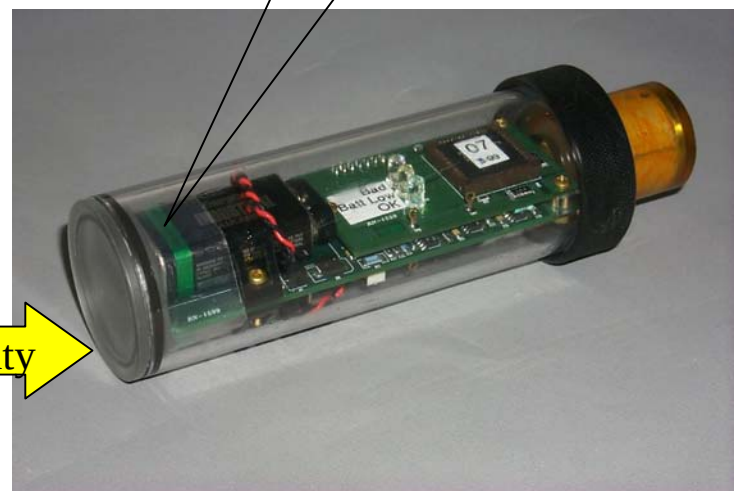


Directional Acoustic Transponder Status

1. Third generation physical transducer complete and ready for in-water testing. Next generation under development – looking for greater depth-tolerance.
2. 6-channel signal conditioning & ADC board complete – some retuning of components underway, PLD-based interface with DSP board nearly complete
3. Integration of TI 6711 digital board with modem nearly complete.
4. Signal processing algorithm implementation underway in TI 6711 DSP
5. Ranging function available in UUV modem, but no implementation yet to compute position based on received message.

SMART MARKERS
Mine reacquisition & Black box pingers
SBIR Phase 2

- 20 kHz frequency band with covert signaling.
- Operates with the Benthos ATM 885 and the WHOI Micromodem.
- Minimum 1 km range.
- Several operating modes
- Multiple form factors

