The Maritime Security Center (MSC)

at Stevens Institute of Technology
Hoboken, NJ

Year 1-2 Work Plan:
1 February 2015 - June 30, 2016
May 2015
1. Overview and Mission Relevance

The Maritime Security Center (MSC) will develop both fundamental and applied research to support DHS’s and other agencies’ maritime security mission goals, including improved detection and interdiction capabilities, enhanced capacity to respond to catastrophic events, and a more secure and efficient marine transportation system. MSC will focus on interdisciplinary research, education, and technology transition in maritime security, maritime domain awareness, and extreme and remote maritime environment issues. The goal is to develop and transition research and technology solutions and educational programs to DHS maritime stakeholders to improve capabilities and capacities for preventing and responding to events in the maritime domain.

MSC led by Stevens Institute of Technology (SIT) is composed of a consortium of internationally-recognized research universities, including SIT, MIT, the University of Miami, the University of Puerto Rico, Louisiana State University, Florida Atlantic University, and Elizabeth City State University. Henceforth in this document, MSC will refer to the efforts led by SIT and carried out with its partner institutions delineated above.

The MSC strategy to achieve its mission centers on the creation and sustainment of a truly collaborative research and education enterprise that draws on the strengths of each partner, as well as their leveraged relevant DHS and non-DHS research and education activities. We believe that these unique attributes – collaborative; integrated research & education; and leveraged relationships with Federal, State, local government, and industry stakeholders – positions the MSC for continued long-term success and impact.

DHS stakeholder components include U.S. Coast Guard and Customs and Border Protection. Specific areas articulated by the National Strategy for Maritime Security: National Maritime Domain Awareness Plan include priorities/gaps in dark vessel detection and tracking, anomalous behavior monitoring and information sharing.
2. Management Plan

Extending the reach of MSC, and facilitating the close collaboration of the faculty, research staff, and students of each partner institution, as well as the essential interaction with DHS, the component agencies, State and local agencies, federal laboratories, and other DHS Centers of Excellence, is a primary task of the Management Plan.

Our management plan and organizational structure also ensures that the MSC research and education activities will be relevant to stakeholders, with strong linkages to government customers and industry partners, and establishes a pathway for transitioning knowledge, technology products, algorithms and processes that will be of use in the field.

The MSC management team includes:

- An Executive Director/Principal Investigator
- A Director
- A Director of Education
- A Management Committee

**Executive Director/Principal Investigator:** Dr. Michael S. Bruno, Dean of the Charles V. Schaefer Jr. School of Engineering & Science at Stevens Institute of Technology will serve in this capacity. Dr. Bruno will function as the primary POC for the DHS Program Manager, and the primary liaison between the MSC team members and DHS and other Federal, State and local agencies as well as industry and non-governmental organizations. He will be responsible for the strategic direction of the MSC, and will serve as Chair of the Management Committee, which has the responsibility for selecting projects to be undertaken each year and for the allocation of MSC resources. Dr. Bruno will also be responsible for overall quality assurance, and for the adherence of the MSC to all contractual obligations under the Cooperative Agreement, including information assurance, information sharing, ITAR/EAR regulations, IRB processes, and health and safety plans. At Stevens, the Executive Director will report directly to the Provost, a reflection of the high priority of this position within the Stevens Administration.

**Director:** Assumes day-to-day management of the Center, and is involved in all aspects of strategic planning and stakeholder engagement. Activities include the preparation of project reports, plans, proposals, meetings, conferences, and workshops, and the coordination of activities at the partner institutions, government labs, and other DHS Centers of Excellence (COEs). The Director will be responsible for the preparation of the Workplans and Annual Reports. The Director will oversee – in coordination with the Management Committee – the scheduling and conduct of all face-to-face meetings and
telecoms among MSC investigators, as well as all meetings with the MSC Science and Education Advisory Committee (SEAC), all Stakeholder meetings, and other meetings as requested by the DHS Program Manager or as deemed necessary by the Executive Director. The Director conducts overall coordination of the (End to End) E to E projects with entities both within and outside of MSC, and incorporates input from USCG Research and Development Center (RDC), SEAC, the Program Manager and other bodies and individuals. The Director works closely with the Director of Education to coordinate outreach activities and to ensure that students are represented in research and stakeholder endeavors. The Director will work to solicit, prepare, and distribute whitepapers for government/stakeholder consumption that describe MSC research efforts and outcomes. The Director also represents MSC internally and externally. Dr. Hady Salloum, Associate Dean for Research, School of Engineering and Science at Stevens Institute of Technology will serve as the Director of MSC.

**Director of Education and Outreach:** will develop the overall vision and strategy for the education programs of the MSC, including Undergraduate, Graduate, and Professional (including certificate) programs, summer experiential programs, and specialized technology transfer meetings, tabletop exercises and other short programs tailored to the needs of the DHS component agencies. The Director of Education and Outreach coordinates, organizes, and implements all education and training-related activities. She will also be responsible for all reporting of education and training-related activities of the MSC, to the MSC SEAC, the Stakeholders, and the DHS Program Manager. Working with the Management Committee and the individual Investigators, the Director of Education will also be responsible for the development of all publications and presentations related to education and training, and all education- and training-related proposals and initiatives. Additional responsibilities include the recruitment, retention, and subsequent placement of students in the various educational programs. As the lead for outreach, this person is responsible for all media relations, newsletters, public and professional outreach, and coordination with the DHS communications personnel. Ms. Beth DeFares, Stevens Institute of Technology, will serve as the Director of Education and Outreach.

**Management Committee (MC):** The MC is responsible for top-level coordination of the MSC activities. The MC will be chaired by the Executive Director and will consist of one representative from each of the partner institutions (typically the co-PI), along with the Director and Director of Education. The MC will also include the DHS OUP Program Manager. In consultation with the DHS OUP Program Manager, we will appoint a limited number of DHS stakeholders, for example from USCG RDC and S&T Borders and Marine to the committee. The MC will be responsible for the selection of MSC projects, the allocation of funds, and the responsiveness to the DHS biennial review.
The MC will meet by conference call on a monthly basis, and face-to-face on a semi-annual basis. The MC will facilitate – through their personal contacts within their own organizations – strong communication among the individual faculty, researchers, and students that make up the MSC, and responsive interactions with DHS and the various stakeholder communities.

**Advisory Board** (Science and Education Advisory Committee). The SEAC consists of representatives from the maritime industry, relevant state and local agencies, academia, and national labs. The SEAC advises the MSC on present and future research projects and educational programs from the perspective of the current state-of-the-art in relevant science and technology, and present and future needs of the MSC stakeholders and end users. The current SEAC Members are listed below. We anticipate to review the current membership and identify potential new members to add or replace existing members:

- Admiral James Loy (USCG ret), Chair
- Vice Admiral Robert Parker (USCG ret)
- Ms. Lilliane Borrone, former Director of the Port of New York and New Jersey
- Mr. Steven Carmel, VP, Maersk Sealand
- Dr. John Montgomery, Director, Naval Research Laboratory
- Ms. Sidonie Sansom, Director of Security, Port of San Francisco
- Ms. Bethann Rooney, Assistant Director of Port Commerce, Port Authority of NY and NJ
- Dr. Martha Grabowski, Professor, Rensselaer Polytechnic Institute

**Facilities**

MSC is headquartered at Stevens Institute of Technology in Hoboken, NJ. The physical infrastructure of Stevens includes direct access to NY Harbor via the Hudson River, a more than 30,000 square foot ocean engineering laboratory complex that houses the most advanced towing tanks and wave tanks in the nation, two fully equipped coastal and estuary research vessels, a Maritime Security Laboratory for real-time data visualization, and an operational ocean and weather observation and forecasting system that covers the region from Nantucket Island to the Chesapeake Bay. Stevens makes available office space, meeting rooms, and conference facilities on its campus, which is conveniently located near three major airports and rail, subway, ferry and bus transportation systems. The space includes offices for the Executive Director, Director, Director of Education, Administrative Assistant, as well as up to six visitor offices for use by individuals from the partner institutions, DHS, and other organizations. The meeting rooms and conference facilities can accommodate groups ranging in size from 20 to 400 people.
Project Evaluation

MSC will continue to measure its progress towards both its short- and long-term objectives through a formal review process. The research evaluation cycle begins with an annual call to the PIs to submit their planned project workplans. These plans will be reviewed by MSC’s Executive Director and Director. This process will be interactive between the research leads (partner university PIs) and the MSC leadership, where feedback will be provided on the technical relevance in the context of the overall Center’s themes and E to E projects. Corrective actions required will also be provided when warranted. The Director will be responsible for tracking post-project developments and for providing measurements of MSC’s progress in transitioning. The Director of Education will be responsible for evaluating specific education programs using metrics described below.

The management committee will conduct a quarterly review of project progress in relation to milestones and metrics. Deviations/delays will be discussed with the DHS Program Manager, and corrective action will be taken.

Our overall approach in the evaluation of the MSC activities is shown below. In essence, the goal is to have a clear understanding by the end of Year 2 as to which activities will be continued, which need to be modified (and perhaps even enlarged) and which need to be ended.

![Project Evaluation & Transition Diagram]

- **Implement** (Just Do It)
- **Challenging** (Requires Coordination/Planning)
- **Possible** (Low Priority)
- **Kill** (Waste No Time or Resources)
The management committee quarterly review will gather data on the following topics/questions and a detailed discussion will be undertaken to establish the continued viability of each project. The discussion will take place with the project PI, and feedback will be consolidated and supplied to the project PI in written format. We expect that the members of the management committee will actively participate in the evaluation of the data gathered, and in the preparation of the feedback to the PI. This process will rely on email correspondence, and phone calls as needed. The issues/questions that need more clarification and/or work progress to address any concerns will be undertaken at the subsequent quarterly review.

Project-based evaluation criteria we will assess (also relevant for biennial review) include:

- Do reported performance metrics and milestones indicate adequate progress towards meeting objectives?
- Alignment with DHS stakeholder research gaps and needs
- Does the project formulation and progress demonstrate an understanding of related studies? Has the PI demonstrated an understanding of previous studies?
- Does the data acquired support the best available and is the data verifiable?
- Has the research contributed to scientific knowledge in relevant fields? Do the findings advance knowledge and do they address the needs of the users?
- Does the project have the potential to create operational efficiencies and/or buy down risk?
- Do the project teams contain an appropriate mix of interdisciplinary skill sets and partners needed to achieve the research objectives within the proposed timeframe?

On an on-going basis, the MSC management team will continue to monitor the quality of the research projects in the portfolio and collect data on:

- Publications and joint publications, refereed articles, technical reports, books, and presentations
- Number of graduate students involved in MSC and MSC-related research
- Adoptions of MSC products by end-users
- Student/faculty exchanges
- Collaborative conferences and workshops (number and attendance)
- Total funding from external sources
- Patents
- Copyrights and trademarks
- Transitions and commercialized products
MSC will take input generated by DHS and reflect this feedback in our education and research projects. In particular, feedback provided by the DHS biennial evaluation will be used to implement changes or corrective actions, as required.

A key feature of our approach to the development, evaluation, and transfer of our research to beneficial use in the field is the fact that we intend to use the process outlined here, including the planned meetings, to gain insights into new products and new approaches that HAVE NOT evolved from MSC activities. We believe that one of our most important roles under the MSC is our function as an impartial arbiter of any and all new developments related to maritime security, either at the request of a component agency or on our own initiative. We expect to facilitate the early adoption by the Department of promising new technologies and procedures, whether or not they are developed by a MSC partner. We recognize that this process may, depending on the nature of the identified need and/or development, require that the MSC reach out to the larger community (e.g., via a request for proposals (RFP) for promising ideas and approaches.

MSC management will begin at the outset to solicit research questions/needs from our DHS customers. Mechanisms to achieve input include stakeholder meetings and The Maritime Risk Symposium, where we intend to define and refine potential research questions. We will avail ourselves of Center outreach mechanisms and will also attend closely to agency/division roadmaps and pursue data-mining to better understand both the technology gaps and the possible non-MSC research performers. Importantly, one possible benefit of this approach would be that the MSC can “buy down” the risk for certain identified areas of R&D being pursued by Division. Once we have identified the technology gaps and the areas of need, we plan to issue RFPs by late Winter, 2016 based on these research questions/needs and the responses will be reviewed to assess scientific quality and relevance. Highly-ranked project proposals will be submitted to DHS by late Spring 2016 in anticipation of new projects starting as other projects end. MSC will, in coordination with DHS Office of University Programs (OUP), establish a formal process to manage the solicitation, selection, and award of projects. This process will include the selection of research topics, the selection of reviewers, the review process, and the selection and ranking of the project proposals. The new projects will be incorporated into the Center and will benefit from the management and evaluation processes described in this Workplan.

