# Department of the Navy SBIR/STTR Transition Program

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Topic # N204-A01

HD Shape Tether for Autonomous Non-Destructive Inspection Tools
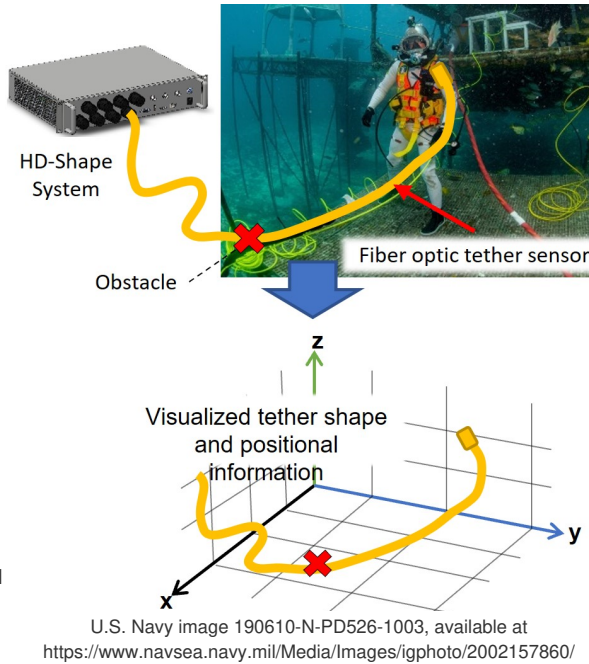Luna Innovations Incorporated

## WHO

**SYSCOM:** ONR
**Sponsoring Program:**
**Transition Target:**
**TPOC:**
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**Other transition opportunities:**
Manned and unmanned tethered diving systems; non-destructive inspection tools for piping, pressure vessels, and legacy structures; nuclear power system and spent fuel cask inspections

**Notes:** The High Definition (HD)-Shape tether is a sensor that provides position and orientation data along its length for non-destructive inspection and diving systems. The tether is designed for integration across multiple inspection and robotic platforms in low-access or GPS-denied applications. It can be leveraged to identify potential obstacles or entanglements on the tether to reduce operational risk to the platforms. An early version of this technology was sold to and commercialized by a medical robotics company.

HD-Shape System

Obstacle

Fiber optic tether sensor

Visualized tether shape and positional information

z

y

x

U.S. Navy image 190610-N-PD526-1003, available at https://www.navsea.navy.mil/Media/Images/igphoto/2002157860/

## WHAT

**Operational Need and Improvement:** 3D position and orientation information of personnel, machinery, or equipment typically use a combination of several technologies. Specifically, diving/salvage or robotic inspections have tethers for data transfer and critical support items. A tether capable of inherently providing its position and orientation will improve upon the current systems by enabling an operator to reduce the risk of tangling or becoming encumbered.

**Specifications Required:** • A robust fiber optic tether package for integration onto manned/unmanned diving platforms or robotic inspection systems.
• Operation in environments with limited physical access or GPS.
• Sensor tip position and angular accuracy less than 2 ft radius and 6°, respectively, for a 150ft tether.
• An update rate up to 30Hz

**Technology Developed:** The HD-Shape tether is a low-profile fiber optic sensor that is integrated or attached to a cable that can provide position and orientation data along its length. The tether can provide information to manual or robotic operators for monitoring or smart decision-making capabilities depending on the scenario or application.

**Warfighter Value:** Readily available positional and orientation data for the warfighter increases effectiveness for diving scenarios. 3D positional data for non-destructive inspections reduces setup time thereby reducing system down-time between missions.

## WHEN

**Contract Number:** N68335-21-C-0236   **Ending on:** February 28, 2022

| Milestone | Risk Level | Measure of Success | Ending TRL | Date |
|---|---|---|---|---|
| Proof of concept demonstrated in Phase I | N/A | Prototype sensor operation providing position and orientation along the entire sensor length | 3 | 1st QTR FY21 |
| Stable and accurate sensor measurements | Med | Demonstrate positional measurements less than 0.5% of sensor length | 4 | 4th QTR FY21 |
| Extended sensor length operation | High | Demonstrate shape and positional measurements with errors less than 0.5% per length | 5 | 1st QTR FY22 |
| Demonstration with end users with support | Low | Sensor operation with corresponding integrated equipment for positional feedback | 6 | 2nd QTR FY22 |
| System provided to customer and operated with minimal or no support | Med | Successful use of the sensor in a relevant environment | 7 | 4th QTR FY22 |

## HOW

**Projected Business Model:** Luna envisions a combination of direct sales and licensing of HD-Shape technology. HD-Shape sensors are well aligned with Luna's current product lines and expertise and provide a pathway to direct sales. Non-destructive inspection groups within power generation industries such as nuclear and petroleum are a method to either license or provide direct sales. Additionally, diving entities may either purchase or license the technology depending on the level of desired integration with existing products.

**Company Objectives:** Luna seeks to achieving "buy-in" from early adopters in commercial and defense industries. Luna has existing accounts with many prime defense contractors who have had favorable experiences using our distributed sensing products. Luna will work to secure one of these industry players as a Phase III partner to aid in requirements development and testing of HD-Shape technology. Phase III funding will originate from this industry partner combined with funds from government stakeholders that require accurate positioning in enclosed environments.

**Potential Commercial Applications:** There are numerous commercial applications for HD-Shape technology, especially in areas where tethers or cables are used extensively. Non-destructive inspection systems that use ultrasonic or eddy current techniques use tethers for data transfer and typically have encoder systems for measuring position. By using HD-Shape technology, a user can easily return to the same location for repeat inspections at lower cost, which is a cheaper solution for nuclear power, petroleum, or other process piping industries. A second application is for commercial manned or unmanned diving since tethered communication or air supply is required. Monitoring the tethers and hoses enables the end users to avoid obstacles and reduce the risk of tangling or damage. This technology may also be coupled to augmented reality systems to allow either a diver or a controller to immersivity monitor a situation.

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