**CASE STUDY – BECOMING A SME**

**I. GENERAL INFORMATION:**

**1. Agency Name -** Office of Naval Research

**2. Research Opportunity Title -** Research and Development/Technology Maturation of Solid State High Power Laser Weapon Systems, Subsystems, and/or Components for Surface Navy, USN

**3. Program Name -** Solid State Laser – Technology Maturation Program (SSL-TM)

**4. Research Opportunity Number –** ONR BAA 12-019

**5. Response Date –** Full Proposals: 10/16/2012

**6. Research Opportunity Description –**

Introduction. The Office of Naval Research, Naval Air and Weapons Department (ONR 35), in cooperation with the Naval Sea Systems Command (NAVSEA) Directed Energy and Electric Weapon Systems Program Office (PMS405), are considering a technology maturation (TM) program supporting the development and demonstration of an advanced, ship-based High Energy Solid State Laser (SSL) weapon system prototype to address Surface Navy capability gaps for area and close-in self-defense and Combat Identification/C4ISR. The ONR funded Solid State Laser Technology Maturation (SSL-TM) Program is focused on the rapid development and prototyping of laser weapon systems suitable for testing at sea on a naval surface combatant. The technology maturation program is currently classified as a science and technology "Leap Ahead" program, but in future may migrate into an Innovative Naval Prototype (INP), Future Naval Capability (FNC), or directly into an acquisition based program, as determined appropriate by Navy and Department of Defense Leadership.

The goal and threshold objective of the program includes demonstrating technical maturity of the solid state laser weapon system against relevant surface and air targets, in realistic encounters including representative ranges from the ship to target, while at sea and firing through a representative maritime environment. This specifically means the building and testing of a prototype laser weapon - off shore, at sea, on a moving ship representative of a naval surface combatant at combat speeds, in "combat like" conditions with representative targets engaged in "live fire" exercises. This also includes the goals of operating the prototypical laser weapon system from the ship's available power and cooling, and being connected to the ship's combat control and support systems.

At present, final transition platforms have not been officially identified by NAVSEA PMS405 for the anticipated future Program of Record. However, at present, two ship classes, the Arleigh Burke Destroyer, DDG-51, and the Littoral Combat Ship, LCS, are primary candidates for initial shipboard installation. Prior to combatant ship installation, prototypes may first need to be extensively tested at sea on other available naval test assets to ensure that technical maturity has been achieved prior to committing to altering operational assets. As indicated, SSL-TM program shall include the maturation of not just laser weapon specific technologies, but also its related weapon subsystems and ship interfaces, which shall enable a cost effective prototypical laser weapon system to transition sooner into a Navy Program of Record (PoR).

The desired approach is one that is based on modular open systems approach (MOSA) and architecture, where multiple vendors may supply subsystems, and connect through published interface control documents (ICDs) which utilize appropriate combinations of military and open industry standard (e.g., ANSI, IEEE, NEMA, etc.) hardware and software. Therefore, subsystems may be developed in parallel, by multiple contractors, and be interchangeable between the prototypes as they are tested. This BAA seeks, in parallel, submissions for:

* Fully Integrated, System Level proposals for development and testing of a prototypical laser weapon system,
* Subsystems Proposals for development and testing of a prototypical laser weapon system, that are able to be introduced through a MOSA approach, and
* Component Proposals for development and testing of a prototypical laser weapon system, that are able to be introduced through a MOSA approach either directly into the Prototype, or through a MOSA approach through a Subsystem and then into the Prototype.

The focus for initial proposal reviews shall be on the Fully Integrated, System Level proposals for the development and testing of a complete prototypical laser weapon system. After these initial proposal reviews are completed, subsystems and components proposals shall then be considered. The typical level one for subsystems of a laser weapon for guidance in developing proposals is as follows:

* Laser Subsystem, including power conditioning and internal cooling
* Beam Director Subsystem, including KINETO Tracking Mount (KTM)
* Targeting & Tracking Subsystem, including illumination, ranging, and aim-point maintenance functions
* Fire Control Subsystem & Software, including interfaces to shipboard combat systems and the Predictive Avoidance (PA) subsystem,
* Power and Cooling Auxiliary Subsystems, including interfaces to ship hotel systems
* Other auxiliary and mission support equipment

The Beam Director Subsystem of the SSL-TM program is seen by the Navy as having a number of highly critical technical risk elements, including the need to function for long periods in the maritime domain. Therefore the SSL-TM program's main focus will be on the engineering and technologies necessary to support extensive testing of a maritime based beam director (which includes generic functions for kinetic tracking mount or K.T.M.) for a laser weapon system, in order to reduce these risks. As a goal, a maritime based beam director from the SSL-TM Prototype may be installed on a Navy surface combatant or other Navy test vessel for long periods of time. This installation may be for periods of at least six months and will preferably be left unattended. This will require careful thought and planning regarding the development of stored configurations, startup sequences with and without a laser subsystem, as well as unattended aperture maintenance.