A consolidated annual report will be produced detailing activities for the previous year, quantitative measurements of the progress towards objectives, and plans for the future. The annual report will detail the Center activities in the research, education, and outreach areas, specifically comparing outcomes with the lists of proposed tasks detailed in the
workplans. The MSC SEAC will be engaged to provide feedback on a semi-annual basis on the progress of the Center.

The following areas will be continue to be monitored and encouraged on a Center basis:
• Quality of research being conducted under various themes
• Relevance and operational impact of research on end-users
• Dissemination of findings, transition of products, and commercialization
• Diversity and work with Minority Serving Institutions (MSIs) and underrepresented minorities
• Education in homeland security, including graduate research support
• Production of homeland security researchers and professionals
• Outreach to other DHS centers; national laboratories; research and security organizations; and Local, State, and Federal agencies
• Organizational efficiency and management (streamlined processes – e.g., consolidated tracking of research progress, DHS research needs, and processes for new project initiation)

An additional cluster of metrics relates to the ability of the aggregated MSC research projects to impact stakeholders. These metrics provide a synergistic integrated layer to the metrics listed above, but overall they represent a means of assessing the Center impact. The expectations will vary by project and stage of research, but overall include:
• Number of high-quality whitepapers produced for government/stakeholders to explain our research progress and/or experiments and outcomes
• MSC scientists used as Subject Matter Experts (SMEs) by stakeholders
• Advice and information provided to Federal, State, and local elected officials and decision-makers, via testimony and other means
• Joint activities with stakeholder organizations (conferences, workshops, exercises, technology evaluations or deployments)

We will also have a cluster of Center-focused transition questions. These questions, which will be used to inform the various review processes, will include:
• How is the Center disseminating research results broadly to the public and to stakeholder end users to enhance their scientific and technological understanding (metrics to include newsletter frequency and readership stats; dissemination of 1-pagers)
• Is the transition strategy and team composition adequate to ensure continued progress toward transition?
• How does the work stand on transition readiness path (e.g., USCG) (formal evaluation status)
• Is the activity sustainable over along enough duration to ensure transition?
Transition Plans

The MSC transition strategy begins with stakeholder guidance, stimulates and sustains interest and confidence in technologies throughout product development, and leverages existing partnerships with industry to ensure timely transition. This includes:

- interacting frequently with DHS stakeholders, primarily in the form of meetings and workshops, to repeatedly assess evolving needs and capability gaps;
- establishing a chain of trusted agents between the technology developers and end users to ensure delivery of robust, fit-for-purpose systems and provision of reliable technical - and operational support from the component level up through the system level;
- engaging DHS stakeholders in joint ventures to the extent appropriate to ensure that dual-use and multi-use transition opportunities are fully considered and exploited.

A key goal of MSC will be to transfer data and knowledge (e.g., via journal and trade publications) and envision ways to transition technology to end-users in an operational environment – including DHS components, and state and local government users. Building the chain of trusted agents and nurturing long-term relationships with the end user communities based on mutual trust and demonstrated performance is essential to the success of the technology transfer efforts.

To assess technology transition readiness, MSC will adapt established methods and metrics used by DOD and NASA. MSC will solicit DHS user input and feedback to help focus demonstrations of early research efforts and feasibility studies at Technology Readiness Levels (TRL) 1 to 3. Likewise we envision field and/or tabletop experiments in support of the acoustic communication and satellite work described herein.

We note here that the Stevens Office of Innovation and Entrepreneurship is specifically chartered to facilitate technology transitioning, and this resource will be applied to assist MSC. Stevens Office of Innovation and Entrepreneurship includes individuals highly knowledgeable in intellectual property development, identification, protection, and commercialization. This office facilitated the commercialization of the Stevens passive acoustic underwater surveillance system in 2012. MSC will continue to look for transition opportunities using all vehicles available (e.g., CRADAs, Memoranda of Understanding, Memoranda of Agreements, Licensing Agreements, patent disclosures, copyrights, etc.).

For fundamental research, knowledge transfer will be accomplished via the traditional routes of peer review and dissemination. These will include conferences, proceedings volumes, books, and peer-reviewed articles in leading academic and professional journals.
A key component of this effort will be to transfer data and knowledge quickly and directly to the user community – NOT via technical journal publications – but rather via short, user-friendly documents tailored to the audience and describing the latest MSC results, e.g., a technology demonstration experiment, a new deployment, or the adoption of a new process or methodology. The intent of these documents is to facilitate rapid information exchange and possible collaboration and end-user opportunities, thereby accelerating the adoption of the portfolio tools and technologies. We will also utilize outreach mechanisms such as newsletters and 1-page research summaries to facilitate this process and keep potential and existing end-users informed, on a project-by-project basis.

As knowledge transfer is also inextricably tied to education, MSC will continue to provide means, motive and opportunities for students to transition from academia into the DHS workforce and for members of the DHS workforce to participate in MSC activities as students.

**Other Activities**

The management team will continually review activities to ensure compliance with federal regulations as well as the terms of the Cooperative Agreement. The MSC team promotes a culture of safety. To that end, we will institute a regular review of the established safety plan by forming an independent panel of experts. Our USCG auxiliary program and advisory personnel will be important resources on this topic, and we intend to insure that the safety priority is communicated and enforced at partner institutions through regular review of their practices and procedures. The safety plan and information protection plan will be reviewed/updated once per year or as warranted.

The MSC management team will organize MSC participation in a DHS-managed, biennial review. The MSC will coordinate activities with other Centers of Excellence, including joint projects and stakeholder events.
3. Stakeholder Engagement

The MSC will be pro-active in working in close coordination with the DHS Program Manager to ensure frequent and ongoing stakeholder engagement. The management team has developed extensive contacts within the community, and has had more than six years of experience in organizing and conducting highly impactful meetings, workshops and conferences. The following summarizes the plans for stakeholder engagement over the period of performance of this Workplan. Note that student internships, the Summer Research Institute, and participation in the workshops/meetings below will be the primary means of engagement of our students with the stakeholder organizations.

Quarterly Stakeholder Engagement Meetings
The quarterly stakeholder engagement meetings will be held at various locations, including Stevens, the USCG Research and Development Center (RDC), and partner university campuses. Stakeholder Meetings will engage a broad array of USCG representatives (from Sector, District, Area, Headquarters, Academy and Fellows), other DHS components (Borders & Maritime, CBP and CBP Air and Marine Operations Center), and other federal stakeholders such as National Maritime Intelligence-Integration Office (NMIO), JIATF-S and National Urban Security Technology Laboratory (NUSTL), Navy and NOAA. Regional and local stakeholders such as Port Authority of NY/NJ, NYPD, NJ Office of Homeland Security and Preparedness (NJOHSP), NYC Office of Emergency Management are expected to attend as well. The meetings may also include industry representatives and academic partners, depending on the topics being covered.

A key objective of the stakeholder meetings is to gain insight on user needs. The purpose of the meetings is to present our research and transition progress in a manner that connects it directly to the potential end-users.

The Quarterly Stakeholder Engagement Meetings will be up to a day-long event and be organized as follows. There will be a brief review of the progress on select Center projects, along with a report on the transition activities and plans related to each project. Feedback will be solicited from the attendees both at the time of the meeting and as follow-up by phone or e-mail. A goal is to actively track the stakeholder response and make adjustments accordingly. The Stakeholder meetings are also valuable to identify potential challenges in transitions of projects downstream so we can anticipate and adapt/respond ahead of time.

The stakeholder community gains an ability to influence the stages of project development in ways favorable to ultimate adoption. They also gain the opportunity to meet researchers and engage in idea generation that could lead to new projects.
DHS Science and Technology (S&T) Outreach Events
MSC will participate in at least two DHS S&T outreach events to showcase our activities, tools and technologies and solicit feedback from potential end-users.

Other Stakeholder Engagement
MSC will seek a variety of other formal opportunities to interface with stakeholders such as Technical Interchange Meetings in coordination with the Coast Guard RDC, meetings to work with our local law enforcement partners (e.g., NYPD, NJOHSP, and PANYNJ), and coordination and information exchange opportunities with the DHS National Urban Security Technology Laboratory, Sandia National Labs, CBP AMOC, among others. These meetings may include coordination on specific projects or opportunities to develop potential new projects.

Maritime Risk Symposium
Stevens will host the Maritime Risk Symposium 16-17 November 2015. This event draws together other Centers of Excellence, the U.S. Coast Guard, various academia participants, DHS components, DoD and industry. It serves as a key stakeholder nexus. As such, it represents a vital opportunity to define and refine research questions/gaps in the maritime domain where Centers can consider focusing research and transition efforts. The theme of the 2015 Maritime Risk Symposium is "Maritime Risk in the Western Hemisphere." Our plan is to involve additional operational elements such as JIATF-S, CBP, and the new JTF-East and West as participants in the Symposium. The organizing committee for the Symposium is drawn from a range of USCG, Academic, and DHS personnel. The panels will be focused around themes that emerged from the recent USCG "Western Hemisphere Strategy." These include 1.) Combating Networks, 2.) Securing Borders, 3.) Safeguarding Commerce. Additional panels will address Predictive Analysis/Future Trends (environmental change), and S3A/Marine Spatial Planning. The moderator of each panel will focus the discussion around questions and gaps that can be ameliorated with research input. To assist with the symposium, we will parse the Strategy to identify the challenges and provide this information to the panel members in advance to focus their discussion points. Panel members will include users (i.e., operators, law enforcement, military, industry) that could speak to challenges noted in the Strategy and government and university academics and researchers that can talk to research completed or underway that is addressing these challenges. The Moderator of each panel will then lead a discussion among all participants to solicit and develop research questions that address knowledge gaps.

The outcomes from this effort will be a Proceedings of the Symposium, including a disk with submitted whitepapers, a rapporteur's report of the key discussion points and key research questions identified during the symposium. Also, a whitepaper for potential publication will summarize the Symposium and made publically available so the research community could explore areas of operational relevance. Finally, after discussions with stakeholders and OUP, we anticipate that we will develop and issue a request for
proposals (RFP), along with a process for the conduct of a merit review of proposals, to address knowledge gaps.

**Meetings of the MSC Science and Education Advisory Committee**
MSC will conduct an annual meeting of the SEAC, on the Stevens campus or at the location of one of our partner organizations. We will also invite the members of the SEAC to some of the activities described above, as deemed appropriate.

**Faculty Exchanges**
We envision conducting several researcher exchanges to stakeholder environments. Venues could include USCG operational settings or headquarters. Through these exchanges, MSC researchers would gain exposure to how the entity conducts its day-to-day operations in the mission space. Exchanges will last a week or longer, and may include longer-term faculty sabbaticals. In addition, MSC will support DHS S&T’s Embed Program as part of the Partnering for Innovation & Operational Needs through Embedding for Effective Relationships (PIONEER), whereby it is anticipated that S&T program staff will be embedded into MSC.

**Engagement with Potential User Groups**
MSC research and education efforts will build upon existing collaborative, interagency and interdisciplinary relationships. In addition to the Port of NY and NJ, the MSC will work with several U.S. ports, including the ports of Los Angeles, Houston, Seattle, Honolulu, San Juan, Miami, and San Francisco. Several organizations currently interact with MSC on a regular basis to determine the homeland security needs of individual critical infrastructure locations and their interdependencies to the region, and representatives of these essential organizations are often members of the MSC SEAC. For example, MSC has been involved with the NJOHSP to determine state and local homeland security needs and we have engaged in organized exercises as evaluators and participants. These activities will be continued and expanded. MSC will also work with local Area Maritime Security Committees (AMSC), an essential element of the DHS national strategy to prevent terrorist attacks, mitigate natural disasters impact, and reduce vulnerabilities to port safety and security.

Future engagement efforts will focus on expanding partnerships with DHS via FEMA, CBP, ICE and the Office of Health Affairs as well as increasing MSC’s strong collaboration with USCG. We will also engage with the national labs.

We will continue a multi-pronged approach to introduce MSC personnel and capabilities to new partners via:

• Meeting in small groups at their facilities to discuss their needs and capability gaps;

• Inviting them to participate in MSC workshops and annual meetings; and
• Attending broader meetings in their fields or at their local venues that pertain to homeland security.
4. Research Projects

The MSC research projects are conducted in Maritime Domain Awareness. The research activities to be conducted are outlined below.

- Maritime Domain Awareness
  - Port Resiliency (FAU)
  - Satellite-based MDA, with a focus on the integration of data streams into DHS systems

In the following sections, we describe the activities to be conducted during the period of performance of the Workplan.

