TECHNICAL SPECIFICATION

FOR

Unmanned Autonomous Vehicle Acoustic Sensor and Autonomous Processing Packages

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1. **Introduction**. The Naval Research Laboratory (NRL) is seeking to acquire up to 4 towable hydrophone array systems. The system is comprised of a hydrophone sensor array, forward Data Acquisition System (DAS), tow cable, drogue and data record system. The record system logs data to disk and broadcasts it over Ethernet to other computers for processing and display. The system should be controlled and monitored via a Graphical User Interface (GUI). The system should be designed to draw less than 25 watts.

   The sensor arrays must be designed to be compatible with a small diameter (~ 14.7 cm) Autonomous Underwater Vehicle (AUV). The array should be designed to have minimal drag when being towed by the AUV. This requires a thin-line design consisting of an outer diameter of less than 38 mm. The array must be flexible having little to no shape memory as well as neutrally buoyant. Thus it must consist of an oil-filled polyurethane hose surrounding the individual hydrophone elements and pre-amplifiers. Additionally, the dry end electronics for the data record system must be compact enough to fit inside the 14.7 cm diameter AUV.

2. **General Requirements**. The contractor shall provide a towable hydrophone array system with the following components: (1) a 32-element hydrophone array, (2) forward data acquisition system (3) tow cable (4) data record system (5) drogue.

   a. **Construction**: The unit must be ruggedized for operation in the harsh marine environment and must be deployable, operable, and retrievable in conditions up to and including sea state 3.
   b. **Operational depth**: The towed array system must meet all specifications and must function at a depth of at least 100 m.
   c. **Hydrophone Array**: The sensor array must consist of 32 phones and have uniform spacing of 0.2 m or have a nested aperture of 21 elements spaced at 0.4 m and 11 elements spaced at 0.2 m as shown in Figure 1. The array should nominally be neutrally buoyant and housed in an oil-filled polyurethane hose that has an outer diameter no larger than 38 mm. The forward and aft ends of the array should be terminated with couplings to provide mechanical attachment points for the tow

cable at the forward end and the drogue at the aft end.

i. **Hydrophones:** Each of the 32 channels should use hydrophone elements with a sensitivity of -201dB//v/uPa +/-1.5dB or better. Alternatively, the contractor may provide a design that uses two spatially separated hydrophone elements tied in parallel at each of the 32 acoustic channels. Each acoustic channel will be spaced 10 cm aft of the preamplifier.

ii. **Non-acoustic sensors:** The array will contain 3 tilt compensated digital compasses on both the head and tail sections of the array as well as a compass at the center. Heading sensor accuracy is an essential part of the array design. The compasses should have a heading accuracy of 0.5 degrees or better at low latitudes and have the ability to be calibrated in-situ. Depending on cost, the contractor may provide estimates for both gimbaled and non-gimbaled compasses. In addition to the compasses, the hydrophone array will also require a pressure sensor at its aft end to facilitate depth monitoring.

d. **Preamplifiers:** The pre-amplifier circuit should be housed in an open-ended thin-wall nylon tube approximately 10 cm forward of the hydrophones. Power, ground and control signals should be bussed the length of the array to all 32 pre-amps. The signals should be daisy chained from one pre-amp to the next and should be free of any external splicing. The pre-amp units should be designed to allow oil to freely pass through the assembly, eliminating air voids.

The preamplifier should feature a fixed gain front end of roughly 26 dB and a programmable gain post amplifier that can be set remotely to 0, 6, 12 or 18 dB of additional gain. Additionally, the preamplifier circuit should feature a bandpass filter with 3 dB cutoffs at 250 Hz and half the sampling frequency.

e. **Forward DAS:** The DAS electronics module should be located at the forward end of the array and contain signal conditioning, digitizing and telemetry electronics. The housing should not exceed 38 cm in length and 43 mm in diameter. The DAS should feature a 32 channel, 16-bit A/D capable of simultaneously sampling each channel at a rate of at least 16 kHz.

f. **Tow Cable**: It is recommended that Falmat "Xtreme Green" electrical cable be used as a tow cable to carry the axial load while towing the array.
   i. **Size**: The tow cable must be at least 8 m in length and have a maximum outer diameter of 1 cm.
   ii. **Construction**: The tow cable should contain an 8-conductor CAT5E cable axial breaking strength should not be less than 800 lbs.
   iii. **Electrical termination**: The AUV end of the cable should be terminated with an Impulse MHDG-9CCP connector. The tow cable should also have the ability mate directly to a bulkhead on the vehicle pressure vessel. The array end of the tow cable must be terminated with an appropriate connector that mates to the DAS electronics housing.
g. **Data Record System**: The data record system must be capable of logging data to disk as well as passing the data along via Ethernet to the vehicle's onboard computer for processing and display. The system must have a hard drive capable of logging at least 5 hours of array element level data as well as non-acoustic data. The form factor of the data record system must be such that it could fit into the upper half of a 14.7 cm diameter cylinder in order to be accommodated within the autonomous vehicle chassis.
h. **Drogue**: The system shall be supplied with a 6 m, 19 mm diameter polypropylene rope drogue. The drogue attaches to the aft end of the array using the same shroud components used to attach the tow cable. The design should allow for the drogue to be easily interchangeable.
i. **Operating temperature and humidity**: All in-water components, together with tow cable, must function and meet all specifications in temperatures of -3 to 30 degrees Celsius.
j. **Storage temperature**: All system components must function and meet all specifications after being stored for an indefinite period of time in temperatures of 0 to 50 degrees Celsius.
k. **Warranty**: The system shall be warranted against defects in materials and workmanship for one year from date of delivery. The contractor shall repair or replace at no charge any part that proves to be defective during the warranty period. This warranty does not apply if the item has been damaged by accident or misuse.

Figure 1 Nested Array Option Sensor Dimensions