Department of the Navy SBIR/STTR Transition Program

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Topic # N181-082
Multi-Dimensional Ambient Noise Model
Metron, Inc.

WHO

SYSCOM: ONR

Sponsoring Program: Office of Naval Research Code 32

Transition Target: NAVSEA (PEO IWS-5), NAVAIR (PMA-264)

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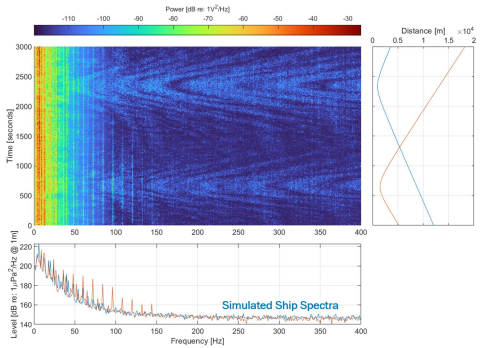
Other Transition Opportunities: Naval Surface Warfare Center Carderock Division (NSWCCD) Tactical Decision Aids Group, Air Anti-Submarine Warfare Systems Program Office (PMA-264), Office of Naval Intelligence (ONI), SONAR system engineering firms and manufacturers, research universities, and organizations conducting ocean acoustic research.



MDANM simulation of ships with distinct spectra passing a single omnidirectional hydrophone

Notes: On contract with Massachusetts Institute of Technology Lincoln Laboratory (as of July 2023) to integrate MDANM-derived timeseries generation and simulation capabilities to support advanced beamforming algorithm development and testing.
MDANM was successfully employed internally at Metron to develop prototype SONAR systems.
The model is pending review by Johns Hopkins University Applied Physics Laboratory for acceptance into the US Navy's Oceanographic and Atmospheric Master Library (OAML).

WHAT

Operational Need and Improvement: MDANM is an ONR-sponsored SBIR that started in 2018 in response to a demand signal from the tactical decision aid (TDA) and modeling communities seeking to improve noise modeling inside US Navy Tactical Decision Aids to produce reliable performance predictions, especially for modern 3-D arrays.

Specifications Required: In light of an increasingly competitive undersea operational arena, the Navy requires a replacement for the current omnidirectional ambient noise model. The envisioned replacement will be a Multi-Dimensional Ambient Noise Model that fully predicts the vector and statistics of the temporally dependent ambient noise field as a function of location, direction, and season over a broad range of tactical frequencies and operational environments. The fully formed model will include a comprehensive understanding of sea surface, volume, bottom noise generation, attenuation, and propagation to the underwater sound field (including biologics, acoustic seafloor loss mechanisms, and scattering).

Technology Developed: MDANM uses a Navy-standard ray tracer to derive the noise field directionality at the modeled sensor. The noise passes through a high-fidelity element-level response model for any sonar array, including all operational US Navy sensors. This approach facilitates the calculation of array covariance matrices that readily support any acoustic sensor, including omni, hull-mounted, directional, pressure, transducers, or accelerometers. Any beamforming algorithm can be applied to the covariance matrices to produce highly realistic estimates of beam noise. Environmental and stochastic uncertainty are accounted for using a combination of Monte Carlo and analytic techniques to represent beam noise as a probability density function.

Warfighter Value: MDANM represents the state-of-the-art in the forward-model prediction of the noise field. MDANM will enhance and expand the Navy's existing sensor performance modeling capabilities. Beam noise probabilities are a far superior way to account for noise in the sonar equation and completely obviate terms such as directivity index (DI), ambient (AN), and array gain (AG). MDANM-derived solutions will accurately represent system detection capabilities with associated uncertainty and inspire operator confidence in TDA results and onstation performance in complex operating environments.

WHEN

Contract Number: N68335-23-C-0225 **Ending on:** Feb 16, 2024

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Production Code Transition	Medium	MDANM C/C++ produces the same results as the original MATLAB prototype	6	1st QTR FY24
OAML Accreditation	Medium	Acceptance into Oceanographic and Atmospheric Master Library	8	4th QTR FY24

HOW

Projected Business Model: Metron plans to retain the SBIR data rights for the developed model and associated signal-processing algorithms. US Navy and large primes would integrate MDANM into tactical decision aids and acoustic simulators for fleet use with the option to employ Metron for direct support during the integration phase. Metron is targeting NAVSEA/IWS-5's Common Tactical Decision Aid (CTDA) suite for an initial transition into the SSN and CRUDES combat systems, with a subsequent transition to related tactical systems to follow.

Company Objectives: As a trusted provider of advanced research, scientific, and software solutions for government and commercial markets, Metron delivers a competitive edge for our customers in five areas: data analytics, autonomy, decision support tools, sensing systems, and experimental capabilities. Metron's MDANM solution leverages our expertise in probabilistic modeling, signal processing, and data fusion to deliver the US Navy's first fully fielded 3-D noise model. MDANM's unique capabilities (beam noise calculation, advanced sonar simulation, and Monte Carlo statistical analysis) will transform information and databases into intelligent actions to solve our customer's most critical mission objectives.

Potential Commercial Applications: Metron's MDANM noise model and sonar simulation suite are ideal for systems engineering firms, manufacturers, research universities, and organizations conducting general ocean acoustic research. MDANM facilitates multi-element array simulations and beam noise calculations with Monte Carlo-derived uncertainty metrics. The model supports accelerometers, omni, pressure, and vector sensor designs. MDANM can model the complete signal processing chain from a pressure wave arriving at an individual element on the sensor to placing a pixel on an operator's display. Metron is contracted with MIT Lincoln Laboratory to deliver advanced MDANM-derived modeling and simulation capabilities to support next-generation beamforming algorithm development and testing.

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