4.1 Port Resiliency (FAU)

A Smart Port Resiliency Assessment and Planning Tool

Principal Investigators

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Abstract

The principal objective is to develop a cost-effective port resiliency assessment and planning tool that can be adapted, through a choice of interchangeable event modules, to assess and plan for evolving threats and hazards to a port and its waterside and landside distribution capacity, in support of avoidance and mitigation of damage and capacity reduction, and aiding rapid recovery from disruptions. Major disruptions at a port may result from such factors as natural disasters, terrorism, labor disputes as well as multiple catastrophic events. The aim is to build on experience in transportation simulation and modeling to develop an integrated tool based on a systems approach to port distribution capacity, port operations, risk management, and policy and jurisdiction considerations. Other objectives include development of databases of human-caused risks and of human responses to natural or human-caused catastrophic events for decision makers and promote related graduate education. The proposed tool will be made available for use by local, state and federal agencies as well as port planners and operators in effective port preparedness for potential disruptions. Considerations will include impact of catastrophic events on port operations in the context of maritime policy, jurisdictional responsibilities, and international relationships. Strategies will be developed for managing risks that have been identified as well as potential additional risks that may be identified in the course of the project. The effect of risks on safety and resilience will be studied and simulation models will be developed to determine system impacts, including throughput and delays.
Baseline, Objective and Purpose

**Objectives:** The principal objective is to develop a cost-effective port resiliency assessment and planning tool that can be adapted, through a choice of interchangeable event modules, to assess and plan for evolving threats and hazards to a port and its waterside and landside distribution capacity, in support of avoidance and mitigation of damage and capacity reduction, and aiding rapid recovery from disruptions. The aim is to develop an integrated tool based on a systems approach to port distribution capacity, port operations, risk management, and policy and jurisdiction considerations and involving simulation and modeling. Other objectives include: 1) Development of a simulation model for selective intermodal facilities that is going to cover operation and logistics, 2) Study and analysis of optimization problems related to resilience that are commonly encountered in intermodal/port facilities to incorporate various stochastic elements such as uncertainty for the terminal’s performance measures in order to evaluate the performance of optimization algorithms under different scenarios, and 3) Promotion of graduate and undergraduate education in transportation and marine engineering.

**Background:** US maritime ports connect maritime commerce, worth over $649 billion annually, to the rest of the country through a network of roads, railroads, and airways. Over 66% of the crude oil consumed in the US is delivered via tankers through these ports. During national emergencies, large military equipment is deployed via selected ports. Further, ports play a major role in the recovery and relief efforts in the wake of catastrophic events, typically as the primary means by which bulk of the disaster relief aid is distributed to the affected communities. The capacity of the ports must therefore be adequate, reliable, accessible, and economical (CMTS, 2008). Impacts due to a major disruption at a port to any one of these attributes, particularly if the disruption is prolonged, can result in reduced capacity, which could seriously impact the US economy and security or humanitarian relief effort. When a port is itself significantly damaged by a catastrophic event, efforts to distribute these vital services and supplies are further crippled. Therefore the highest degree of resiliency of a port and associated distribution capacity is desired so that damage or disruption to a port is, in the first instance, avoided or mitigated, and secondly, should damage or disruption occur, the port can rapidly recover and respond effectively, reestablishing normal or near-normal levels of operations. A resilient port incorporates flexibility in its operations and quickly recovers in the wake of a catastrophic event.

Recent major natural disasters had significant impacts on seaports of the global supply chain system: Hurricane Sandy on the port of New York / New Jersey, the 2011 Tohoku earthquake and tsunami on several Japanese ports, and the 2010 Haiti earthquake on Port-au-Prince. Best practice recommendations, based on lessons learned from these events, have been proposed and can be utilized in developing strategies for safe ports.
FAU will build on experience in transportation simulation and modeling and take a systems approach to port distribution capacity, port operations, risk management, and policy and jurisdiction considerations in developing the proposed tool.

Ports are complex with many public and private stakeholders. Therefore, we will aim to engage with them early in the process. Our team will take advantage of the existing strong relationship between MSC researchers and the stakeholder community within the Port of NY/NJ, as well as the stakeholder communities that have been engaged by Jim Rice and his colleagues from MIT. In conjunction with these stakeholders, including port administrators, US Coast Guard, maritime industry, the requirements for the proposed tool will be defined. The requirements that will need to be defined are discussed in Task 4 below.

Merits of the Proposed Smart Tool: The proposed effort is based on developing a tool that has the following merits. The approach discussed is aimed at incorporating these attributes in the tool.

1. Adaptability and versatility for addressing evolving threats and hazards via interchangeable event modules that can be revised and replaced as the situation demands while maintaining the structure of the basic tool.

2. Focus on the impact of a disruption on landside as well as waterside capacity distribution is clearly needed.

3. Based on a multi-disciplinary approach

4. Cost-effectively meet the demands of increasing freight and port traffic.

Overall Research Approach: The tool development will be based on modeling and simulation, taking a systems approach to port distribution capacity, port operations, risk management, and policy and jurisdiction considerations. Risk management of a catastrophic event (Conger, 2011) involves careful assessment of the vulnerability of the port to natural and human-caused catastrophic events; implementation of prevention or risk reduction measures to avoid or mitigate damage; advance preparation for quick and effective response and proactive measures to ensure financing is available to cover the costs of response and recovery. Principal considerations in the approach include:

- Identification of threats and hazards to port transportation system
- Safety, security and resiliency of the port infrastructure: Requirements for port operations and increase in capacity, weather readiness, exposure and mitigation of threats and hazards, disaster response
- Safety, security and resiliency of the waterside distribution capacity: Requirements for sea freight, navigation infrastructure, ship traffic management, maritime surveillance, weather readiness, exposure and mitigation of threats and hazards, disaster response
- Safety, security and resiliency of the landside distribution capacity: Requirements for road and rail freight, road and rail infrastructure,
Intermodal connections, weather readiness, exposure and mitigation of threats and hazards, disaster response

- *Interagency and stakeholder coordination*: Community resources and societal impact, compliance with policy, jurisdiction and maritime security governance

The basis of the simulation will be integrated modeling software such as Aimsun NG (Xiao et al., 2005), which is used in transportation simulations by governments, planners, industry and academia worldwide. The software requires prescribing specific models for characterizing features of a given dynamic problem, and uses a built-in library of rules and behaviors to simulate responses to an event. Port operations may be complex and dynamic with many degrees of freedom and uncertainties in initial states. The events or operations may be discrete or continuous. Discrete events may be modeled with the Monte Carlo method to generate a range of possible outcomes and the best solution would be determined using the Brute Force method. Continuous events/operations would be modeled by a set of non-linear differential equations. Resilient states may correspond to equilibrium points of the equations in the parameter space and the resiliency is measured in terms of the departure from that state by a disruption or the time it takes in the parameter space to return to a resilient state. Where the resilient state corresponds to a path in parameter space rather than the equilibrium points of the differential equations, the Viability Theory (Aubin, et al. 2011) of evolution of dynamical systems is used to determine a system that collapses if it departs from a subset of state space called the viability constraints set – optimal paths within the parameter constraints in returning to resilient states within the shortest times are determined through optimization. The model development effort will be carried out in stages and in flexible ways to facilitate verification and to allow making changes to the models.

To simulate activities at a port, key elements of the port such as location of buildings, docks, road networks, traffic lights, locations of junctions etc. are first defined. Next, critical functions of port elements are identified and their vulnerabilities, represented by variables $\bar{z}$ are assessed, at the individual-element level and in the global context of the port. Then external disruptors, characterized by parameters $\bar{p}$ that can impact port activities are identified. Finally, decisions, represented by vector $\bar{x}$, that may mitigate or exacerbate the vulnerabilities may be specified. The Aimsun hybrid simulator, for example, takes this information as input, combines it with a library of rules and models of operational dynamics to provide a simulated realization $\tilde{f}(\bar{x}, \bar{z}, \bar{p}, \bar{e})$ of a set of measures, such as speed, volume and density of people or vehicles in a given scenario, as response to the decision vector $\bar{x}$; here $\bar{e}$ is a random component of the simulation response. The simulator simultaneously provides an event-based mesoscopic simulation together with more detailed time-sliced microscopic simulation for each realization. Depending upon the port operation, rules within the library may be added or modified in a given simulation. The outputs of the simulation are characteristics of the port elements such as, occurrence of queues and bottlenecks and associated wait times at various
times of the day or in response to a disruptive event. The output may include a port management optimization scheme formulated as

\[
\min_{\tilde{x}, \tilde{z} \in \Omega} E[\tilde{f}(\tilde{x}, \tilde{z}, \bar{p}, \bar{e})]
\]

where \(\Omega\) is the feasible parameter space that links \(\tilde{x}, \tilde{z}, \bar{p}\), and realized measures \(\tilde{f}\). Other outputs include 2D and 3D realizations of the simulation runs. These are not only highly desirable features but can also aid the analysis and understanding of the operation of the port element being studied as well as examine complex operational strategies.

Simulations may be conducted on macroscopic, mesoscopic or microscopic levels. Macroscopic simulations deal with aggregated characteristics of port elements. Mesoscopic simulations analyze port elements in small groups, within which elements are considered homogeneous. Microscopic simulations study individual elements of a system, such as a port, such as individual vehicle dynamics and individual traveler behavior. Aimsun NG (Xiao et al., 2005), which contains algorithms for accurately modeling and simulating various layers of simulation, will be considered to conduct simulations simultaneously at different levels. The approach will be based on multi-scale hybrid simulation models, comprising components executed in parallel. One component may involve simulation of discrete events, while the other may involve simulation of continuously occurring port activities and flow-through. Both types of simulations may be conducted at mesoscopic and microscopic levels allowing consideration of static or routine activities/operations with dynamic ones using the Aimsun platform.

Other key features of the selected toolset will include the ability to model dynamic demand patterns and stochastic processes. Part of our work will be to compile a series of simulation realizations of performance measures \(\tilde{f}(\tilde{x}, \tilde{z}, \bar{p}, \bar{e})\) that include normal operation scenarios vs. incident scenarios with the required level of impact to provide projected results of decisions \(\tilde{x}\) for the two cases. The vulnerabilities \(\tilde{z}\), external parameters \(\bar{p}\), the decisions \(\tilde{x}\) as well as the performance realizations \(\tilde{f}\) may each be assigned a Bayesian (conditional) probability. Then using available algorithms based on Bayesian networks (Zhang and Taylor, 2006), or California Algorithm or SVM (support vector machine), anomalies in the realization \(E[\tilde{f}(\tilde{x}, \tilde{z}, \bar{p}, \bar{e})]\) may be identified and analyzed to determine the source of the anomaly. Each method has various attributes. For example, the California Algorithm is based on suggesting occurrence of an incident if any of the thresholds assigned to the performance measures are exceeded. The Bayesian network algorithms are based on causal relationships so that anomalies in performance measures related to given decision vectors \(\tilde{x}\) may be traced to vulnerabilities \(\tilde{z}\) or external factors \(\bar{p}\). We will analyze the attributes of the various methods for the proposed application and select one that is most suitable. A number of Modules will be developed that model human behavior under various conditions (e.g., natural disasters, homeland security scenarios) (Kaisar et al., 2014).
A regional scale multimodal simulation of a port distribution network will be developed. Using meso- and micro-scale modeling (cf. Dixit et al., 2011) of land, rail, and sea facilities, a quantitative assessment of port distribution capacity will be developed. Next, a series of disaster scenarios ranging in scale will be simulated within the network. Using the computation power of the simulation model the reduction in capacity at each stage of supply chain will be calculated. Using this information it is possible to identify the key components contributing to capacity reduction within the network. Once identified, a survey of port administrators, emergency managers and transportation officials will be used to develop mitigation strategies. Also a recover priority hierarchy (see for example, Kaisar et al., 2003) will be established using stakeholder input, which will advise future managers on how best to mediate distribution capacity reduction caused by a regional catastrophic event.

Strategies will be developed for managing risks that have been identified as well as potential additional risks that may be identified in the course of the discussions with the stakeholders. The effect of risks on safety and resilience will be studied and simulation models will be developed to study systems impacts (throughput, delays, etc.), in support of improving resilience of a port and associated distribution systems. In addition, a port operation simulation model will be incorporated to capture physical, operational and management complexities, in support of complex interactions for preparedness and response to catastrophic events.

Identified Tasks and Proposed Schedule

The following tasks and associated schedule are identified:

Task 1a. Develop detailed work plan

Task 1b. Define the port system and scope of the project: As a first step, we will define the "port system" to be modeled. The system will include ships, trains, trucks, containers, cargo, people, and elements of the port infrastructure and local amenities, and associated vulnerabilities, particularly roads, buildings, intermodal facilities, docking facilities and port terminals, as well as potential disruptors such as loss of the electric grid or port surveillance system. We will establish who will be the operators of the proposed system-based tool; we envisage combination of the Port Authority, USCG, and DoT since a typical port has multiple stakeholders. In conjunction with these stakeholders and USCG R&D Center, we will determine what information is available and accordingly establish the scope of the project given the available resources and timeframe. This will include the level of fidelity of the simulations and the classes of parameters that will be considered. Performance metrics for various project milestones will be established in conjunction with stakeholders.