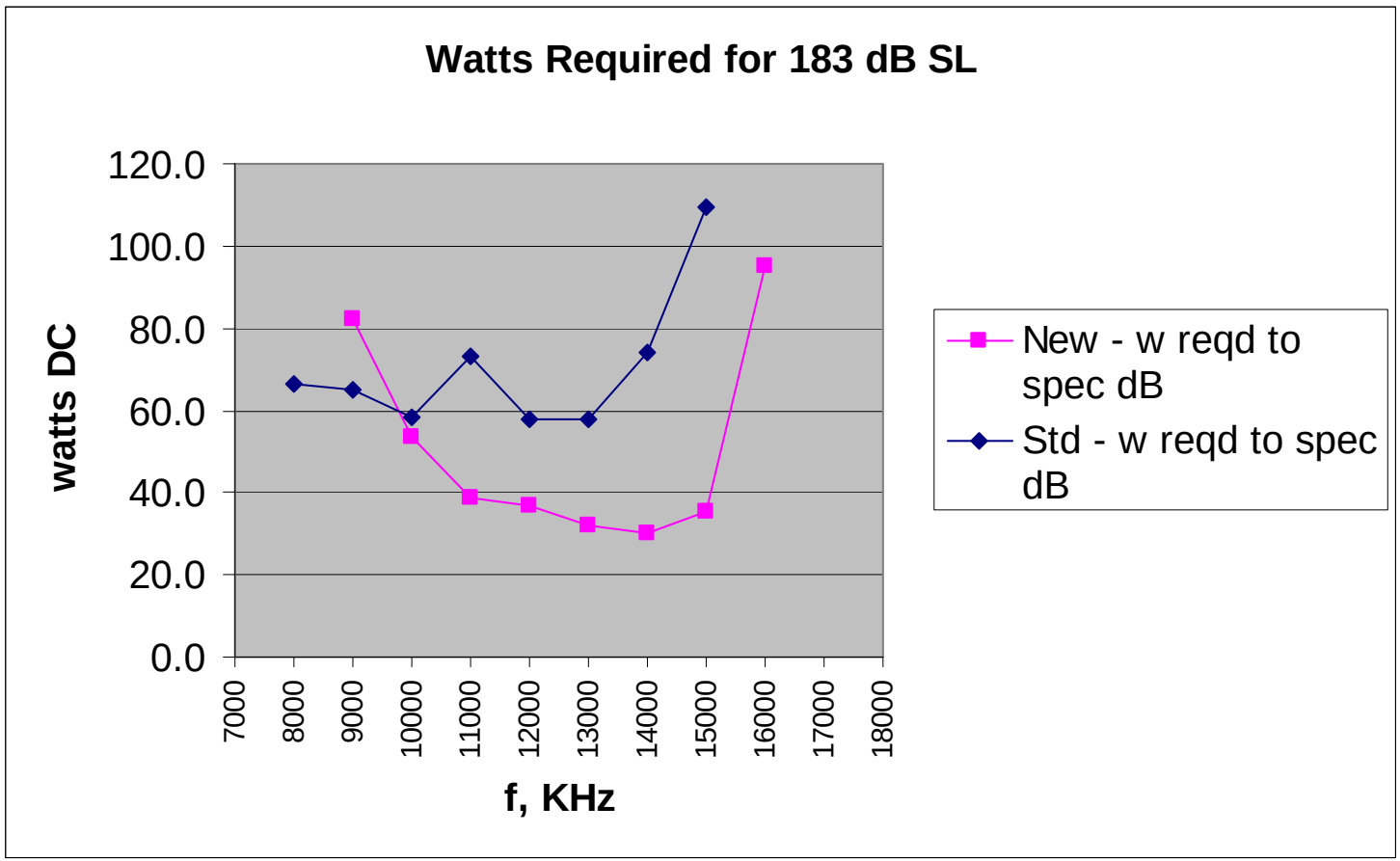


Another possibility

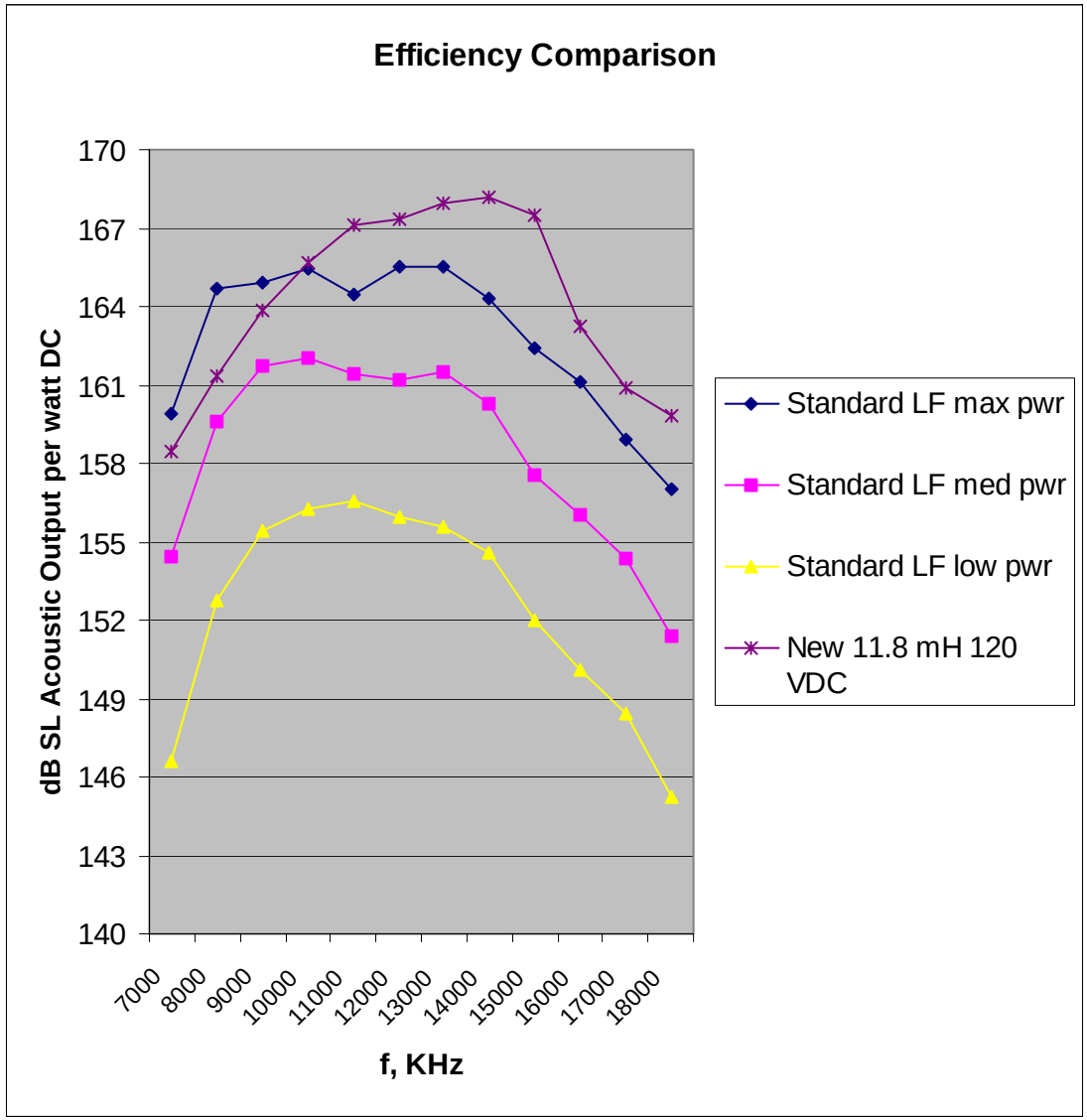
Existing marker, ARL/UT & SPAWAR