A stated goal is that during this six month "installed period" aboard ship - that there shall be little to no need for support personnel or extensive engineering support while in a stored configuration. Further, it has been stated that there would be no requirement for ship's personnel to adjust, clean, or examine either interior or exterior optics in the entire laser weapon system. Therefore, health monitoring of the optical train for a high power laser beam bath shall be considered a critical review item, as well as having unattended operations for verification and cleaning of external apertures.

Additionally, the potential exists for the SSL-TM prototype beam director, optics and associated mount and other subsystems to be exercised or used in collaborative testing, where a high energy laser subsystem is not installed or enabled. The vendor will be included in discussions of such use before it occurs, and the design concepts shown shall require an approach that considers robust self-diagnostic, automated maintenance, alignment & possible self-cleaning of optics, related human-systems interface with combat control systems engineering and development.

Other critical technical milestones, but potentially demonstrated to a lesser extent, shall be the high power laser's propagation in the marine environment to relevant target ranges in realistic at-sea weather conditions to collect scientific atmospheric propagation data, to perform predictive avoidance function verification, and to validate predictions of lethality/M&S against mission critical targets.

A second critical subsystem/element shall be the development and testing of associated external power distribution and cooling auxiliary systems, including designs of interfaces to the test platform's hotel systems. It is recognized that test platform power and cooling capabilities and quality may vary widely from land based test sites to sea based test sites. The government will be heavily involved in ship power and cooling interface developments. Where possible, the contractor shall clearly identify any power and cooling requirements expected to successfully field test the proposed prototype. Vendors should refer to references for ship power standards and possible fluctuations articulated in MIL STD 1399.

In early phases of the SSL-TM program, however, land based testing shall occur. Proposals received should supply technical information on any specifications necessary for sizing or acquiring external power generators and/or water chillers needed for land based testing. For land based testing, the cost of temporarily providing a support power and cooling system should be included, and for planning purposes, be over two separate testing periods of two weeks each. During concept development phase, the government shall reassess the ability to provide power and cooling as GFE/GFP for prototypes at any land based test sites. Further discussion of any intermediate power and cooling distribution subsystems development shall be provided throughout the concept development and detailed design process, including sharing technical details on how the prototype shall be connected to available power and cooling for an at-sea test platform.

The subsystem functions of source power and cooling shall be considered to be the responsibility of the contractor to provide if a "stand alone" configuration of the prototype is offered, but this shall be refined with the contractor during initial concept design phases.

In order to reduce the future risks to future prototype integration on a naval surface combatant, a notional laser weapon - ship integration study has been funded by ONR and is being cooperatively being developed with NAVSEA. The detailed results of that study, when complete, shall be provided at time of Phase I award. Additional, focused ship integration studies are expected to be continued by the government, and results of those studies shall be shared with the vendors in Phase I, as appropriate.

Achieving success in these critical technical elements simultaneously shall require a solid state laser subsystem, but it is accepted that the technology maturity or technology readiness level (TRL) of a high power laser subsystem may be lower than other subsystems, and can be mitigated through an modular open systems approach (MOSA) that leverages other funded science and technology development efforts - enabling future upgrades as the technology or subsystem is matured.

For example, a laser subsystem at higher power levels may not have been fully shock tested, but might be considered as a permissible final test criteria, provided there was sufficient planning and documentation on the engineering processes needed to mature and test the laser subsystem to grade A shock hardness as specified in MIL STD 901C, and that no other significant technology risks remained.

Documentation of the resulting engineering development path becomes part of the knowledge base that shall be shared by both industry and government product teams. Those subsystems already in laser subsystems development, for example, those already funded by the OSD High Energy Laser Joint Technology Officer in Albuquerque, New Mexico in the robust electric laser initiative (RELI), are of particular interest.

In order to develop a cost effective, prototypical laser weapon system, it is accepted that the laser subsystem could be less mature than the beam director or other supporting subsystems. The government recognizes that a laser subsystem could potentially be purchased separately and then offered as government furnished equipment (GFE) in order to reduce cost and minimize schedule risk. While recent success in high energy lasers at power levels up to 100 kilowatts have occurred and are expected to continue, and with higher power levels with solid state lasers seen as achievable within a decade, a modular open systems approach (MOSA) of multiple lasers built as line replaceable units (LRUs) is seen as having "best value" to show progressively increasing lethality. Similarly, testing to realistic power levels with non-rugged laser subsystems has also been shown to have value, result in a balancing of program cost for developing any new laser subsystems, and is expected to ultimately reduce the time required to achieve an initial operational capability (IOC) on a surface combatant. Therefore, the laser subsystem is still assessed by the Navy to potentially be a costly subsystem to develop and requires significant manufacturing lead times to produce quantities to conducting exhaustive testing for some projected mission scenarios at ranges relevant to their success and seeks innovative strategies to reduce that risk.