

Topic: N151-033

## Daniel H. Wagner, Associates, Incorporated

### State Estimation Tool for Undersea Systems (SETUS)

Passive sonar is an essential tool for covertly detecting threats to friendly submarines. However, it is difficult to accurately determine threat range directly from passive sonar contacts. SETUS is designed to enhance threat range estimation by accounting for uncertain environmental conditions, threat acoustic signature, and threat tactics. SETUS is developed by Daniel H. Wagner Associates, who has more than fifty years of experience in Navy algorithm development, including pioneering work in anti-submarine warfare (ASW). SETUS combines a new statistical approach to account for uncertainties in the acoustic environment, and a sophisticated Agent-Based Simulation with Bayesian Weights (ABSBW) algorithm to infer threat range, acoustic signature, and tactics. SETUS will be transitioned to U.S. submarines via the Advanced Processor Build (APB) software development Step process.

### Technology Category Alignment:

Advanced Computing/Software Development

Acoustic, Seismic and Magnetic

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**SYSCOM:** NAVSEA

**Contract:** N00024-16-C-4529

 Corporate Brochure: [https://navystp.com/vtm/open\\_file?type=brochure&id=N00024-16-C-4529](https://navystp.com/vtm/open_file?type=brochure&id=N00024-16-C-4529)

Department of the Navy SBIR/STTR Transition Program

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NAVSEA #17-528

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State Estimation Tool for Undersea Systems (SETUS)  
Daniel H. Wagner, Associates, Incorporated

WHO

**SYSCOM:** NAVSEA

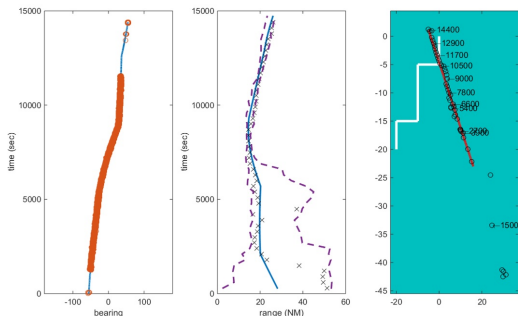
**Sponsoring Program:**

**Transition Target:** Advanced  
Processor Build (APB) 21

**TPOC:**  
(860)694-3857

**Other transition opportunities:**

**Notes:** The image to the right shows SETUS position estimates for a simulated passive sonar contact. Panel 1 and 2 show range and bearing estimates, while panel 3 shows a track reconstruction for the target ground truth (in red) based on own-ship position (in white).



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WHAT

**Operational Need and Improvement:** Improve contact range and velocity estimation for passive sonar systems.

Exploit environmental information to enable enhanced state estimation.  
Incorporate environmental fluctuations and uncertainties into state estimate AOU.

**Specifications Required:** Interface with existing Navy environmental databases and calculations.  
Approach must be self-assessing and self-regulating.  
Rapid and effective operator interaction with the system when required.

**Technology Developed:** Daniel H. Wagner Associates has designed a State Estimation Tool for Underwater Systems (SETUS) to enhance passive sonar state estimation. SETUS uses an innovative new approach known as Area Statistics (AS) to quantify uncertainty in acoustic propagation due to underwater environmental conditions, and incorporates this environmental data into comprehensive state estimates of passive sonar contacts. SETUS enhanced state estimates are driven by Wagner's powerful Agent Based Simulation With Bayesian Weights (ABSBW) tracking approach, which treats detection as a stochastic process, driven by the geometry of the scenario, environmental conditions and fluctuations, and variations in the target acoustic signature. The ABSBW is ideal for long term encounters with intermittent contact, such as in difficult environments, due to the ability to process negative information (loss of contact or failed search) as well as positive information.

**Warfighter Value:** SETUS offers passive sonar operators an automated tool for contact range and velocity estimation. SETUS incorporates existing Navy environmental measurements and models into its state estimation algorithms, allowing for faster and more accurate estimations of target location and heading. Further, the SETUS unique tracking approach gives solutions which properly account for multiple sources of uncertainty, and degrade gracefully when contact is lost or interrupted. A key distinguishing feature of SETUS is that it generates a full target state estimate, including indirectly observable features, such as target acoustic signature, which allow for target classification and discrimination.

WHEN

**Contract Number:** N00024-16-C-4529 **Ending on:** August 15, 2018

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Internal Demonstration on Classified Data	Med	AOU reduction of 50% compared to conventional approaches	5	September 2017
APB21 Step 1	Low	Demonstrated benefit of SETUS	5	January 2019
APB21 Step 2	Low	Independent test and evaluation with real-world and simulated data	6	July 2019
APB21 Step 3	Low	Test and evaluation within submarine combat system with real-world and simulated data	7	June 2020
APB21 Step 4	Low	Test and evaluation of SETUS at sea	8	TBD

HOW

**Projected Business Model:** Daniel H. Wagner Associates will provide SETUS functionality to the government as part of APB21, and further enhance SETUS to support other applications. Since SETUS is focused on passive sonar tracking, the primary customers, in addition to IWS5A/PMS425/PMS401, would include DoD organizations involved in passive sonar tracking such as ONR, PMS406, and DARPA. We have extensive experience in technology transition, an example is N05-046, Multi-Sensor Data Fusion System, which transitioned search effectiveness optimization and evaluation modules into two programs of record (PoRs): Undersea Warfare Decision Support System (USW-DSS) (IWS5E) and Littoral Combat Ship ASW Mission Package (LCS ASW MP) (PMS420). In addition, we could license SETUS for enhanced passive sonar tracking, as we have previously licensed data fusion systems for unmanned vehicles and border security (DFEN), and search optimization systems for mine warfare (MEDAL) and underwater search (MELIAN II).

**Company Objectives:** Daniel H. Wagner Associates is seeking to transition SETUS into the submarine combat system as part of APB21.

**Potential Commercial Applications:** Daniel H. Wagner Associates is looking for additional applications of our technology and methodology to other similar technology gaps. In particular, SETUS is applicable to surface ships, sonobuoys, and UUVs which use passive sonar arrays to detect, discriminate, and track underwater threats.

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