Smart Marker - Transmitter

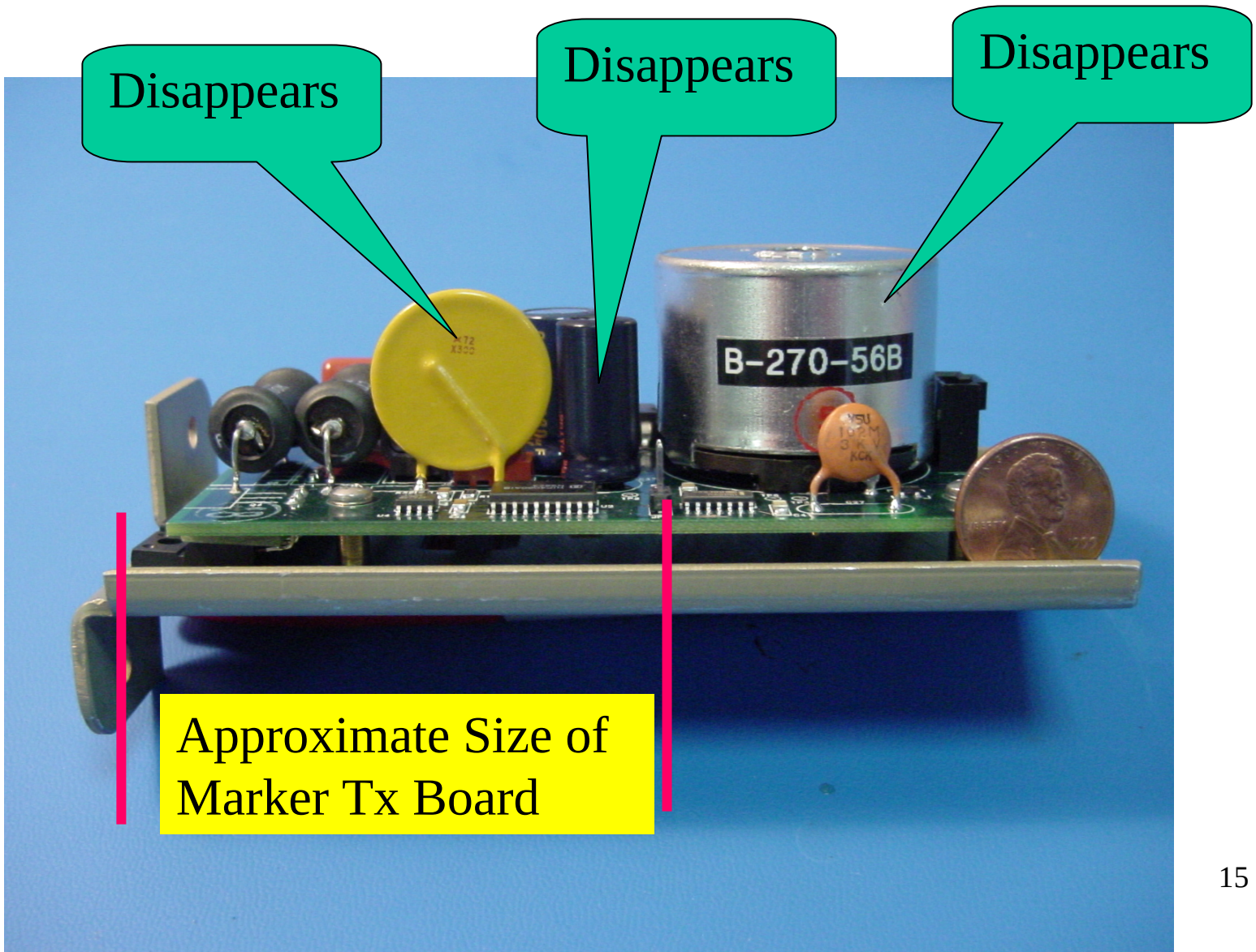
- We have developed a new (for sonar) technique for transmitter design involving a direct digital drive of the transducer from the DSP – using a software sigma-delta converter to directly drive high voltage FETS.
- Results