Task 2a. Assess port vulnerabilities: Research, identify and analyze available data on the aftermath of previous natural and human-caused disaster impacts
on ports to identify vulnerabilities of a port system. Determine the representative variables \( \mathbf{z} \) that characterize the vulnerabilities of the system elements and the Bayesian probabilities of their failure, including cascading failures of the system.

**Task 2b. Identify characteristics of external disruptors:** Port authorities, USCG, DoT, other federal and local agencies and other stakeholders will be engaged and in identifying threats and hazards. Available USCG data, such as MSRAM and CART, will be analyzed to establish parameters \( \mathbf{p} \), with associated Bayesian probabilities, that characterize external disruptors in the system model. Data will be needed from USCG and we will utilize available dataset developed by Jim Rice.

**Task 3. Establish port rules, policies and decision-making process:** At any time the port activities are governed by a set of rules, policies and day-to-day decisions that may be characterized by the vector \( \mathbf{x} \) in the system model. These incorporate strategies for mitigation of disruption, and interruptions and for better coordination of public and private security efforts. These will be determined through engagement with the stakeholders.

**Task 4. Define requirements for the proposed tool.** This will be accomplished through engagement with the stakeholders. Questions related to software, licensing, and training will be addressed. Required tailoring per port area for incorporation in the model and associated challenges will be assessed in setting up the system requirements, including who will do the tailoring and the associated costs. We envisage that the tool will be utilized in planning as well as for response. The requirements for "real-time" usage will be established. O&M requirements will be determined. Threshold levels for identifying failure of a system element will be defined. Performance metrics for evaluating the proposed tool will be developed, including rate of detection of incidents, rate of false alarms and time of detection.

**Task 5. Develop strategies for the development of the proposed tool.** Based on the information gathered and the requirements established, strategies will be developed for the tool development, including how its various modular features will be incorporated, selection of a simulation platform, selection of technique for incident identification.

**Task 6. Develop simulation model and conduct initial test and performance validation:** This is a core task that requires implementing the acquired knowledge and data from the previous tasks into a simulation model using a meso-micro simulation platform. The model will capture such features as the dynamic movements of traffic in and out of the port and the movements of goods in the intermodal facilities. Along with the simulation model, realistic animation objects will concurrently be included to facilitate the verification and debugging process. The model’s design must be well thought out to facilitate later the integration of the
optimization models with the simulation. The team will seek feedback from stakeholders and use available data for indirect and direct assessment of the simulated realizations of the performance measures $\tilde{f} (\tilde{x}, \tilde{z}, \tilde{p}, \tilde{e})$, in terms of their meaningfulness and realistic representation of the real system.

Task 7. **Formulate mathematical model:** Mathematical optimization model (optimal routing) will be developed to identify alternative routes of transport and to examine the effects of policy actions that involve changes in freight flow pattern as well as changes in transportation-related attributes. Emergency management practices put into place by network authorities may ease their movements in this stage compared to the simulation stage. Discrete as well as continuous events will be identified and modeled. The use of the simulation as an objective function will help quantify stochastic processes associated with intermodal facilities, and facilitate identification of causes for the anomalies in the simulated realizations of the performance measures $\tilde{f} (\tilde{x}, \tilde{z}, \tilde{p}, \tilde{e})$.

Task 8. **Develop optimization models for resiliency and emergency management:** The objective of the task is to develop and analyze the efficiency of the emergency management and resiliency in intermodal/port facilities. The model will determine representations such as $\min_{\tilde{x}, \tilde{z} \in \Omega} E[\tilde{f} (\tilde{x}, \tilde{z}, \tilde{p}, \tilde{e})]$ of the simulated performance measures to aid emergency management and for assessing the performance across the terminal.

**Anticipated Future Tasks – Phase 3**

Task 9. **Test and validate mathematical models and optimization algorithms:** In this task, the model and algorithms developed in the previous tasks will be studied, analyzed and evaluated. Different problem scenarios and instances will be created to test the performance of the proposed solution methods. The simulation model will be used to realize the performance measures for various scenarios. We have identified the following scenarios for case studies:

- Container Terminal: low, medium and high number of container and different levels of vessels arrivals
- Intermodal facility: Serving as a Transshipment facility
- Equipment: Modeling and simulation of chassis deployed in port/container terminal
- Intermodalism: Train serving intermodal facility
- Based on availability of data, a previous natural hazard impact on a port, such as the effect of Hurricane Sandy on Port of New York / New Jersey
- Others as may be proposed by stakeholders.
Task 10. **Identify and develop a theoretical and empirical basis to evaluate the effectiveness of critical protection for the port and associated distribution capacities**

Task 11. **Complete modular algorithms and user interfaces for the new tool**

Task 12. **Engage stakeholders in demonstrations of the tool and evaluate the tool using available real data**, basing the evaluation on meeting the requirements established in Task 4.

Task 13. **Prepare final report and transition tool to stakeholders.**

Proposed Project Schedule:

<table>
<thead>
<tr>
<th>Phase 1: May 1 – June 30, 2015</th>
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</thead>
<tbody>
<tr>
<td>Quarter 1: 5/1/15 – 6/30/15</td>
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<table>
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<tr>
<th>Phase 2: July 1, 2015 – June 30, 2016</th>
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<tbody>
<tr>
<td>Quarter 1: 7/1/15 – 7/31/15</td>
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<tr>
<td>Quarter 2: 8/1/15 – 10/31/15</td>
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<tr>
<td>Quarter 3: 11/1/15 – 1/31/16</td>
</tr>
<tr>
<td>Quarter 4: 2/1/16 – 4/30/16</td>
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<tr>
<td>Quarter 5.1: 5/1/16 – 6/30/16</td>
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</table>

**Considerations in Conducting the Work**

It is critical for tool developers to understand the details of the transportation system and resilience in port operations. Therefore regular meetings and communication with local port/intermodal steering committees and port management will be required. The team will demonstrate its preliminary work and based on multiple meetings with the stakeholders will propose the methodology for comments and suggestion. Necessary data will be required to populate the simulation and optimization models.

**Research Design for Simulation Modeling:** The main challenge that arises during the operations of the intermodal/port facility is congestion and how efficient and productive is the facility. If operations are not efficient or executed optimally, there will be a series of bottleneck issues which will not only increase cost, but will also decrease terminal operations. Therefore, in dealing with port operations as a supply chain management in a way that ensures efficiency will improve operations on all levels in any intermodal facility, and efficient operations can be achieved with an optimal number of instruments with an adoption of advanced technology. Using a port’s existing infrastructure, the research team will develop a simulation model corresponding to its operations that will be responsible in improving planning decisions, efficiency and in improving productivity. To accomplish the objectives of
the project, a Simulation Optimization model will be developed as one of the most reliable methods of modeling operations and logistics in dynamic and complex environment. This approach has been used with a variety of applications in transportation, including port operations.

*Research Design for Optimization Modeling:* The simulation model will be used as an objective function evaluation tool necessary to assess the performance of different optimization models especially when stochastic elements are considered. The development of this model will be just a starting step in the direction of optimizing operations. Resource allocation, planning and scheduling algorithms can be developed for port resilience and emergency management as needed and its performance will be evaluated using the proposed simulation to measure the impact and select the best strategies. The following optimization methods will be developed in this project for the problems identified above:

- **Mathematical Modeling:** Several mathematical models exist in the literature for intermodal facilities (e.g. port operations, container terminals, etc.) and new improved models are continuously being developed. The main advantage of the models that our research team will develop in the proposed research is their exact application to the specific cases where the formulations will be tailored to the design, data and interest of the nation's intermodal facilities. The data collection and input analysis step discussed in the research method can be utilized to help in achieving the project Objectives. Moreover, these models will consider uncertainty and use the simulation as a tool to evaluate the objective function.

- **Development of Algorithms:** when dealing with difficult combinatorial problems, an exact solution may not reach optimal solution(s) in reasonable time, especially when the problem size becomes large. Researchers in such cases tend to venture into developing approximate methods like local search algorithms and metaheuristic algorithms to reach near-optimal solutions. Metaheuristics such as Genetic Algorithms (GAs), Simulated Annealing (SA), Tabu Search (TS), etc. are among the most prevalent heuristic techniques implemented, as they balance the trade-off between efficiency and accuracy. Our research team during the project period will investigate the use of effective local search and metaheuristic algorithms in producing near optimal solutions especially for large size problems.

Two graduate students and a post-doctoral associate will support the PIs, Drs. Manhar Dhanak and Evangelos Kaisar in carrying out the work. Participation by undergraduate students will complement the team.

**Performance Metrics:**
Anticipated milestones with proposed performance metrics are provided below:
<table>
<thead>
<tr>
<th>Milestone</th>
<th>Performance Metrics</th>
<th>Timeline Target</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Problem Definition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Attended and participated in organized workshops and additional meetings with USCG and with MSC on port resiliency</td>
<td>Adequate information is available to develop definition of the port system in simulations</td>
<td>End of 1st quarter</td>
</tr>
<tr>
<td>2. Port system definition complete</td>
<td>Basic simulations can be performed using the defined port system</td>
<td></td>
</tr>
<tr>
<td>3. Preliminary scope of the tool established</td>
<td>Acceptable results (to be defined in Task1) of stakeholder surveys of adequacy of scope in terms of the fidelity of the proposed tool and its limitations.</td>
<td></td>
</tr>
<tr>
<td>4. Port vulnerabilities identified</td>
<td>Acceptable results (to be defined as part of Task 1) of survey of stakeholders; Each element of the port system can be represented as a variable $Z$ with associated probabilities for failure in the simulation</td>
<td>End of 2nd quarter</td>
</tr>
<tr>
<td>5. Required data on impact of previous hazards on ports identified and gathered</td>
<td>Results of survey of stakeholders to assess if all available data have been gathered; adequate information available to assess identification of several external disrupters</td>
<td></td>
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<tr>
<td>Milestone</td>
<td>Performance Metrics</td>
<td>Timeline Target</td>
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<tr>
<td>6. External disruptors identified; Port rules, policies and decision-making processes established</td>
<td>Acceptable results (to be defined as part of Task 1) of survey of stakeholders; Each disruptor can be assigned parameters $\bar{p}$ with associated probabilities for failure in the model; A set of decision steps available for assignment as vector $\bar{x}$ in the simulation, with associated probabilities for binary ‘Yes’ or ‘No’ decisions</td>
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<tr>
<td>7. Requirements for the proposed tool defined;</td>
<td>Acceptable results (to be defined as part of Task 1) of survey of stakeholders; Required performance metrics for the tool and thresholds available to initiate simulation of test scenarios</td>
<td>End of 3rd quarter</td>
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**II. Development of Concepts for the New Tool**

<table>
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<tr>
<th>Milestone</th>
<th>Performance Metrics</th>
<th>Timeline Target</th>
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<tbody>
<tr>
<td>8. Needs incorporated and full scope of the tool identified</td>
<td>Acceptable results (to be defined as part of Task 1) of survey of stakeholders</td>
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<tr>
<td>9. Identification of various modules of the tool</td>
<td>Acceptable results (to be defined as part of Task 1) of survey of stakeholders</td>
<td></td>
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<tr>
<td>10. Strategies for the development of the proposed tool determined</td>
<td>A coordinated plan in place; simulation platform and incident identifier algorithms available for</td>
<td>End of 4th quarter</td>
</tr>
<tr>
<td>11. Development of the simulation model completed</td>
<td>Results of stakeholder surveys of reasonableness (to be defined in Task 1) of realized performance measures $\bar{z}(3, 2, 3, 2, 3)$ for low</td>
<td></td>
</tr>
<tr>
<td>12. Initial case studies of various known scenarios completed as pilot studies</td>
<td>Key performance measures realized for known scenarios to a specified level of accuracy (to be defined in Task 1)</td>
<td></td>
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<tr>
<td>Milestone</td>
<td>Performance Metrics</td>
<td>Timeline Target</td>
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<tr>
<td>III. Proof-of Concepts</td>
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<tr>
<td>Assessment of costs</td>
<td>Acceptable results (to be defined as part of Task 1) of survey of</td>
<td></td>
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<tr>
<td>IV. Development of the New Tool</td>
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<tr>
<td>13. Formulation of mathematical model completed</td>
<td>Adequate theoretical framework available to model discrete and continuous events.</td>
<td>End of 5th quarter</td>
</tr>
<tr>
<td>14. Optimization model for resiliency and emergency management and optimization algorithm tests completed</td>
<td>Optimization of performance measures for low degrees of freedom can be accomplished, e.g., $\min_{\tilde{x}, \tilde{z} \in \Omega} E[\tilde{f}(\tilde{x}, \tilde{z}, \tilde{p}, \epsilon)]$</td>
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</tr>
<tr>
<td>15. Detailed modeling and simulations completed; Model verification and validation completed</td>
<td>Key performance measures realized for known scenarios to a specified level of accuracy (to be defined in Task 1)</td>
<td>End of 6th quarter</td>
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<tr>
<td>16. Completion of detailed algorithms and user interfaces for the new tool</td>
<td>Satisfactory results (to be defined in Task 1) of stakeholder survey of the utility of the tool with its various modules</td>
<td>End of 7th quarter</td>
</tr>
<tr>
<td>17. Engagement with stakeholders in a demonstration completed</td>
<td>Satisfactory results (to be defined in Task 1) of stakeholder survey with the performance measures realized in the simulation of available real data and its demonstration as a decision-making tool.</td>
<td>End of 8th quarter</td>
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<tr>
<td>Milestone</td>
<td>Performance Metrics</td>
<td>Timeline Target</td>
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<tr>
<td>18. Completion of a final report.</td>
<td>Acceptance/dissemination of the report</td>
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</table>

**Stakeholder Engagement:** The FAU team will actively collaborate with the Port authorities and USCG R&D Center in conducting the project. This will include frequent phone calls, face-to-face work sessions at USCG R&D Center and regular electronic correspondence. As part of Task 1, champion entities at USCG R&D Center will be LCDR Erich Stein.

