



The Maritime Security Center (MSC)

**at Stevens Institute of Technology
Hoboken, NJ**

**Year 3 Work Plan:
July 1, 2016 – June 30, 2017**

APPROVED July 7, 2016

Table of Contents

1. Overview and Mission Relevance.....	3
2. Management Plan	3
3. Stakeholder Engagement.....	11
4. Research Projects	13
4.1 Smart Port Resiliency Assessment and Planning Tool	13
4.2 Maritime Cyber Security Project	21
5. Education and Outreach.....	22

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 ensure that the MSC research and education activities will be relevant to stakeholders, with strong linkages to government customers and industry partners, and establish 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 of Education
- ❖ A Management Committee

Executive Director/Principal Investigator: Dr. Hady R. Salloum, Associate Dean of Research and ECE Professor in the Charles V. Schaefer Jr. School of Engineering & Science at Stevens Institute of Technology will serve in this capacity. Dr. Salloum 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 evaluating project progress and providing input for the allocation of MSC resources. Dr. Salloum 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 Dean, a reflection of the high priority of this position within the Stevens Administration.

Director of Education and Outreach: The Director of Education 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 of Education. The MC will also include the DHS OUP Program Manager. The MC

will be responsible for the review of MSC projects and the allocation of funds, and the responsiveness to the DHS biennial review.

The MC will meet by conference call approximately on a monthly basis, and face-to-face on a semi-annual basis when possible. 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 or SEAC). 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 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 Solicitation

MSC will continue to engage with the DHS stakeholders to discuss their high priority challenges. To address these challenges, we will solicit proposals on a quarterly basis via White Papers or Request for Proposals. The topics solicited will be aligned with the original Center's Funding Opportunity Announcement (FOA) as well as the Integrated Product Team (IPT) topics. We will also continue to socialize the Center's projects and encourage existing and new partners to submit new ideas that can help the Center in its research and education missions. Such new ideas for projects will be considered for funding when it becomes available.

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 work plans. These plans will be reviewed by MSC's Director. This process will be interactive between the research leads (PIs) and the MSC leadership, where feedback will be provided on the technical relevance in the context of the overall Center's themes and 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 progress of each project will be discussed during the management committee meetings as well as other meetings with the PIs. Milestones and project metrics will be reviewed with the PIs on an ongoing basis and evaluated. Deviations/delays will be discussed with the DHS Program Manager, and corrective action will be taken.

Our overall evaluation goal is to have a clear understanding by the end of each year as to which activities will be continued, which need to be modified (and perhaps even enlarged) and which need to be ended. The reviews 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 review.

Project-based evaluation criteria we will assess (also relevant for biennial review) include the following to continue to evaluate whether each project is good science, it is

relevant to the DHS stakeholders, and is progressing as planned. We will use the following questions as a guide:

- Do reported performance metrics and milestones indicate adequate progress towards meeting objectives?
- Is there 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 encourage the PIs with the following items, where these items being used as an indicator of the quality of the research projects in the portfolio:

- 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. MSC management will begin at the outset to solicit research questions/needs from our DHS customers. Mechanisms to achieve input include stakeholder meetings and other communication. 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-MSR 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 develop project proposals via White Papers or RFPs as needed.

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 work plans. 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 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. We will also continue to create abstracts and fact sheets for new projects.

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 seven 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.

Stakeholder Engagement Meetings

The 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 Stakeholder Engagement Meetings will be up to a day-long event, combined with other meetings when appropriate (e.g., workshops, annual meeting, etc.) and cover the following topics. 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 1 DHS S&T outreach event 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.

Meetings of the MSC Science and Education Advisory Committee

MSC will invite the SEAC to its annual meeting to the Stevens campus/Washington DC office 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 will encourage the project leads and other faculty to participate in 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 if workable.

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 CBP and ICE 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 areas related to maritime security, including Maritime Domain Awareness, Maritime Cyber Security, and Port Resiliency. The research activities to be conducted are outlined below.