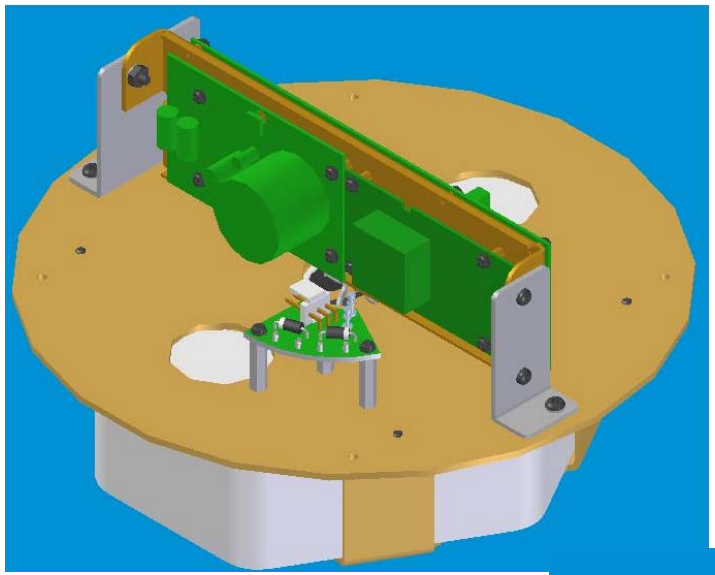
Smart Marker - Transmitter

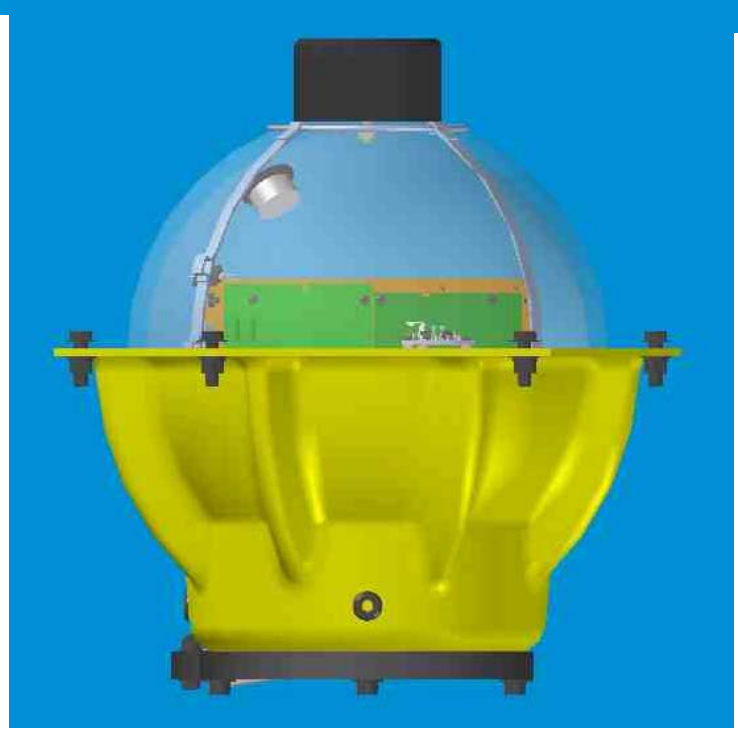


Current Generation Modem Transmitter Board



SMART MODEM

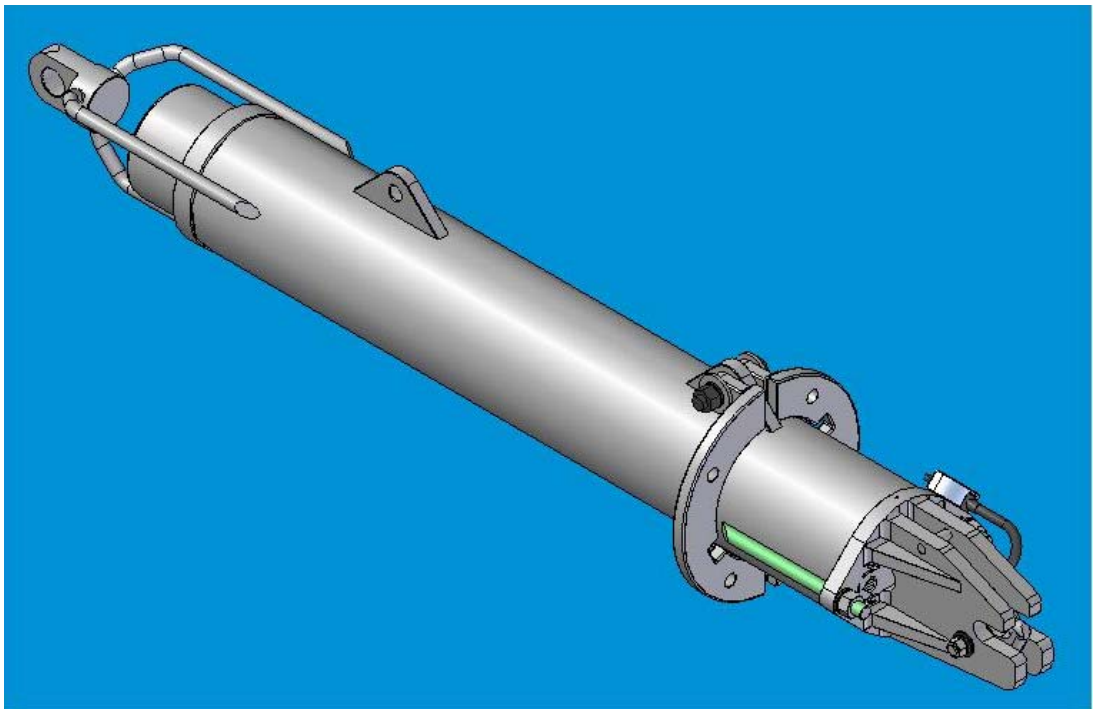




Features:

1. Fully functional modem
2. Burn-wire release
3. Full Ocean depth
4. 13“ or 17“ sphere
5. Supports 2-4 RS232

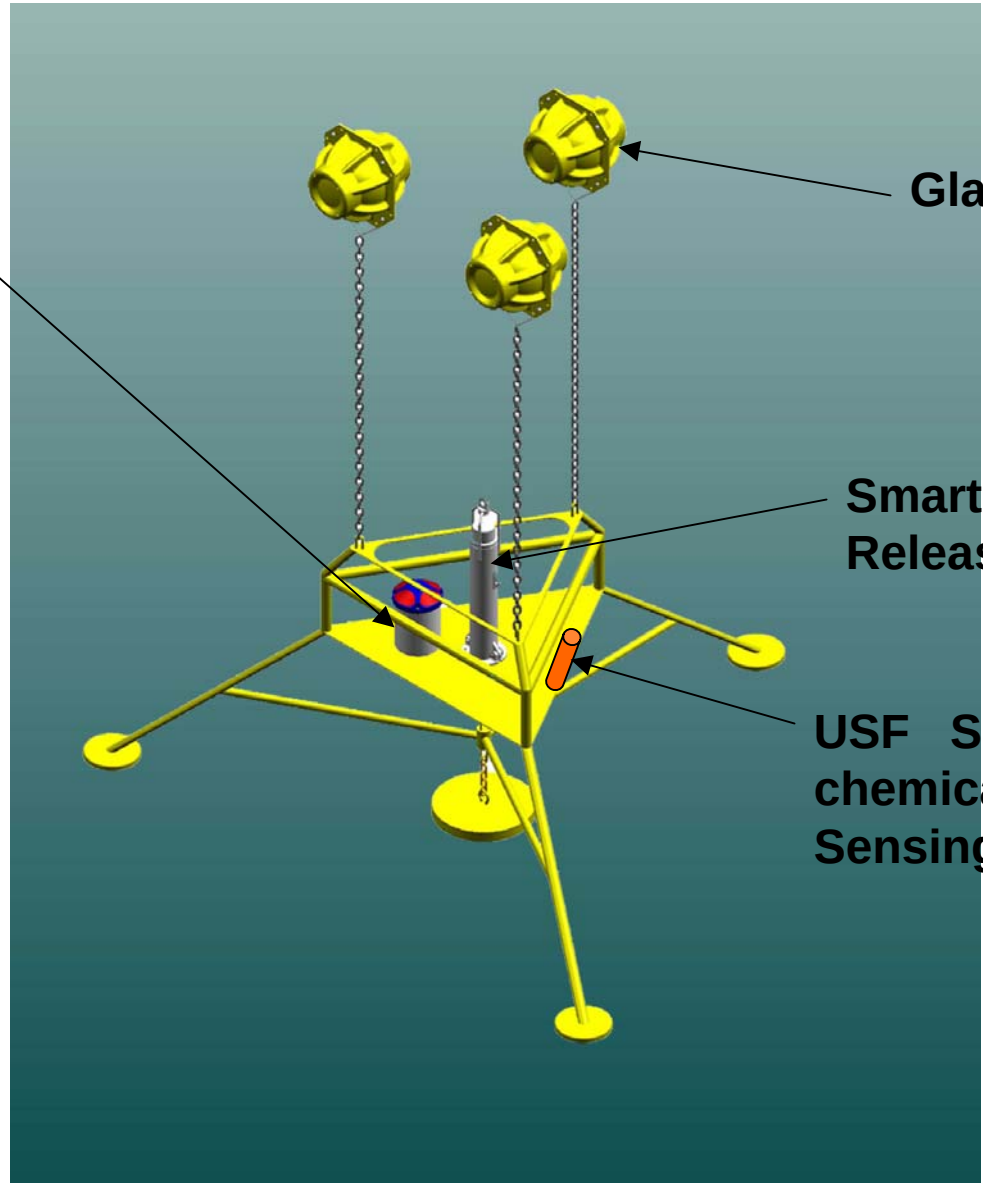
SMART RELEASE



Features:

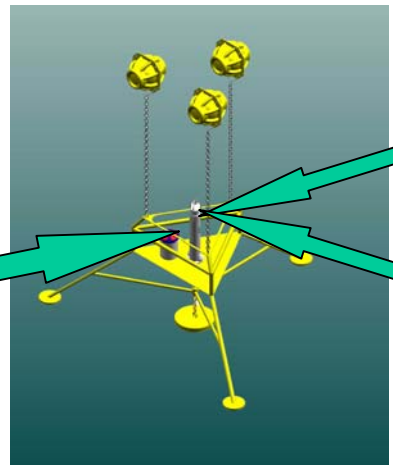
1. Fully functional modem
2. Mechanical release
3. 12000 m depth
4. 5000kg load
5. Supports 1-2 RS232

Autonomous 4-D Observatory



1. All components are COTS
2. RDI ADCP & WAVMON integration complete
3. University of South Florida SEAS chemical sensing
4. Other sensors TBD