**Outcomes and Outputs:** It is anticipated that a new validated tool will result with the necessary attributes to support (i) provision of means to reduce risk - this will be measured through developing comparative realizations of performance measures $\bar{f}(\bar{x}, \bar{z}, \bar{p}, \bar{e})$ for various decisions $\bar{x}$ for given port vulnerabilities $\bar{z}$ and external disrupters $\bar{p}$ and identifying optimal decisions, for example; (ii) identification, assessment, and monitoring of disaster risks and improvement of early warning systems - the improvements will be measured through developing comparative realizations of performance measures as in (i), but for various levels of port vulnerabilities $\bar{z}$ and seeking optimal solutions; (iii) identification of safety and resiliency measures at all levels through use of knowledge, innovation, and education – this involves using the tool in its decision making and port planning capacities; (iv) reduction in consequences from underlying risk factors – this will be measured through an optimization of the realized performance measures

$$\min_{\bar{x}, \bar{z} \in \Omega} E[\bar{f}(\bar{x}, \bar{z}, \bar{p}, \bar{e})]$$

over the ranges of values of vulnerabilities $\bar{z}$ and external disruptors $\bar{p}$. (v) provision of port coordination with medical facilities to enable coping with local surge in demand for medical treatment – based on previous work, this is where the proposed tool will be utilized in its decision-making and port planning capacities, through simulating and predicting optimal response scenarios in the event of a major disruption such as an outbreak of disease or involving casualties and injuries, taking into account the location of nearest medical facilities, etc.; (vi) improvement in disaster preparedness of ports and its water and land side capacity distribution – the improvement will be measured through comparative realizations as in (ii); (vii) speeding up the post-disaster recovery – as described under the overall approach, mathematical models will identify resilient states in the parameter space and the return to these states from a departure from it due to a disruption will be measured in terms of the time of return and acceleration will be based on seeking optimal path of this return; (viii) facilitation of coordination of resumption of commercial service and relief activities – throughput will be one of the performance measures $\bar{f}^2$ in the simulated realizations and will be optimized as
in (vii) and will be tested using available historical data; and (ix) improvement of interagency coordination and communication – this will be through the tool being used as a decision-making and port-planning instrument as in (v).
4.2 Satellite MDA

**Satellite Radar Data Integration in the Coastal and Maritime Domain**

**Principal Investigator**

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Center for Southeastern Tropical Advanced Remote Sensing  
University of Miami, Miami, Florida

**Abstract**

Open ocean satellite-based surveillance is a key capability in the development of Maritime Domain Awareness (MDA), particularly with respect to ship detection, classification and identification. While large vessels are required to carry Automated Identification System (AIS) transponders, smaller vessels, in particular, go-fast, semi-submersibles and other small boats do not transmit a similar message providing basic information of ownership, ship characteristics, position, speed and course, and destination. These vessels are often used as a means to transport illegal drugs and contrabands as well as smuggling and trafficking of humans and pose a severe threat to our national security. They operate in the coastal domain but outside the range of terrestrial radar stations and move at low light conditions to elude detections by law enforcement ships and aircrafts. However, satellite synthetic aperture radars (SARs) are sensitive to roughness modulations of the ocean surface and motions of fast moving targets. SARs have demonstrated to be able to detect readily vessels of medium to large lengths. New satellite systems have improved imaging modes and spatial resolutions to allow detections of even smaller boats and non-emitting targets. New algorithms to detect wakes of boats can now be used to detect the presence of small, non-emitting boats.

The purpose of this project is to reformat and test satellite data and products for ingestion into DHS’s Coastal Surveillance System (CSS) and Air and Marine Operations Surveillance System (AMOSS), operating at the Air & Marine Operations Center (AMOC) utilizing NIEM formats and the OWF architecture. The goal is to reformat and test timely and actionable information to the AMOC. With this test we want to establish a CSTARS baseline for timeliness and minimum information needed for actionable response. The initial phase of this project will test the integration of CSTARS’ satellite image data and products into the CSS and develop CONOPS to provide future satellite imaging data for time-sensitive applications and exploitations. The test baseline will consider operator needs (e.g. actionable information to operations for cuing near-real time).

**Baseline**
The Over-The-Horizon Targeting GOLD (OTG) report provides a standardized method for transmitting selected data of ship detection products between OTH-Targeting (OTH-T) systems (e.g. satellite EO and SAR) and OTH-T support systems (e.g. DHS’ CSS & AMOSS). The reason for using OTGs is that it’s based on structural rules for format and sequence of text and information. This information is based on the Operational Specification for Over-The-Horizon Targeting Gold Baseline 2007 document from the Navy Center for Tactical Systems Interoperability (NCTSI). As a minimum it provides information on the source of target detections, the time and position of the target. Additional information, if available, may include the target speed and/or heading as well as the length and width. While OTG formats are standards, there are subtle differences in the structural formats that are used by different agencies and end customers. Therefore, appropriate modifications need to be made allowing integration into the CSS system.

Additional information complementing the OTG are image chips of the targets. These small, full resolution image vignettes are very useful for the operator to view in parallel to the OTG message. It provides a visual description and characterization of the targets. The image chips are usually transmitted in jpg formats. Furthermore, a kmz file readily loaded into GoogleEarth showing all the detected targets provides confirmation to the positions and number of detected targets. The kmz files could also include shapefiles of the targets which are easily ingested by ESRI-type GIS systems.

CSTARS collects and processes EO and SAR satellite images and generates Level 2A\(^1\) products which are radiometrically and geometrically corrected and converted to geo-referenced tiff file formats or geotiffs. These geotiff files are readily displayed geographically correct in GoogleEarth or any GIS-based application such as ESRI’s ArcGIS. Value added products include OTG reports (ASCII), metadata (XML), image chips of targets and features (geotiff), situational awareness (ppt and pdf), change detection products, 3CMV color views (geotiff), dual-, cross- and quad-pol products (geotiff) and others customized products. This will include Rapid Tasking EO products following the SAR pass when applicable (suspicious target identified). Note all geotiff products can also be produced in NITF 2.0 formats. In addition CSTARS produces from SAR data the Sensor Independent Complex Data (SICD) format which would be suitable for incorporation into CSS and AMOSS. For non-complex data such as ScanSAR, a Sensor Independent Detected Data (SIDD) image product is generated. The SICD and SIDD formats will simplify the integration of different SAR sensor data into CSS and OWF since only one format is needed. Initially these will be the products used in CSS and OWF, while others may be developed on demand with the customers and stakeholders.

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\(^1\) Level 2A is defined as radiometrically and geometrically corrected satellite product that includes geophysical variables and georeferencing and sometimes mapping projections. This is the next level up from Level 1B which is still in engineering units.
In addition to the CSS there is the data exchange format National Information Exchange Model (NIEM) and the Ozone Widget Framework (OWF). Specifically NIEM will use XML files to share information between domains and transfer data and metadata from one computer system to another. CSTARS’ EDGE (Enhanced Dashboard Geospatial Environments) and the CSTARS backbone are based on CSTARS XML and are flexible to interface readily with other frameworks such as CSS and OWF. As a result of the Deepwater Horizon oil spill CSTARS developed a data format structure called CSTARS XML to deal with different satellite sensors and other non-satellite data. During the DWH event there were six different SAR satellite "families". A significant challenge for automated processing of SAR imagery for oil detection is that each "family" has its own unique data format and metadata system. The result of this effort is a metadata parsing, definition, storage, and processing system we refer to as CSTARS XML. CSTARS XML is a platform-independent XML structure that holds metadata for most of the SAR sensors currently commercially accessible. This XML structure contains both metadata and all the required information needed for importing the SAR imagery into a computational platform. For SAR imagery, CSTARS XML is much more complete a store of SAR metadata than any standard currently defined.

The OWF is a Java Web-based application which can operate on servers like Tomcat and JBoss. OWF can tailor dashboards to user preferences and permissions as may be the case with CSS users. Currently OWF is supported on IE7+ and Firefox 3.6+. These are all web browser supported by CSTARS. OWF has now users from multiple DOD agencies, and the broader intelligence community and recently the U.S. Coast Guard has also adopted OWF.

**Objective and Purpose**

The overall objective and purpose of this project is to reformat and test satellite data and data products containing information of targets in the maritime domain that are readily incorporated and exploited by the Coastal Surveillance System (CSS). A key requirement will be testing of open and/or secure data transmission connectivity with AMOC to transmit satellite data and exploitable products compliant with NIEM format, including OTH-G format for integration into AMOSS. Testing is needed to determine which means of transmission (open and/or secure) allows the largest and fastest throughput of data to achieve near-real-time results – (near-real time is defined in part as programming the satellite up to one hour in advance of the constellation pass). Furthermore, we will work with DHS stakeholders to reformat and test data and data products which would enhance maritime domain operational picture.

**Research Method**

The initial focus of effort will be to acquire the technical specifications and data requirement documents for CSS, NIEM and OWF and then work with SRI to develop
interfaces of standard data and value-added products using historical satellite data sets.

CSTARS will produce the above described products from historical satellite data of the various sensors which we would plan to use in the future for maritime applications and small boat detections. Following the technical specifications and data requirements we will work with SRI’s test system to test data and product transfer and interfaces both on open and/or secure connections. We would compare the image and data quality on SRI’s test system with the original data sets generated at CSTARS to ensure now data loss in the transfer process. We would employ NIEM as the primary format to transfer data and evaluate data transfer rates and latency between SRI and CSTARS using different mechanisms such as dropbox, secure ftp or http using both push or pull options and for OTH Gold reports encrypted, secure email could also be considered. If transfer rates are not satisfactory we will jointly explore solutions to improve data transfer rates using different compression and encryption techniques as well as improved routing. CSTARS has three independent fiber-optic connections utilizing different paths at 10 Gbit/s or OC-192 that connect to the world through Verizon’s Network Access Point Data Center – NAP of the Americas in Miami. It will also be important to understand data transfer rates to compare CSS & AMOSS ability to identify potential sources as a capability (latency) gap.

Ultimately the above tests must be replicated with AMOC to ensure that data formats, images and products are uncompromised accessible at the AMOC site. Similarly, we would need to test again the data transfer and latency issues, but specifically with AMOC to achieve near-real time results. We would engage with AMOC-IT and explore if open and/or secure communications would be the preferred option for CSS.

In parallel CSTARS would visit AMOC and work with AMOC IT personnel to incorporate AMOSS (AMOC’s operational picture) into CSTARS effort. Specifically, we will modify the OTH Gold format to be compliant and consistent with the format previously arranged with CTAR. Again, the OTH Gold messages would be tested with historical data sets from different sensors to ensure compliance.