- Port Resiliency (Florida Atlantic University)
- Maritime Cyber Security (TBD)

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

4.1 Smart Port Resiliency Assessment and Planning Tool

Florida Atlantic University
Lead Researcher: Manhar Dhanak

Project Overview

The Year 3 effort will be in the development of the proposed tool to complete the identified tasks and continue to engage stakeholders. Based on available information and stakeholder discussions to date, the scope of the project has been defined to include three disruptive scenarios: 1) disruption at a port along the east coast due to a major storm, 2) disruption at a port in the Gulf of Mexico due to an accident involving major oil spill, and 3) disruption at a port along the west coast due to a labor strike. Requisite data are currently being sought from Port Everglades, Ports of New Orleans and Houston, and Port of LA/Long Beach as initial considerations in developing the port

resiliency assessment and planning tool. Stakeholder survey questions have been prepared and a database of Port authorities and relevant stakeholders, including USGC and port recovery specialists, is being assembled to engage with and seek feedback. Literature reviews have been conducted to identify existing related tools, identify threats and associated vulnerabilities, as well as various strategies employed to mitigate impact and to recover from disruptions. Development of AIMSUN based simulation case studies of the various types of disruptions, such as storm-related flooding at Port Everglades, and their impacts is underway in order to establish the necessary databases. In Year 3, Tasks 11-13 will be completed.

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

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.

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. Serve as a *decision-support tool*
5. *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.

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.

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 Schedule

The tasks for Year 3 are Tasks 11 through 13. Tasks 1 through 12 are the scope of Years 1 and 2 and are listed for reference (details may be found in the Years 1 and 2 Workplan).

Task 1a. *Develop detailed work plan*

Task 1b. *Define the port system and scope of the project*

Task 2a. *Assess port vulnerabilities*

Task 2b. *Identify characteristics of external disruptors*

Task 3. *Establish port rules, policies and decision-making process*

Task 4. *Define requirements for the tool*

Task 5. *Develop strategies for the development of the tool*

- Task 6. *Develop simulation model and conduct initial test and performance validation*
- Task 7. *Formulate mathematical model*
- Task 8. *Develop optimization models for resiliency and emergency management*
- Task 9. *Test and validate mathematical models and optimization algorithms*
- Task 10. *Identify and develop a theoretical and empirical basis*
- Task 11. Complete modular algorithms and user interfaces for the new tool **[To be completed 11/1/16 – 3/31/17]**.
- 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 **[To be completed 11/1/16 – 3/31/17]**.
- Task 13. Prepare final report **[To be completed 4/1/17 – 6/30/17]**.

Considerations in Conducting the Work

It is a 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.

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 $\vec{f}(\vec{x}, \vec{z}, \vec{p}, \vec{e})$ for various decisions \vec{x} for given port vulnerabilities \vec{z} and external disrupters \vec{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 \vec{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

$\min_{\vec{x}, \vec{z} \in \Omega} E[\vec{f}(\vec{x}, \vec{z}, \vec{p}, \vec{\epsilon})]$ over the ranges of values of vulnerabilities \vec{z} and external disruptors \vec{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 \vec{f} 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).

Performance Metrics:

Anticipated milestones with proposed performance metrics are provided below:

<u>Milestone</u>	<u>Performance Metrics</u>	<u>Timeline Target</u>
1. Completion of simulation modeling, detailed algorithms and user interfaces for the new port resiliency assessment and planning tool.	The new tool-based predictions of the impact and recovery of port capacity validated against available historical data from 2 to 3 ports involving closure of a port over a period of time ranging from a few days to several weeks.	<u>March 31, 2017</u>
2. Completion of the development of best practices guidelines and Port Resilience Indices for specific disruptions using the new tool.	The merits of the Port Resiliency Indices and best practice guidelines evaluated through stakeholder feedback. Response from over 30 stakeholders will be sought.	<u>June 30, 2017</u>

<u>Milestone</u>	<u>Performance Metrics</u>	<u>Timeline Target</u>
3. Completion of a final report.	Acceptance/dissemination of the report, publication of results in a technical journal and one TRB conference, and delivery of algorithms, surveys and related materials to DHS.	

Stakeholder Engagement

The FAU team will actively collaborate with the Port Authorities, Port Recovery Specialists, and USCG in conducting the project. This will include frequent phone calls, face-to-face work sessions at USCG, and regular electronic correspondence. As part of Task 1, champion entities at USCG are identified.

Benefit to DHS Stakeholders

The proposed effort is consistent with DHS Mission 5: Strengthen National Preparedness and Resilience that call for facilitating recovery following a disaster through promotion of infrastructure resilience guidelines and development of continuity plans for communities, government entities, and private-sector organizations. It is also consistent with Mission 2: Secure and Manage our Borders that calls for strengthening the security and resilience of the global supply chain and the international travel system through establishing and enforcing security standards and plans that maintain or restore infrastructure capabilities, including at ports, to be resilient from attacks and natural disasters. The port resiliency assessment and planning tool is aimed to allow assessment and planning for evolving threats and hazards to a port and its waterside and land-side distribution capacity, in support of avoidance and mitigation of damage and capacity reduction, and aiding rapid recovery from disruptions.