Local Area Network

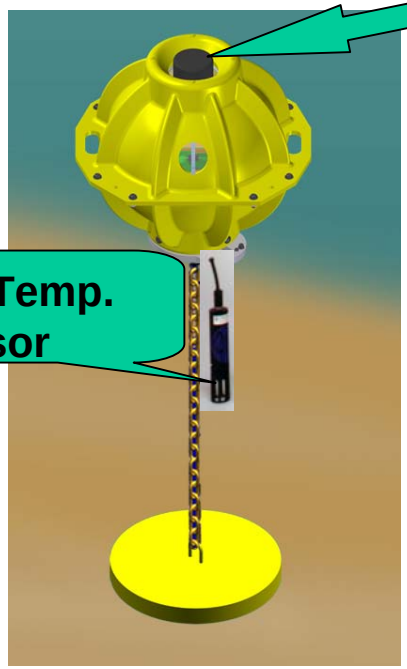


Gateway comms

Relay

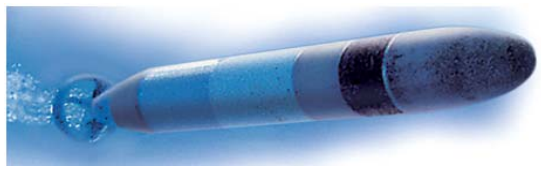
Undersea Network

Smart Release on lander



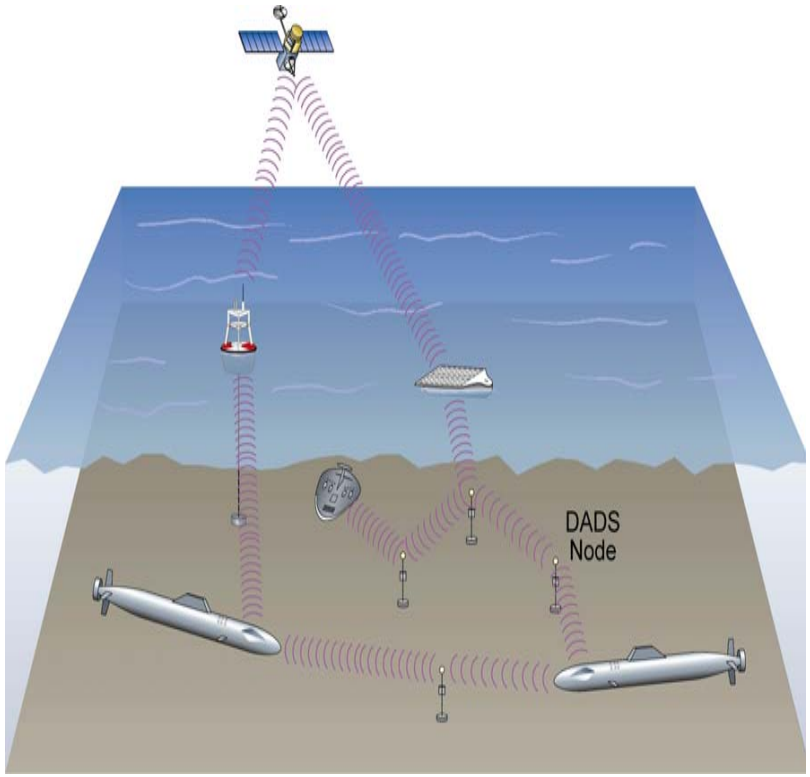
FSI Temp. sensor

Command & control and data transfer



Smart Modem

Communications at Speed and Depth



Supporting SEAWEB, tracking and node-to-node telemetry

Featuring:

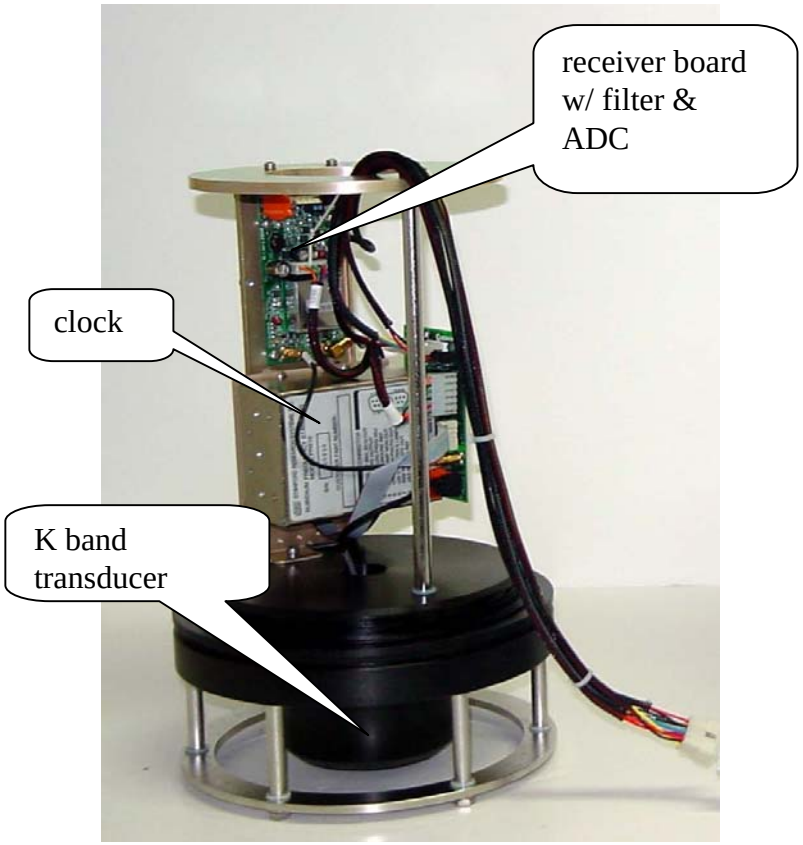
- Inexpensive COTS hardware
- Navy/commercial DSP firmware
- 9-14, 16-21, 25-30 kHz operating bands
- Doppler-tolerant to > 20 knots
- BSY-1 and WQC-2 Sublink TempAlts demonstrated at sea
- Robust 9-byte utility packets for handshaking and navigation
- Data telemetry up to 4 Kbyte/packet; 80 bps to 10+ Kbit/s
- Network scalable to 255 nodes
- Enabling DADS (Littoral ASW FNC), SDV comms (Sea Eagle ACTD) and AUV programs
- Enabling portable acoustic ranges