Once all stakeholders confirm compliance of data formats and data integration, satisfactory latency and data quality, we will perform simulations with historical data sets to test the E2E with AMOC. This will also include AMOC submitting simulated requests to CSTARS specifying the location, time, sensor and sensor mode as well as polarization and imaging modes (resolution and swath). It will be important for AMOC to know how the requests are submitted, so DHS visits to CSTAR facilities to learn how tasking of SAR and EO is conducted will be critical.
Stakeholder Engagement

The primary stakeholders of the Homeland Security Enterprise for this CSTARS project will be the DHS’ Science and Technology (S&T) customers, particularly CBP and USCG, and and AMOC IT. Key DHS POCs include Mr. Jeff Mayer (CBP) and Mr. MK Tribbie (DHS S&T). Engagement will include time to educate and interact with stakeholders on CSTARS capabilities to learn about its constellations and its ability to task satellites, and pull and transmit data. To ensure compliance of data formats and products we will work with the Stakeholders to ensure correctly reformatted information is provided. We will maintain an on-going dialog, especially with AMOC, to match data and informational contents to their mission. Once the CSS, AMOSS, NIEM and OWF have been fully vetted at SRI with historical data, we propose a meeting with CSS and AMOSS to establish CONOPS and expectations. We will establish regular channels of communications between CSTARS, MIFC and AMOC to assure that information needed by either side is always up-to-date and near-real-time. We will engage in regular meetings (e.g. frequency TBD by customer) to learn of successes and misses and jointly discuss how to improve weak links.

Milestones & Performance Metrics

<table>
<thead>
<tr>
<th>Milestone: Phase 1 Reformatting &amp; Testing</th>
<th>Performance Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Establish POC at SRI and execute an NDA with CSTARS.</td>
<td>Contact to implement project.</td>
</tr>
<tr>
<td>2. Obtain technical specifications of CSS, NIEM and OWF currently implemented at DHS stakeholders.</td>
<td>Information on system specifics.</td>
</tr>
<tr>
<td>3. Modify CSTARS XML and data products to be compliant with M2.</td>
<td>Modifications to generate compliant products.</td>
</tr>
<tr>
<td>4. Test data transfer between SRI and CSTARS to establish baseline transfer times and rates</td>
<td>Establish data latencies, size limitations, optimal routing.</td>
</tr>
<tr>
<td>5. Test integration of all CSTARS data and products into CSS and OWF at SRI.</td>
<td>Data integration at test facility of all available products. Format modifications to be compliant.</td>
</tr>
<tr>
<td>6. Simulate integration of OTG, XML and image chips with SRI in technical demonstration.</td>
<td>Full scale technical demonstration of integration and transfer process.</td>
</tr>
<tr>
<td>7. Midterm project meeting with stakeholders to evaluate progress and obstacles of objectives.</td>
<td>Up-to-date achievements and future corrections needed for success.</td>
</tr>
<tr>
<td>8. Perform simulation test as describe in M4 with AMOC.</td>
<td>Establish data latencies, size limitations, optimal routing with end customer.</td>
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<tr>
<td>9. Perform simulation test as describe in M5 with AMOC.</td>
<td>Implement system procedure at end customer.</td>
</tr>
<tr>
<td>10. Perform “live” test with AMOC of E2E process.</td>
<td>Perform E2E near-real time test. Near-real time is defined as programing the nearest available satellite up to one hour in advance pass over the area of interest to task.</td>
</tr>
<tr>
<td>11. Final project of Phase 1 to evaluate project goals and achievements and plan next phase.</td>
<td>Evaluate achievements of goals and overall achievements and successes.</td>
</tr>
</tbody>
</table>

**Outcomes and Outputs**

Following the milestones above we expect that *Phase 1: Reformatting and Testing* will establish seamless integration of CSTARS multi-sensor satellite data and products into DHS’ Coastal Surveillance System (CSS). The data products such as OTG, XML, image chips and others will be compliant as specified by the requirements. Data and information transfer are expected to be achieved with either open and/or secure communication paths to provide timely actionable information for situational awareness of the maritime domain. The simulation and testing of satellite data and products for enhancing the operational picture of the maritime domain will be near-real time for an actionable response by AMOC. Finally, a key outcome is document CSTAR’s capabilities for delivering a real-time information product.
**Tentative Year 2 Workplan**

Since the primary focus is small boat detections, particularly the go-fasts, SPSS and SPFS, an opportunity may be available in Calendar Year 2015 during a commercial vendor “Plug & Play” demo. This demo would involve DHS' SPSS “Pluto”. While there have been tests in the past (e.g. Thunderstorm, DIA) with overhead assets on SPSS vessel, none have been performed with the recent improved imaging and resolution capabilities of the current commercial satellite SARs and EOs in space. Also, new algorithms have been developed with specific emphasis on small boats and wakes which have, to my knowledge, never been applied to a real situation involving an SPSS and/or go-fast. Such a test would further help DHS and CSTARS to refine the analysis tools and parameter space under which detections of targets with small radar cross-sections can be successful. Such small cross-section targets may exhibit signatures that could be better identified with a corroborating target in order to select correct features in images and refine processing techniques. Such a data set would be extremely valuable to determine current capabilities of space assets to detect such “dark targets” and guide future development of new imaging modes and processing algorithms.

The Year 2 workplan will tentatively include:

1. **Field Experiment Preparation**
   Design and develop realistic operational scenarios such as slow and fast speeds and DIW (dead in water) situations; along-track and cross-track operations relative to satellite orbit subtrack; adding weight, etc.

2. **Conduct of Experiment**
   Plans must be made where to conduct the experiment in terms of time of day and location. Since these are “dark targets” additional support vessels need to be available to prevent interference from outsiders as well as guard the targets from unintentional commercial and recreational boat traffic interference.
   In parallel CSTARS will select and plan imaging modes and polarization from different satellite SAR sensors as well as optical sensors to acquire an unprecedented dataset for specific “dark target” processing and analysis.

3. **Preliminary Analysis of Results**
   The acquired satellite data with GPS data from the “dark targets” will be analyzed using different processing schemes to suppress speckle or noise and enhance the presence of low scattering targets. In particular we can test our wake detection algorithm and evaluate its sensitivity to real small radar cross-section targets.
   Prepare a presentation on the results and discuss with DHS Stakeholders the results and implications for future detection of “dark targets” using current commercial satellite assets.
The interpretation of SAR images is not readily obvious and SAR data can be processed to display information in different ways not commonly available with optical and infra-red images. CSTARS would provide guidance to AMOC personnel on the capabilities and applications of SAR imagery to the maritime domain. Examples of a variety of targets and those acquired during the “Dark Target” demo would be used to present a user’s guide on how to interpret different data products. A similar User’s Guide which would focus on terrestrial applications related to border issues could be also provided.
5. Education and Outreach

Education and Outreach Overview
MSC is committed to enhancing the knowledge, technical skills, preparedness and leadership capabilities of our nation’s current and prospective maritime security workforce. At the core of the MSC’s mission, is the transfer of its research and expertise into highly relevant, innovative maritime security-centric educational programs.

MSC’s educational programs leverage the teaching talents, research assets and subject matter expertise of its academic partners to provide real-world, multidisciplinary, and experiential learning opportunities for students, professionals, stakeholders, and the general public.

Collectively MSC academic partners will:
- Contribute to one or more components of the Center’s educational programs and experiential learning activities.
- Leverage their existing platforms, programs and stakeholder connections to achieve MSC’s education objectives.
- Make available enhanced educational opportunities for women and students from underrepresented communities.
- Coordinate their education and outreach efforts to maximize MSC’s educational impacts and experiential learning opportunities for students.

Over the course of Years 1 and 2, the Center’s academic partners will each contribute to the MSC’s Summer Research Institute and the Maritime Systems Seminar Series discussed below. Participation by the Center’s partners may include guest lectures in one or both of the programs and inclusion of their university’s students in the Summer Research Institute (SRI). In addition, each academic partner (ECSU, FAU, LSU, MIT, UPRM) will conduct outreach to promote the Center’s educational activities and opportunities for HS-STEM focused students and professional development programs for homeland security practitioners. Outreach efforts will include the distribution of MSC program literature, electronically or in hardcopy, to increase the awareness of the Center among their student populations and their local and regional homeland security contacts.

The Center’s academic partners will also share information about their own respective university’s STEM-based educational programs, scholarships, fellowships, internships and research opportunities with the MSC’s director of education. In turn, the director of education will establish a resource webpage of affiliate educational opportunities on the MSC website, to be widely communicated with the Center’s partners, students, and industry and government stakeholders.

The Center’s educational programs for Years 1 and 2 will include the following:
- College-level experiential learning and research-based programs:
  - The Summer Research Institute
Education Area 1: College-level experiential learning and research-based programs:

The Summer Research Institute

Baseline
Over the past five years, MSC has engaged high-potential STEM students from around the nation in its maritime security-centric Summer Research Institute (SRI). Since the program’s inception in 2010, 88 students, representing 17 U.S. universities, including MSI and HBCU universities, have collaboratively worked with researchers and homeland security practitioners to develop innovative solutions and creative approaches to advancing the capabilities and functionality of the center's existing and evolving tools and technologies for transition to end-users (e.g., USCG, CBP, U.S. Navy). Program outcomes have included the use of Machine Learning Algorithms to automatically classify vessel acoustic signatures and the development of a user-friendly, real-time decision-support web-interface, called Magello, which is currently being supported by the U.S. Coast Guard for further development.

With the inclusion of its new and incumbent academic partners, MSC will continue to build upon its highly successful Summer Research Institute and will expand its outreach to encourage student participation from each of the Center’s academic partner schools. The Center will also maximize its efforts to conduct targeted recruitment from MSI schools and student members of minority and women-based professional societies and organizations (e.g., the National Society of Black Engineers, the Society of Hispanic Professional Engineers, the Society of Women Engineers), to ensure diversity in the SRI and to facilitate enhanced opportunities for women and students from underrepresented communities.

Objective and Purpose
The maritime security-centric research program is designed to provide high-achieving undergraduate and graduate-level students with a unique opportunity to learn about the maritime domain and the Marine Transportation Systems (MTS), through relevant, hands-on research projects in conjunction with MSC researchers and the center’s industry and government homeland security partners.

The objectives of the Summer Research Institute are to:

- O Maritime Security Master’s and Doctoral Fellowship Programs
- O MSI Outreach and Engagement in Research
- O USCG Auxiliary - Stevens Detachment

- Professional development programs:
  - O Maritime Incident Preparedness and Response - Discussion-based Exercises
  - O Maritime Systems Webinar/Seminar Series
• Expose a diverse group of students from a variety of STEM disciplines to the maritime domain, the marine transportation system (MTS), the sensor technologies used in port security applications, and the tools and techniques used to enhance port resilience.
• Encourage students to think along the lines of public and private stakeholders to understand the complex challenges in maritime and port security operations.
• Engage students in rigorous research activities that produce innovative solutions and quality research outcomes.
• Cultivate a strong and active alumni network to serve as program ambassadors.
• Enhance the interest of students to pursue advanced academic study and careers in the homeland security domain.

Methodology and Stakeholder Engagement
MSC will employ the lessons learned over the five-year delivery of the SRI to continue to refine and improve the program format for Years 1 and 2. Feedback from past student surveys and discussions with MSC researchers and stakeholders have identified the following activities to have had tangible, long-term impacts on student participants, and will serve as the ongoing framework for the program:
• Participation in seminars provided by MSC research members and homeland security practitioners.
• Engagement in hands-on, multi-disciplinary research projects focused on real-world maritime and homeland security issues.
• Field-visits and field-based activities with state, local and federal homeland security practitioners. (e.g., CBP, NJ OHSP, NYPD, NUSTL and USCG)
• Professional development activities, including oral presentations, team projects, report writing, and networking.

MSC researchers play a significant role in the professional development and mentoring of SRI participants. Students in the 2015 and 2016 programs will be given the opportunity to learn first-hand from leading researchers in the fields of maritime security, remote sensing, emergency management and response, and maritime system resilience. Students will be given unique access to cutting edge tools and technologies, data sources and an extensive network of industry and government homeland security experts and stakeholders.

The goal of the 2015 and 2016 SRI programs is to further connect students with MSC stakeholders and to engage them in research projects that are responsive to and directly impact the knowledge and technology needs of maritime and homeland security practitioners. Over the next two years, the summer research program will build upon MSC’s ongoing research to enhance maritime domain awareness (MDA) and maritime system resilience, and will incorporate the Center’s emerging projects in the areas of mobile MDA and MTS resiliency. SRI student participants will contribute to the advancement of the Center’s research and tool development through the summer research program and will assist in the transition of the Center’s work through field-based activities and engagements with MSC stakeholders.
Outcomes and Output

SRI 2015 and 2016 projects may include:

- Enhancing the functionality and capabilities of Magello.
- Assessing port facility vulnerabilities to cybersecurity threats and port disruptions.
- The use of unmanned systems for situational awareness and port security applications.

Additional student projects will be created in collaboration with MSC stakeholders and as issues arise in the maritime domain.

Participation in the SRI program is competitive and requires students to complete an application for admission, submit a letter of recommendation and provide a statement of interest. The SRI application process is held annually from December – February and admission notifications are made in early March. Students from MSC partner schools and women and students from underrepresented communities (MSI schools) are given priority in SRI admissions decisions, as are those students who are able to attend the program leveraging external (non-MSC) funding, e.g. Stevens Scholars program, DHS Scientific Leadership Award and CDG-funded students. Each year, MSC sets aside funding support to facilitate MSI student participation in the SRI. These efforts have resulted in student participation from ten minority-serving schools throughout the nation. Since 2010, more than half of the SRI student participants have been women and/or minority students.