4.2 Maritime Cyber Security Project

Provided separately.

5. Education and Outreach

Overview

MSC is committed to enhancing the knowledge, technical skills and leadership capabilities of the 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 relevant, innovative maritime security-centric educational programs. The Center's educational programs leverage the teaching talents, research assets, and subject matter expertise of its academic partners to provide multidisciplinary and experiential learning opportunities for students, professionals, stakeholders, and the general public.

During Year 3, 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, 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 educational programs for Year 3 will include the following:

- College-level experiential learning and research-based programs:
 - The Summer Research Institute
 - Maritime Security Master's and Doctoral Fellowship Programs
 - MSI Outreach and Engagement in Research
 - USCG Auxiliary - Stevens Detachment

- Professional development programs:
 - Maritime Incident Preparedness and Response - Discussion-based Exercises
 - Maritime Systems Webinar/Seminar Series

Education Area 1: College-level experiential learning and research-based programs

Project 1.1 The Summer Research Institute

A. Project Description

MSC has developed an eight-week intensive HS-STEM focused summer research program designed to expose students to the maritime and homeland security domain and to engage them in research projects tailored to address critical issues in maritime domain awareness, emergency response and maritime system resilience.

Over the past six years, the Center 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, 103 students, representing 20 U.S. universities including MSI and HBCU universities, have collaborated 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). Student research outcomes have included co-authored papers, participation at national conferences and the development of an emergency response tool among others. The Center has been able to track the long-term impacts of the program on student choices to pursue advanced academic study and careers in HS-STEM related areas.

With the inclusion of its academic partners, MSC will continue to build upon its 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 to ensure diversity in the program and to facilitate enhanced opportunities for women and students from underrepresented communities.

B. Benefits to DHS Stakeholders:

Prospective HS-STEM students: The summer research program engages STEM students in hands-on multidisciplinary research projects focused on critical issues in maritime security. The program exposes students to homeland security concerns and to new academic opportunities and careers within the homeland security enterprise. Students enhance their professional development by actively engaging in team-based projects, collaborating with academic researchers and networking with homeland security practitioners.

Homeland Security Enterprise: The Summer Research Institute provides a forum for high-achieving STEM students to network and engage with homeland security practitioners in the public and private maritime sector. The program provides opportunities for homeland security practitioners to contribute to the development of relevant security research projects and to the education of the future homeland security work force.

C. Methodology:

Feedback from past student surveys and discussions with Center 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, multidisciplinary research projects focused on current maritime and homeland security issues.
- Field-visits and field-based activities with Federal, state, and local homeland security practitioners. (e.g., USCG, CBP, NJ OHSP, NYPD-CTD and NUSTL)
- Professional development activities, including oral presentations, team projects, report writing, and networking.

Lessons learned over the six-year delivery of the Summer Research Institute will continue to inform and guide the implementation of the program in Year 3.

MSC researchers play a key role in the professional development and mentoring of SRI participants. Students in the 2016 and 2017 programs will be given the opportunity to learn first-hand from experienced researchers in the fields of maritime security, cyber security, remote sensing, and emergency management and response. 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 SRI program is to further connect students with homeland security stakeholders and to engage them in research projects that are responsive to and directly impact the knowledge and technology needs of homeland security practitioners. During Year 3, the summer research program will build upon the Center's ongoing research to enhance maritime domain awareness (MDA) and will incorporate the Center's emerging projects in the areas of Maritime Cyber Security and mobile MDA platforms. 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's stakeholders.

D. Project Milestones:

1. Featured lectures by MSC researchers and invited guests. (6/6/16 – 7/29/16)
2. Field-visits and field-based activities. (6/6/16/16 – 7/29/16)
3. Diversity of student participants. (6/6/16 – 6/30/17)
4. Research Reports, presentations and posters. (6/6/16 – 7/29/16)
5. Post-Program Student Survey. (7/25/16 – 8/5/16)

E. Performance Metrics:

The performance metrics are mapped to the milestones listed above.

1. A minimum of two homeland security/maritime industry guest speakers will be hosted during the summer research program:

- 1a. A minimum of six faculty lectures will be provided during the eight week research program.
- 1b. The quality of and knowledge learned from the lectures will be assessed through a post-program student survey.

