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# 32-Channel Digitizer for a Moored Hydrophone Array for Low-to-Mid Frequency Shallow-Water Acoustics Experiments

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## LONG-TERM GOALS

Acquisition of an in situ, 32-chanel digitizer capable of sampling at a rate of 8kHz, with a maximum depth rating of 1 km and data storage capacity sufficient to support continuous recording for a 10-day deployment. This system, when coupled to an existing, 32-channel hydrophone array owned by the Naval Postgraduate School, will enable future research efforts to investigate three-dimentional effects on sound propagation caused by a sharp front, large amplitude internal waves, and significant batheymetri changes, which are common environmental features in a shelf-slope environment.

The procurement of the proposed 32-channel digitizer will help to fill the data and knowledge gaps that exist in the shallow-water acoustics research community. The first deployment will be in the next multi-institutional shallow-water acoustics experiment that is targeted for the FY14 timeframe.

## OBJECTIVES

This project will obtain an underwater digitizer system for an existing 32-element, 155m aperture hydrophone array. The combined digitizer and array system will enable the measurement of the horizontal or vertical properties (depending on the moored orientation) of the low-to-mid frequency (500–3,000 Hz) shallow-water sound field.

This electronics system will be capable of: 8kHz continuous sampling over a 10-day period; an Analog-to-Digital converter resolution of 16-bits; a correctable clock stability of 1 ms over the deployment; and a 1km maximum operating depth.

## APPROACH

The proposal submitted by Teknologic for the government contract has the following system features:

- 32 channel hydrophone signal interface providing hydrophone power, signal conditioning, and COTS 16-bit sigma-delta converters

- Single board computer system to buffer and time-tag the hydrophone data, formats data and controlls the logging to solid state drives
- Precision oscillator providing a stable 10MHz clock signal to the field programmable gate array for precision timing of all data acquisition functions. Oscillator interface is provided to allow for recallibration of signal with GPS/topside synchronization. The onboard clock will be based around the Symmetricom SA.45s Chip Scale Atomic Clock, with a stability of 5 parts in $10^{11}$.
- The 32-channel digitizer system will operate at a maximum synchronous sample rate of 8kHz, capturing data up to ~3.9kHz bandwidth, with provisions for lower sampling rates to be selected prior to deployment.

In addition to the 1,000 m rated electronics module, the 32 channel digitizer will utilize a windows based software system for programming and control, communicating over a wired Ethernet connection through and endcap bulkhead connector.

## WORK COMPLETED

The government contracting proceedures were successfully navigated during the first half of FY12, however an open solicitation was necessary. During this procedural delay, additional vendors were identified, however all vendors came in over the available budget due to cost increases since the initial proposal submission. Teknologic LLC of Edmonds, Washington was awarded the contract to deliver the 32-channel digitizer in March 2012, with a low bid of $99,500 for the base 32-channel system. Additional costs were necessary to increase their base system capabilities to meet proposal objectives: an additional $20,298 was needed to obtain a 14-day recording capacity and 16-bit ADC resolution, and another $4,900 was needed to provide 3-axis tilt sensor, depth/pressure sensor and battery voltage monitoring for engineering data capability. The additional $8,698 required above the $116,000 provided in this award was cost-shared.

Design and assembly of the system will continue into FY13, with a contract delivery date on or before 05 April 2013.

## IMPACT/APPLICATIONS

This equipment will complement the other two moored, 32-channel receiver arrays available to the research community: the Applied Research Laboratory, University of Texas at Austin SWAMI-32 array) and the Woods Hole Oceanographic Institution SHARK array. This system will complement the arrays with added diversities in the frequency and angular regimes as well as added horizontal coverage. Increased horizontal coverage is particularly important to support future research to investigate three-dimensional effects on sound propagation caused by a sharp front, large amplitude internal waves and significant bathymetric changes, which are common environmental features in a shelf-slope environment.

## RELATED PROJECTS

After wet and bench testing in FY13, this equipment will be deployed in a FY14 ONR experiment on the upper slope of the northeastern South China Sea to study sound propagation over large sand dunes.