The Summer Research Institute will continue to be held at the Stevens Institute of Technology campus in Hoboken, NJ. Stevens provides a unique research venue for the summer research program allowing students and faculty access to a robust suite of research assets and facilities including the Center’s Maritime Security Laboratory (MSL). The Center’s geographical location also provides unique opportunities for students to participate in field-visits to DHS component agencies, including CBP at the Port of New York/New Jersey, NUSTL in New York City, and USCG Sector New York.

Program outcomes will include quality research reports and formal presentations for MSC researchers, stakeholders and invited guests from DHS component agencies. Student research reports and presentations are part of several metrics of success that will be employed in the post-SRI program assessment. Additional metrics will include the percentage of students seeking advanced academic study or careers in maritime and homeland security-related fields; the development of new knowledge, technologies, or processes that had not previously been achieved under the MSC research programs; and the strengthening of partnerships with stakeholders and MSI institutions.

An assessment of the SRI outcomes and lessons learned will be conducted through student and stakeholder surveys. Collectively the surveys will address the following key areas:

- Program strengths and weaknesses;
- Skills and knowledge learned;
- Impact on career and academic interests;
• Areas for program improvement; and
• Impacts on, and engagement with stakeholders and end-users.

The administration of the summer research program will be provided by MSC’s director of education, with curriculum support provided by Dr. Barry Bunin, Director, Maritime Security Program and Chief Architect of the Maritime Security Laboratory.


<table>
<thead>
<tr>
<th>Milestones</th>
<th>Performance Metrics</th>
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<tbody>
<tr>
<td>1. Featured lectures by MSC researchers</td>
<td>-A minimum of two homeland security/maritime industry guest speakers will be hosted during the summer research program.</td>
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<tr>
<td>and invited guests. (Weeks One – Eight)</td>
<td>-A minimum of six faculty lectures will be provided during the eight-week program.</td>
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<tr>
<td>SRI 2015 (6/1/15 - 7/24/15)</td>
<td>-The quality of and knowledge learned from the lectures will be assessed through a post-program student survey.</td>
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<td>SRI 2016 (6/6/16 – 7/29/16)</td>
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<tr>
<td>2. Field-visits and field-based activities.</td>
<td>-SRI students will engage in a minimum of two field-visits per summer research program.</td>
</tr>
<tr>
<td>(Weeks One – Seven)</td>
<td>-MSC will facilitate a minimum of one field-based activity (meeting with stakeholders, research experiments/deployments, attendance at a workshop) during the program.</td>
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<tr>
<td>SRI 2015 (6/1/15 – 7/17/15)</td>
<td>-The impacts of the field-visits and field-based activities on student professional development and networking skills will be assessed through a post-program student survey.</td>
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<tr>
<td>SRI 2016 (6/6/16 – 7/22/16)</td>
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<tr>
<td>3. Diversity of student participants.</td>
<td>-Diversity will be measured according to the range of engineering and science majors represented in the program. A minimum of four different disciplines will be represented per SRI program.</td>
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<tr>
<td>SRI 2015 (6/1/15 – 7/24/15) and SRI 2016 (6/6/16 – 7/29/16)</td>
<td>-Student diversity will be measured by the percentage of women and minority students participating in the program each summer. A diverse student population will include a minimum of 50% women and/or minority students.</td>
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<tr>
<td>4. Research Reports, Presentations and Posters.</td>
<td>-A minimum of two student research team reports will be prepared at the end of each</td>
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(Week Eight)
SRI 2015 (7/22/15 – 7/24/15)
SRI 2016 (7/25/16 – 7/29/16)

SRI program.
-A minimum of two student research team posters will be prepared at the end of each SRI program.
-Students will engage in weekly status update presentations during weeks three – seven.
-Stakeholder engagement will be assessed by representation of MSC stakeholders attending the final student team presentations.
-Quality of SRI research outcomes will be assessed by MSC research mentor feedback and the number of projects selected for presentation at conferences (e.g. DHS OUP University Summit) and/or for publication.
-Program impacts, e.g., professional development, technical skills learned, teamwork, and student interest in advanced academic study or careers in homeland security will be assessed by a post-program student survey.

5. Post-Program and SRI alumni survey.
Post-program surveys to be conducted (Week Eight)
SRI 2015 (7/22/15 – 7/24/15)
SRI 2016 (7/25/16 – 7/29/16)

SRI program alumni survey to be completed during SRI 2015 (6/1/15 – 7/24/15)

-A minimum of one student survey will be conducted at the end of each summer research program. The survey will be used to measure the strengths and weakness of the program, the program’s impacts on student interest and skills development, and to gather feedback to enhance the future delivery of the program.
-A minimum of one SRI student alumni survey (collective of all SRI programs 2010 -2014, etc.) will be conducted on a biennial basis. The alumni survey will be used to assess the program’s long-term impacts on student academic and career choices.

Maritime Security Master’s and Doctoral Fellowships

Baseline
Stevens Institute of Technology with the support of MSC’s director of education, has been awarded three consecutive DHS Career Development Grants and one DHS Career Development Supplement. Collectively, the grants have provided for nine fully-funded Maritime Systems Master’s Degree Fellowship awards and one Maritime Security Doctoral Fellowship award. The awards provide for full-tuition support and stipends to
high-achieving U.S. students committed to pursuing graduate and doctoral study in maritime security and whose career goals include employment in the maritime homeland security domain.

Since the first CDG award in 2010, five students have completed the Maritime Systems Master’s Degree Fellowship program. Four out of the five graduates have successfully received employment in homeland security related positions at PNNL, NATO-MSCE, DNV-GL, and Analytic Services, Inc., and the fifth student has recently been awarded a DHS-funded Doctoral Fellowship to continue his research in the area of passive acoustic detection systems on the doctoral level at Stevens Institute of Technology.

**Objectives and Purpose**
The objectives of the two Fellowship programs are to enhance our nation’s technological leadership and to produce highly skilled engineers and scientists who are well prepared to address the nation’s homeland security and national defense needs.

**Methodology and Stakeholder Engagement**
The Fellowship program has effectively engaged students in advanced research projects through the SRI and has embedded students in ten-week, field-based internships with the USCG Atlantic Area Operations and Analysis Division, the USCG Command Center at Sector New York, the Naval Undersea Warfare Center Newport, and the Naval Surface Warfare Center-Carderock. MSC is currently making arrangements to place its Fellowships students in internships at the USCG R&D Center in New London, CT, and at the CBP New York Laboratory in Newark, NJ, during Year 1 and is discussing opportunities for placement at Sandia National Laboratories for Year 2.

MSC is committed to increasing the pool of highly qualified students pursuing advanced academic study in HS-STEM fields and to leveraging its stakeholder partnerships to create field-based internships and career opportunities for its students. During Years 1 and 2, MSC will proactively pursue minority student candidates for the Fellowship program, by reaching out to faculty advisors and student chapter members of minority and women-based professional societies. The Center will also reach within its SRI alumni network and will leverage its DHS OUP channels to promote fellowship opportunities to MSI faculty contacts and students. The MSC director of education will continue to coordinate the Center’s maritime security focused Master’s and Doctoral Fellowship programs in Years 1 and 2, and will aggressively pursue new Career Development Supplements as they become available.

**Outcomes and Outputs**
Fellowship recipients are required to complete coursework leading to the Master of Science Degree in Maritime Security, with a Graduate Certificate in Maritime Security. Students must maintain full-time enrollment throughout their two-year fellowship program and must engage in two internships during the tenure of their fellowship. The first internship requires participation in the MSC Summer Research Institute and the second internships involves field-based placement with a DHS component agency or a related national defense organization. At the culmination of the Fellowship program,
students are required to commit to a minimum of one-year employment in the homeland security domain.

**Milestones and Performance Metrics**

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Performance Metrics</th>
</tr>
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<tbody>
<tr>
<td>1. Student outreach and recruitment. (11/1/14 – 6/1/15 for the remaining fellowship under the 2012 CDG award.)</td>
<td>-Confer one Master’s degree fellowship award on or before June 2015.</td>
</tr>
<tr>
<td>2. Degree requirements.</td>
<td>-CDG Master’s degree fellows, currently three total, will enroll in nine credits per semester during their first two semesters, and a maximum of six credits during their third and fourth semesters of the fellowship. -CDG Master’s degree fellows will complete a six-credit thesis requirement. -The doctoral fellow (one student) will complete an average of 28 credit hours of coursework and research each year over a three-year period.</td>
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<tr>
<td>CDG 2011 Master’s Fellowship (11/1/14 – 8/30/15)</td>
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<tr>
<td>CDG 2012 Master’s Fellowship (11/1/14 – 6/1/16)</td>
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<tr>
<td>CDG 2013 Doctoral Fellowship (11/1/14 – 6/1/17)</td>
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<tr>
<td>3. Student placement in field-based internships.</td>
<td>-Master’s degree fellowship students will complete two ten-week summer internship requirements, during the tenure of their program. -A minimum of one internship placement will include participation in the MSC SRI and the other will include a field-based internship with a MSC stakeholder or affiliate DHS component agency. Three students will be eligible for field-based internships in 2015. -Impacts and quality of the field-based placement will be assessed through a formal CDG fellow presentation and summary report and a post-internship survey completed by the host organization.</td>
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<tr>
<td>CDG 2011 Master’s Fellows (one student) (6/1/15 – 8/7/15)</td>
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<tr>
<td>CDG 2012 Master’s Fellows (two students) – 6/1/15 – 8/7/15</td>
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<tr>
<td>4. Career Placement and post-program tracking.</td>
<td>-Stevens CDG fellows will assume homeland security related employment within a period of six months following the completion of their degree programs. To date, one student will be eligible for placement in 2015 and two students will be eligible for placements in 2016.</td>
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<tr>
<td>2011 CDG fellow placement in a homeland security related position. 8/30/15 – 2/1/16.</td>
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security related position. One student placed between 1/1/15 – 6/1/15 and the remaining student placed between 6/1/15 – 11/1/15. (Milestone dates will be determined for the third DHS CDG Master’s fellow as soon as the student has been identified and the remaining 2012 award has been conferred.)

-CDG fellows will maintain employment in the homeland security domain for a minimum of one-year.
-Student employment and professional activities will be tracked through a post-program survey.

| 5. Work plans will be created for new Career Development Supplements during Years 1 and 2. (2015 and 2016) | -MSC will apply for additional Career Development Supplements, as they are made available through DHS OUP. |

**MSI Outreach and Engagement in Research**

**Baseline**

MSC’s academic partners include two Minority Serving Institutions (MSIs), Elizabeth City State University and the University of Puerto Rico – Mayaguez. The Center has routinely set aside funding to support MSI participation in the Summer Research Institute and has hosted students from ten MSI schools since the program’s inception in 2010. The number of MSI students supported each year varies and is contingent upon the Center’s annual funding.

**Objective and Purpose**

During Years 1 and 2, MSC will broaden its outreach to create greater opportunities and pathways for MSIs to engage in the Center’s research and educational programs. The MSC will continue to cultivate its MSI relationships and will increase its outreach to develop new contacts and partnerships with minority-serving schools associated with and geographically located near MSC’s new academic partners from LSU and FAU.

The Center will also work closely with its academic partners to identify MSI candidate schools as prospective partners in applying for DHS Scientific Leadership Awards (SLA). During Year 1, the Center will review the project submissions/titles of past SLA recipients and will reach out to those whose research complements the Center’s work and with whom collaboration with the MSC COE will maximize research opportunities for their faculty and students. During Year 2, the Center will identify and target MSIs to work with and will initiate and support SLA proposals for collaboration. Previous SLA collaborations with ECSU and UPRM have resulted in the participation of nine students and one faculty member in the Summer Research Institute.