2. Students will engage in a minimum of two field-based activities during the summer research program. (e.g., participation in a stakeholder meeting/workshop/training, research experiments/deployments, operational facility tours) during the program.

- 2a. Impacts of the field-based activities and stakeholder engagements on student professional development and networking skills will be assessed through a post-program student survey.

3. Diversity will be measured according to the number of students from underrepresented communities (MSI schools, minority students and women), and to the number of STEM disciplines represented in the program. A minimum of four different disciplines will be represented.

- 3a. Student diversity will be measured by the percentage of women and minority students participating in the program. A diverse student population will include a minimum of 50% students from underrepresented communities. (e.g., women, students attending MSI's or minority students.)

4. A minimum of two research summary reports and research posters will be prepared at the culmination of the SRI program.

- 4a. Students will engage in five research status update presentations (Weeks 3 – 7) during the SRI.
- 4b. Stakeholder engagement will be assessed by representation of homeland security representatives attend the final student research team presentations (Week 8).
- 4c. Quality of research outcomes will be assessed by MSC research mentor feedback and the number of projects submitted for presentation at conferences and/or for publication.
- 4d. Program impacts on professional development, technical skills learned, project teamwork, and expressed student interest in advanced academic

study or careers in HS-STEM will be assessed by a post-program student survey.

5. A minimum of one student survey will be conducted at the end of the 2016 SRI. The survey will be used to measure the strengths of the program and areas for improvement.

F. Outputs/Outcomes:

MSC will provide a structured eight-week summer research program for STEM students to engage in hands-on homeland security-focused research. The program consists of faculty and invited guest lectures and field-based activities, and professional skills development exercises. Outcomes from the program will include student exposure and awareness to maritime and homeland security concerns, enhanced oral presentations skills and project teamwork, and research reports and posters articulating the student's research activities and knowledge learned.

G. Transition Plans:

Student team final summary research reports and presentation slides will be made available on the MSC website. The Center also actively pursues post-program opportunities for students to present their work at national conferences and events. In the past, students have been selected to present their work at such conferences as the SPIE Optics and Photonics conference. At this particular conference, the student's work caught the attention of representatives at Sandia National Labs, who later reached out to the Center and visited for a guest lecture.

H. Stakeholder Engagement:

Stakeholder engagement in the SRI has been a key facet to the summer research program since its inception. Representatives from the USCG (Sector New York, Research and Development Center and LANT Area), NYPD (Counterterrorism Division and Information Technology Division) and Customs and Border Protection (Field Operations) have offered their support and participation in the Year 3 summer research program through the following activities: hosting field-visits and facility tours (CBP Port New York/Newark), engaging student's in training (e.g. NYPD-CTD's Port Awareness and Response training course), guest lectures (USCG RDC), and research project advisement (NYPD Information Technology Division).

I. Potential risks to completion:

The SRI program occurs over an eight-week period. While past student groups have achieved significant outcomes, research progress and outcomes rely upon the availability of research assets (e.g. working and available equipment (radar, passive

acoustic systems, teaching expertise, etc.). In past cases where needed technologies have been broken or deployed, we have relied upon past data sources and tools and technologies loaned to us from other Stevens departments. SRI mentors and administrators are flexible and agile to ensure that students are provided with alternative resources as needed throughout their research experience.

Project 1.2 Master's and Doctoral Fellows and Graduate Research Assistants

A. Project Description:

Leveraging the support of DHS Education Supplement awards and DHS Career Development Grants the Center has developed an actively engaged Master's Degree and Doctoral Degree Fellowship program. The homeland security-focused Master's and Doctoral Fellows program provides for full-tuition support, a monthly stipend and field-based internships and robust networking opportunities with homeland security decision makers and practitioners.

Collectively, the MSC has supported three Doctoral Fellowships in the areas of Mechanical Engineering and Homeland Security, Passive Acoustics and Maritime Security, and Applied Marine Physics, and ten Master's Maritime Systems/Security Degree Fellowships and Graduate Assistantships. To date, eight of the nine Master's Degree Fellows have successfully completed their degree programs. Six of the program alumni are currently employed in the homeland security space and two are actively seeking employment.

