ADDRESSING SENSING CAPABILITY GAPS USING ECONOMICAL PROFILING TECHNOLOGY

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Figure 1 - NOAA Testing MASED in Alaska.

The ability to collect oceanic data quickly, accurately, and economically has a significant impact on the success of commercial, military, and maritime research operations. Requirements and applications for oceanic sensing vary significantly based on the type of information targeted in specific weather patterns, climate regions, and oceanic zones. Boston Engineering's new sensing technology platform is addressing a breadth of maritime data collection needs by reducing barriers created by high costs and harsh environments.

MARITIME SENSING TECHNOLOGY SNAPSHOT

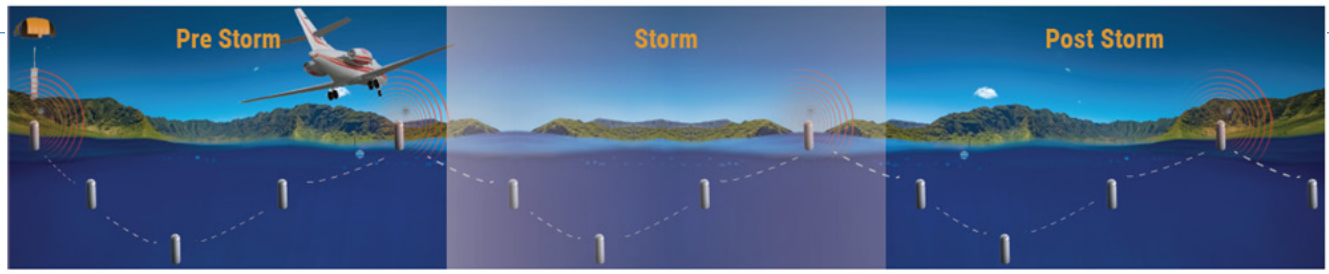
Buoys, unmanned vehicles (UxVs), and sondes each have their advantages, but high costs and data collection limitations can make it prohibitive to deploy these technologies. As an example, the average price tag of a tethered weather buoy can reach $375,000. UxV costs can also be high for some applications, and require capture for reuse. Lower-cost sonde instrument probes such as Expendable Bathythermographs (XBT) have a limited field of exploration because data transmission requires cable or wire connectivity.

To reduce the cost per data-point collection in mission-critical maritime environments, Boston Engineering is developing a maritime sensor family of platforms to support a range of applications across multiple industries. The platform's "plug-and-play" capabilities enable the rapid integration and use of a myriad of commercial sensors. Boston Engineering's platforms are capable of being widely distributed at reduced cost.

MASED Overview

The following MASED overview highlights how Boston Engineering is applying its maritime sensor platform to address specific needs. MASED—a Multipurpose Above/Below Surface Expendable Dropsonde—is the first product to collect ocean data during developing hurricanes via multiple submerge-and-surface cycles. The data collected by MASED will allow researchers to better understand, analyze, and forecast hurricanes. Additionally, it will contribute to significant financial and economic benefits for affected hurricane regions.

Cost was a significant consideration in developing this expendable (if desired) product. At costs per profile in the range of hundreds of dollars, MASED will complete a user-specified number of profiles (a minimum of five) over two days. Developed through a National



MASED Transmits Multiple Sensor Readings via Satellite, Enables Mission Configuration by Duration, Profile Frequency, and Depth.

Oceanographic and Atmospheric Administration (NOAA) SBIR grant, Boston Engineering is providing NOAA's Aircraft Operations Center with prototypes for field testing.

Illustrating Expendable Maritime Sensor Capabilities via MASED

MASED includes the following technologies and capabilities that are also used throughout the company's maritime sensing product line:

- **Variable Buoyancy System (VBS)**: Achieves multiple submerged water column profiles through its Variable Buoyancy System (VBS). The ability to change buoyancy allows MASED to make multiple controlled descents to a preprogrammed depth then ascend to the surface to transmit the collected data.

- **Modular Software and Operating System:** Provides control via microcontroller of IMU, GPS, SATCOM, datalogger, CTD, and other sensors. Enables users to communicate, upgrade, modify, and test systems with ease.

- **Sensor Nose (with CTD sensing):** Measures water temperature, conductivity, and pressure through the water column profiles and while at the surface. The modular design enables multiple types of sensors to be deployed.

- **Electronics and Communications Modules (Satellite Communication with GPS):** Missions can be preprogrammed but a sample is that the device collects baseline data on day one, profiles again (multiple times) while the storm passes over, then transmits the data via Iridium to the Iridium satellite constellation, which can then be accessed quickly from anywhere in the world.

- **Ruggedized Design:** Operates in harsh conditions. MASED is deployed from standard AVAPs launch tubes from aircraft flying up to 45,000 feet. The parachute system automatically detaches when in the water.

Boston Engineering is utilizing MASED's core technologies to address needs for the Naval Air Systems Command (NAVAIR), Naval Sea Systems Command (NAVSEA), and the Office of Naval Research (ONR). Figure 1 shows the Boston Engineering product family, into which MASED's core technologies were incorporated.

BUILDING A MARITIME SENSOR PRODUCT LINE

The modularity and adaptability of MASED provides a significant advantage to address multiple applications and markets. Boston Engineering can deliver reliable, low-cost products by utilizing the latest technologies, and by applying our expertise in modularizing designs through design for manufacturing and optimization (DFx) best practices (see Table 1).

Additional Maritime Sensor Products

In addition to MASED, Boston Engineering is developing the following capabilities:

Proteus is a persistent ocean profiling system that gathers high-density measurements through hundreds of profiles over the course of many months to provide the Navy with accurate year-round ocean environment data at a lower cost than today's methods. Proteus provides highly reliable oceanographic data with sensors including GPS, water temperature, water salinity, pressure (for depth calculation), turbidity, and background noise. Proteus is being developed under a NAVAIR Phase II SBIR.

MEDUSAE is an autonomous, jellyfish-inspired vehicle capable of conducting autonomous station-keeping in dynamic environments to act as an oceanographic sensor node for 2-12 months. MEDUSAE utilizes its own energy harvesting sub-system to continuously provide highly reliable oceanographic data using a variety of sensors. MEDUSAE is being developed under an ONR Phase II STTR.

SVP Sonde is a low-cost MASED variant that provides sound velocity profiles (SVP) and conductivity readings in support of U.S. Navy Littoral Combat Ship (LCS) operations. SVP-Sonde is being developed under a NAVSEA Phase II SBIR.

Sensing Product	Application	Deployment Options	Duration
MASED	Enhance hurricane forecasting	Targeted, aerially deployed	Days (varies based mission configuration)
SVP Sonde	Collect readings for U.S. Navy mine countermeasures (MCM)	Targeted, UxV or vessel deployed	Days (varies based mission configuration)
Proteus	Persistent ocean profiling system with sensors for anti-submarine warfare (ASW)	Deployed in advance, aerially deployed	Months
MEDUSAE	A jellyfish-inspired vehicle that acts as a sensor node with autonomous station-keeping	Deployed in advance, various deployment methods	Months

Table 1: Boston Engineering's Expendable Maritime Sensor Product Family (Note: product scale is not exact)

DELIVERING LOW-COST SENSING FOR MARITIME APPLICATIONS

Boston Engineering is developing and delivering reliable, low-cost maritime sensing products for multiple maritime applications. The company is building on its experience integrating and optimizing industry-leading sensing technologies to operate in harsh or congested environments. Its maritime technologies include the BIOSwimmer UUV, GhostSwimmer AUV, robotic systems, and other capabilities for mission-critical environments.