In addition to supporting MSI SLA proposals, the Center will seek to host MSI faculty and students through the DHS OUP Summer Research Team Program (SRT). Similar to its approach in identifying MSIs for SLA proposals, the Center will work to identify opportunities within its academic partnership to connect and place MSI Summer Research Teams. The Center will work to host a minimum of one SRT group annually at Stevens or at a MSC academic partner location during Years 1 and 2.
### Milestones and Performance Metrics

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Performance Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Minority and women student participation in the Center’s annual</td>
<td>- Diversity in the SRI program will reflect a minimum of 50% women and minority student participants.</td>
</tr>
<tr>
<td>Summer Research Institute.</td>
<td>- MSI outreach and recruitment efforts will be assessed by the number of targeted email communications and personal conversations with women and</td>
</tr>
<tr>
<td>SRI 2015 – outreach and recruitment</td>
<td>minority student-focused professional societies (SWE, NSBE, SHPE student chapters) and email announcements distributed through DHS OUP MSI contacts</td>
</tr>
<tr>
<td>(11/1/14 – 2/27/15)</td>
<td>and channels.</td>
</tr>
<tr>
<td>SRI 2016 – outreach and recruitment</td>
<td>- DISA will host a minimum of one MSI SRT team per summer.</td>
</tr>
<tr>
<td>(9/1/15 – 2/26/16)</td>
<td>- Outreach efforts to recruit MSI SRT participation will be measured by the number of targeted email distributions and personal conversations had with MSI</td>
</tr>
<tr>
<td></td>
<td>representatives.</td>
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<td></td>
<td>- Outreach in the form of targeted emails and personal conversations with MSI schools will be conducted to encourage MSIs to prepare SLA proposals in</td>
</tr>
<tr>
<td></td>
<td>conjunction with the MSC.</td>
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<tr>
<td></td>
<td>- SLA proposals will include MSI faculty and student participation in the Center’s summer research program and in other ongoing research initiatives.</td>
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<tr>
<td>2. MSI participation in MSC research activities/programs.</td>
<td></td>
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<tr>
<td>Summer Research Team program</td>
<td></td>
</tr>
<tr>
<td>YR 1 – 6/1/15 – 8/7/15</td>
<td></td>
</tr>
<tr>
<td>YR 2 – 6/6/16 – 8/12/16</td>
<td></td>
</tr>
<tr>
<td>Scientific Leadership Awards (SLA)</td>
<td></td>
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<tr>
<td>YR 2 – 7/1/15 – 6/20/16</td>
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</table>

### USCG Auxiliary University Programs – Stevens Institute of Technology

**Baseline**

MSC in collaboration with the USCG Auxiliary District 1, Southern Region, has created an on-campus Auxiliary program for Stevens students. The program is one of only seven university-based programs in the nation and the first to be partnered with a DHS Center of Excellence. The USCG Auxiliary is a volunteer, non-military service unit that assists the USCG in missions related to safety and security, and marine environmental protection. To date, nine Stevens students, faculty and staff have been sworn in as Auxiliary members and the program has been officially recognized as its own Auxiliary Detachment. Stevens Auxiliary members have engaged in USCG harbor patrol missions aboard the USCGC Sturgeon Bay, they have assisted in the deployment of sensor
equipment during MSC research experiments, and they have conducted outreach at local events to educate the public on the impacts of pollution to our waters and marine life.

Methodology
During Years 1 and 2, the Center will continue to grow the Stevens-based program through member recruitment and greater opportunities to engage student members in field-based activities (e.g. vessel safety inspections and harbor patrols) with active duty Coast Guard.

Milestones and Performance Metrics

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Performance Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. USCG Auxiliary on-campus student meetings. Year 1 – 11/1/14 – 5/2/15 Year 2 – 8/29/15 – 5/7/16</td>
<td>-Meetings will occur once a month during the Stevens academic year. -Student member dues are required annually, each November. (2014, 2015 and 2016).</td>
</tr>
<tr>
<td>2. New member recruitment. Year 1 – 11/1/14 – 5/2/15 Year 2 – 8/29/15 – 5/7/16</td>
<td>-Student recruitment is continuous and will include participation in Stevens Club Fair events, announcements in the Stevens Student Life Newsletter and through campus posters. -The Stevens-based Auxiliary program will recruit a minimum of two new members each academic year to ensure sustainability of the campus-based program.</td>
</tr>
<tr>
<td>3. USCG Auxiliary student activities. Year 1 – 11/1/14 – 5/2/15 Year 2 – 8/29/15 – 5/7/16</td>
<td>-Completion of online and on-site training requirements will be completed as directed by the USCG Auxiliary. -Student community service and field-based activities will include a minimum of two organized events per academic year. (e.g. harbor patrols with the USGC or Aux education outreach at community events.)</td>
</tr>
</tbody>
</table>

Education Area 2. Professional Development Programs.

Maritime Incident Preparedness and Response - Discussion-based Exercises

Baseline
MSC’s director of education and its DHS CDG-funded fellowship students have served as observers, participants, scribes and evaluators for several local tabletop and full-scale exercises facilitated by the USCG, the Port Authority of New York and New Jersey, and
the NJ Office of Homeland Security and Preparedness. The Center’s participation in these exercises have contributed to the Center’s funded-participation in the DHS OUP Liberty Series of Discussion-based exercises, and inspired a research project during the 2014 SRI that included the development of maritime incident threat scenarios and exercise manuals that can be used by local law enforcement.

**Objective and Purpose**
To ensure continuous learning opportunities for maritime and homeland security practitioners, MSC will expand its professional development programs to include the development and implementation of port specific preparedness and response discussion-based exercises for port operators. The purpose of the exercises will be to enhance the preparedness of U.S. ports. The exercises can also be used to test and validate the safety and security plans used for MTSA compliance. The exercises will serve as a tool for port partners to assess their processes to prevent, protect, mitigate, respond and recover from a range of events.

**Methodology**
During Years 1 and 2, MSC will leverage the expertise of its partners from the Stephenson Disaster Management Institute (SDMI) at LSU, an established leader in executive training for emergency management and homeland security professionals, to develop exercises for select U.S. port locations. The exercise curricula will be prepared with input from MSC and its stakeholders (e.g. USCG, NJ OHSP.) and SDMI’s robust network of disaster and emergency management partners. The exercises will include scenario driven, discussion-based tabletop, seminar and/or workshop events and may include one or more of the following topics: port disruptions and closures, small vessel threats or influenza pandemics. In the development of these exercises, the Center will conduct conference calls with the appropriate academic partners and stakeholders to vet out strategic port locations for implementation. The Center will then establish the necessary connections to identify an organization to pilot the exercise program.

**Outcomes and Output**
Following the implementation of an exercise, MSC and SDMI will assess the effectiveness of the event through feedback gathered from participant surveys and evaluator notes. The Center will then compile a report that includes a summary of participant feedback, a matrix of the core capabilities assessed, the reported and observed strengths and weaknesses in meeting those core capabilities, and recommendations for improvements and after-action tasks. Exercise participants may receive participant certificates and/or professional development units to be granted by either Stevens Institute of Technology or SDMI at LSU.

Following the successful completion of one or more port-specific preparedness exercises, the Center will explore the development of an “Exercise in a Box” kit, that can be customized for future discussion-based exercises. The exercise kit will include multiple exercise options (varying scenarios) to choose from, with the ability to customize according to the unique characteristics and needs of the port operator.
<table>
<thead>
<tr>
<th>Milestone</th>
<th>Performance Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Development of scenario driven tabletop exercise(s).</strong></td>
<td>-MSC academic partners (Stevens/LSU/MIT and designated stakeholders) will plan a minimum of four (virtual and/or face-to-face) meetings to discuss port location(s), scenario themes, and objectives for a tabletop exercise. -A summary of the scenario planning process and port location details will be chronicled in meeting summary reports. -LSU/SDMI will identify and confirm a port partner in the New Orleans region to engage in and host the tabletop exercise. -LSU/SDMI will prepare a draft exercise manual for review and input by MSC partners. -A date will be confirmed for the exercise, participants will be identified and a final exercise manual will be prepared.</td>
</tr>
<tr>
<td><strong>Year 1 and 2 – 11/1/14 – 2/1/16</strong></td>
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<tr>
<td><strong>2. Delivery of MSC sponsored discussion – based tabletop exercise.</strong></td>
<td>-A minimum of one tabletop exercise will be delivered during Year 2. -LSU/SDMI will facilitate and deliver the exercise in conjunction with MSC partners. -Exercise participants will receive certificates or PDUs for their participation.</td>
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<tr>
<td><strong>Year 2 – 3/1/16 – 6/30/16</strong></td>
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<tr>
<td><strong>3. Exercise reports prepared.</strong></td>
<td>-An assessment of the exercise will be gathered from participant surveys and exercise evaluator notes. -A report will be prepared for the host organization to include a matrix of the core capabilities assessed, the reported and observed strengths and weaknesses in meeting the core capabilities, and recommendations for improvements. -MSC will prepare a second report detailing lessons learned in the planning and delivery phases of the exercise to be used for future tabletop exercises and/or the development of a port focused “Exercise in a Box” kit.</td>
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<tr>
<td><strong>Year 2 – 3/1/16 - 6/30/16</strong></td>
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</table>

**Maritime Systems Webinar/Seminar Series**

**Baseline**
MSC has sponsored several Maritime Systems-focused seminars designed to engage the Center’s students, researchers and industry and government partners in conversations regarding important and timely topics in Maritime Domain Awareness and the Marine Transportation System.

Objective and Purpose
The Center will facilitate outreach and relationship building by expanding its Maritime Systems webinar/seminar series. Featuring lectures by MSC researchers and nationally recognized homeland security leaders (e.g., Dr. Steve Flynn, Northeastern University) the webinar/seminar series is intended to engage a broad audience of faculty, students, and industry and government stakeholders in relevant and timely topics related to the maritime domain.

Methodology
MSC will rotate the delivery of seminars in order to drive broader participation among its academic partners, expand the breadth of its seminar topics, and build greater awareness of the center’s research capabilities and resources.

Center leadership leverages their homeland security partnerships and connections within industry, government, and academia to facilitate and extend guest speaker invitations. Since the Center does not provide honoraria for seminar series speakers, the Center makes every effort possible to schedule guest speakers around times in which they are confirmed to be on campus for other university events or are attending related Center meetings (e.g. stakeholder meetings, research discussions, Stevens hosted workshops, general guest visits, etc.).

Center administrators and Stevens faculty members proactively reach out to prospective guest speakers to complement the topics being covered in the Maritime Security program curricula (e.g., Risk Assessment, Game Theory, etc.), or if current events in the field (e.g. Hurricane Sandy, Fukushima, etc.) provide unique learning opportunities for students, faculty and the general homeland security enterprise.

Upcoming webinar/seminar guest speakers will include:
### Seminar Content

<table>
<thead>
<tr>
<th>Seminar</th>
<th>Faculty/Guest Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>PANYNJ OEM Operations, Missions and Areas of Responsibility</td>
<td>Jerry McCarty, Director OEM PANYNJ</td>
</tr>
<tr>
<td>Undersea Cables – Security Concerns and Procedures</td>
<td>Dr. Phil Vitale, Director, Ocean Engineering, Naval Facilities Engineering Command</td>
</tr>
<tr>
<td>ROVs and Unmanned Systems for Persistent Surveillance and Situational Awareness</td>
<td>Dr. Brendan Englot, Assistant Professor, Stevens</td>
</tr>
<tr>
<td>Center for Maritime Research and Experimentation – Sensor Platforms &amp; Harbor Security</td>
<td>Chris Francis, Research Engineer Stevens and former DHS CDG Fellow</td>
</tr>
<tr>
<td>Approaches to Critical Infrastructure Protection using Green Technologies</td>
<td>Dr. Allison Fitzgerald, NJ City University and DHS SRT participant</td>
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<tr>
<td>Additional guest speakers will be confirmed in conjunction with the Center’s academic partners.</td>
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</tbody>
</table>

MSC will develop a publically available library of seminar recordings on the center’s website and other media outlets (e.g., iTunes U). When possible, the Center will leverage Stevens Institute of Technology’s online learning platform, Blackboard Collaborate and its web conferencing system WebEx, to host and record the webinar/seminar series.

### Outcomes and Output

The Maritime Systems Webinar/Seminar Series will feature a minimum of four seminars during Year 1 and six during Year 2. The Center will utilize the Seminar Series to broaden its outreach and to feature topics of interest and concern to maritime and homeland security practitioners. Participants will be asked to complete a short survey at the end of each seminar to assess the quality of the presentation, the relevance of the topic to the participant, and to gather feedback on future seminar topics.

### Milestones and Performance Metrics

<table>
<thead>
<tr>
<th>Milestone</th>
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</thead>
<tbody>
<tr>
<td>Delivery of maritime systems/homeland security focused seminars.</td>
<td>-MSC will host four seminars during Year 1 and six seminars during Year 2.</td>
</tr>
<tr>
<td>Year 1 – 1/1/15 – 6/30/15.</td>
<td>-A survey will be used to assess the quality of the presentation, the relevance of the topic and to gather feedback for future seminars.</td>
</tr>
<tr>
<td>Year 2 – 7/1/15 – 6/30/16.</td>
<td>-Webinar/Seminars will be made available to the public. (e.g., presentation slides will be posted on the MSC website and podcast recordings will be available on Stevens iTunes U account.).</td>
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<tr>
<td></td>
<td>-Speakers will include MSC researchers and guest speakers from the homeland</td>
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</tbody>
</table>
security domain.