The objectives of the MSC Fellows program is to educate the next generation of technical leaders who will assume positions within the homeland security domain and who will have a positive impact on the Nation's maritime and homeland security challenges. During Year 3, the Center will seek to confer a minimum of three Homeland Security Graduate Research Assistantships. The Research Assistantship program will provide tuition support and a monthly stipend throughout a two-year academic program.

The Graduate Research Assistantship will function as an interdisciplinary program integrating course work from the Mechanical Engineering and Electrical and Computer Engineering programs with course work from the Stevens Maritime Security curriculum. The interdisciplinary program will leverage the faculty resources and research assets of the three Stevens academic departments to provide a robust and multifaceted Master's degree experience. The goal of the Homeland Security Graduate Research Assistantship program will be to provide a foundation for solving problems associated with threat detection and surveillance challenges in the maritime and homeland security domain through the use of advanced signal processing techniques associated with sensing technologies and scientific approaches (e.g., optics, radar, etc.).

During Year 3, MSC will also introduce a new requirement for its Doctoral Fellows to present their research in a formal MSC Doctoral Fellows Research Symposium. The annual event will provide the opportunity for MSC sponsored doctoral candidates to present their research in a half-day research event and receive feedback from MSC researchers, Stevens faculty, DHS stakeholders, and peers. The Symposium will serve as a forum for the Center's doctoral students to network, share ideas and resources, and build community within the Fellowship program. The Doctoral Research Symposium will be held on-campus at Stevens and will be held in conjunction with an MSC stakeholder's meeting.

B. Benefits to DHS Stakeholders:

HS-STEM career focused students: The graduate-level Fellows program provides HS-STEM career focused students with a unique opportunity to complete their coursework on a full-time basis and to engage in hands-on multidisciplinary research projects with MSC researchers. The Fellows program facilitates opportunities to gain invaluable experience through field-based internships and collaboration with homeland security practitioners.

Homeland Security Enterprise: The MSC Fellows program is a rigorous HS-STEM focused education program requiring students to engage in advance-level coursework, hands-on research, field-based experiential learning and thesis preparation. Graduates of the Fellows program enter the HSE well informed of current issues and the state of practice in the field, possess superior technical skills and have field-based work experience. The Fellows program helps to support DHS workforce imperatives.

C. Methodology:

The new Homeland Security Graduate Research Assistantship program will function as an interdisciplinary program integrating course work from the Mechanical Engineering and Electrical and Computer Engineering programs with course work from the Stevens Maritime Security curriculum. The interdisciplinary program will leverage the faculty resources and research assets of the three Stevens academic departments to provide a robust and multifaceted Master's degree experience.

The goal of the Graduate Research Assistantship program will be to provide a foundation for solving problems associated with threat detection and surveillance challenges in the maritime and homeland security domain through the use of advanced signal processing techniques associated with sensing technologies and scientific approaches (e.g., optics, radar, etc.).

Students awarded a Graduate Research Assistantship will participate full-time in a graduate-level degree program in any of the following fields, Electrical Engineering,

Mechanical Engineering, or Computer and Electrical Engineering at Stevens Institute of Technology. The educational objectives of the degree program are to:

- Provide fellowship students with the technical skills and organizational knowledge needed to assume positions of responsibility in homeland security organizations that deal with the threats posed to coastal borders, vessels, ports, and facilities.
- Enable the students to acquire and apply knowledge of a broad range of technologies to maximize the effect in the field of homeland security.
- Provide the students with a practical knowledge of the operational and regulatory skills needed to manage and lead organizations responsible for port, facility, and vessel security.
- Provide students with the basic knowledge needed to pursue research in the maritime security arena.

At the completion of the Research Assistantship program, fellowship students will receive a Master of Engineering Degree in Mechanical Engineering, Electrical Engineering, Computer Engineering or Electrical and Computer Engineering. To be considered for the Homeland Security Assistantship program students must meet the following criteria:

- U.S. Citizenship
- Cumulative GPA of 3.30 or better
- Possess an undergraduate degree in Engineering or anticipate completion of their degree by May 2016.
- Students must be in the process of applying or have already been formally admitted into one of the following Stevens Master's Degree programs Mechanical Engineering, Electrical Engineering, Computer Engineering or Electrical and Computer Engineering.