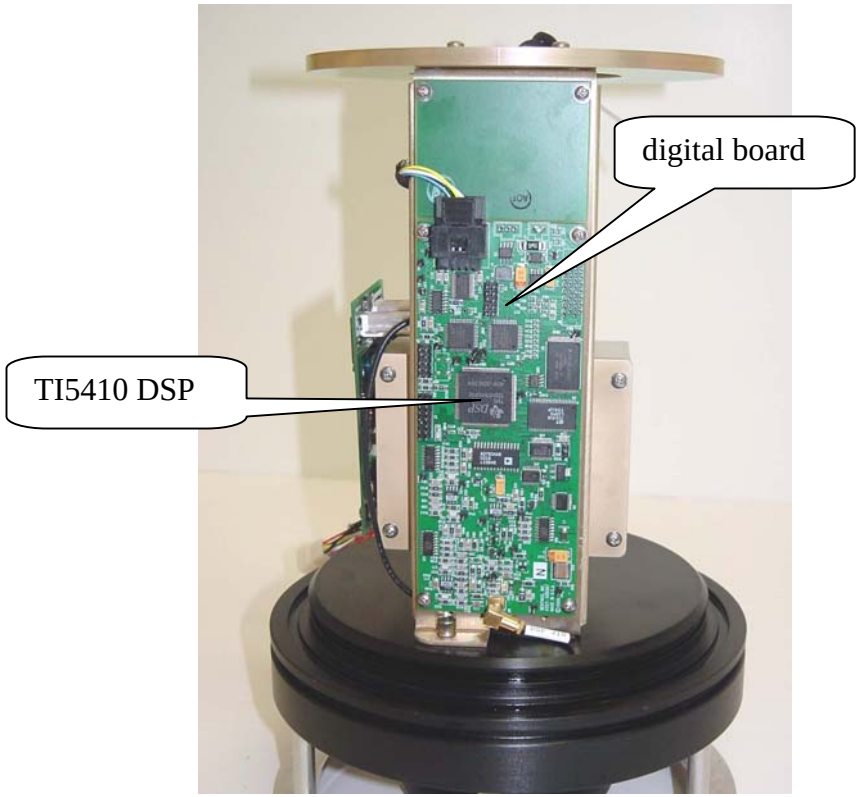
Tracking Ranges

Modems have been modified in support of NUWC Keyport to enable:

- Comms with high speed platforms (patent pending)
  - Demonstrated in range tracking applications at > 15 kts
  - Demonstrated at UD ’04 (SEAWEB) at > 20 kts
- Modem technology used to develop a receiver for standard tracking range signaling schemes:
  - K-band PSK signaling (simultaneous 2 codes, 2.5% doppler)
  - Delivered substantial hardware/software capabilities
- Anticipate SBIR Phase 3 follow-on efforts during FY ‘05

Portable Range Prototype





Benthos ATM 88x

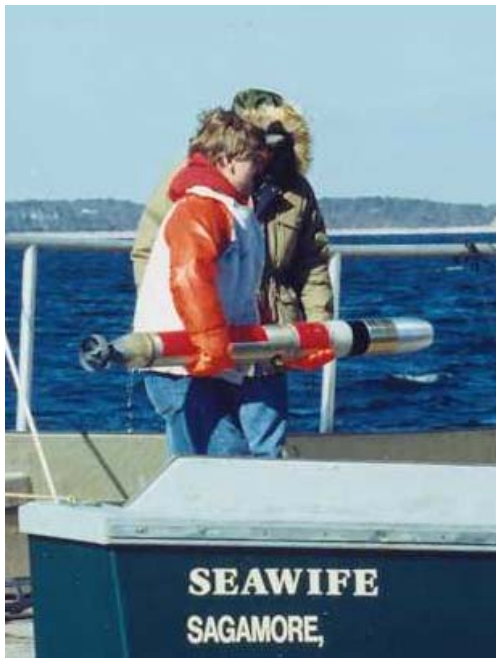
	Value	Comments
Bandwidth (kHz)	5.12	
Frequencies (kHz)	9-14; 16-21; 25-30	Any 5.12 kHz band up to 35 kHz
Max/Min SL (dB/μPa) (transducer dependent)	183/162	Changes in 3 dB steps
Relative velocity compensation vs frequency (kts)	12 kHz ± 40 kt 18 kHz ± 25 kt 28 kHz ± 20 kt	demonstrated to + 22 kts in LF band (patent pending)
Sleep power (Watts)	70 mW	Awakens to acoustic signal or RS232 data.
Fully awake Rx (W)	0.5 W @ 21 V	
Out-of-band Tx noise	-50 dB	-60 dB easily achieved
Tx/Rx Band Shape	flat within ± 2 dB	All three standard bands
Max power Tx (Watts)	21-40 W	Depends on frequency and transducer
Range resolution (meter)	1/3	
Modulation Schemes	FH/FSK 80 bps MFSK:140 - 1200 bps MPSK:2560 – 10240 bps	for multi-access, UW/GPS, covert (?) Standard Seaweb/Commercial schemes w/ daughter board, benign channels, commercial

L.M. CETUS2

CSS Crawler

SAUV

NPS Aries



Sippican EMATT

Bluefin

Webb Slocum Glider