Student recruitment efforts will include outreach to Stevens and MSC academic partners. Student applicants from MSC partner universities and those recommended by MSC and Stevens researchers will be given priority in the Graduate Assistantship review process. Additional recruitment efforts will be conducted through electronic announcements distributed through DHS S&T OUP education representative and MSI channels. The Graduate Research Assistantship review committee will conduct a two-phase approach in the selection candidates. In the first phase, the Committee comprised of MSC administrators and Stevens faculty members will assess applicant transcripts, letters of recommendation and personal statement of interest, and will select the top candidates to participate in on-campus or phone-based interviews. In the second phase of the selection process, the review committee will conduct individual interviews with the candidates and will select the student's who best demonstrate leadership potential and commitment to careers in the Homeland Security domain.

D. Project Milestones:

1. Homeland Security Graduate Research Assistantship - prospective student outreach and recruitment. (6/1/16 – 12/30/16)
2. DHS CDG - Maritime Systems Fellow placement in field-based internships. (6/1/16 – 8/30/16)
3. MSC Fellows fulfill graduate degree requirements. (7/1/16 – 6/30/17)
4. Career placement and post-program student tracking. (6/1/16 – 6/30/17)
5. Doctoral Fellows Research Symposium. (7/1/16 – 12/30/16)

E. Performance Metrics:

1. Confer a minimum of one Graduate Research Assistantship.
2. Place Master's Degree Fellow (one eligible student) in a ten-week field-based internship with a DHS component agency. (e.g. HSSAI)
3. Master's (two students) and Doctoral Fellows (three students) maintain GPA requirements and enroll full-time in coursework and research credits.
4. Graduating Fellows (one eligible student) complete coursework and thesis requirements.
 - 4a. Graduating Fellows (one eligible student for placement) will assume employment in the homeland security enterprise.
 - 4b. Student employment and professional activities will be tracked through a post-program survey.
5. Doctoral Fellows Research Symposium held in conjunction with an MSC stakeholder meeting.
6. MSC will apply for additional education supplements, as they are made available through DHS OUP.

F. Outputs/Outcomes:

The MSC Fellows program was developed to meet DHS workforce needs and to create a steady pipeline of highly-skill STEM students entering technical leadership careers within the maritime and homeland security space. To date, MSC Fellows have participated in summer internships with the USCG RDC, USCG LANT-Area, USCG Sector New York, U.S. Navy, and have obtained employment with HSSAI, PNNL, NATO-CMRE, DNV-GL, and LMI.

Additional program outcomes include maritime and homeland security-centric Master's Thesis and Doctoral Dissertations.

G. Transition Plans:

Graduates of the MSC Master's and Doctoral Fellows programs are required to assume employment within the Homeland Security space following completion of their degree programs. The transition of highly-skilled STEM focused students into homeland security careers will enhance the technical capabilities and thought-leadership of the DHS enterprise.

H. Stakeholder Engagement:

Students in the MSC Fellows and Graduate Research Assistantship programs routinely interact with homeland security stakeholders (e.g., USCG, CBP, NYPD-CTD, NJ OHSP, NUSTL and other DHS component agencies) through Center research projects, MSC Lab presentations, MSC and DHS hosted meetings and events, and field-based internships. During Year 3, Tyler Mackanin, 2012 CDG Master's Degree Fellow will engage in a ten-week summer internship with the Homeland Security Studies and Analysis Institute.

I. Potential Risks to Completion:

The success of the Fellows program relies on two key components, the Center's ability to attract and retain self-motivated, STEM-focused students who have an interest in careers in the Homeland Security domain, and the ability to match those students with relevant and engaged field-based internships with DHS stakeholders. Without the appropriate mechanisms for vetting Fellowship candidates and strong stakeholder partnerships, the Center would not be able to fulfill the mission and requirements of its HS-STEM career development and placement program.

Project 1.3 MSI Outreach and Engagement in Research

A. Project Description:

MSC's academic partners include two Minority Serving Institutions (MSI's), 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 (SRI). As of Year 3, the Center will have hosted students from thirteen unique MSI schools since the SRI's inception in 2010. The number of MSI students supported each year varies and is contingent upon the Center's annual funding.

B. Benefits to DHS Stakeholders:

MSI Students and Faculty: Students and faculty from underrepresented communities will be provided with a robust and engaged research experience with MSC researchers and Stevens faculty members. The Center will enhance the professional development of MSI students and faculty members through mentorship, access to state-of-the-science research assets and facilitated networking and engagement with MSC stakeholders.

MSC engagement with MSI students and faculty will create pathways for future field-based internships, career placement and new research partnerships.

Homeland Security Enterprise: DHS will benefit from a broader and more diverse pool of HS-STEM focused students interested in advanced academic study and careers within the homeland security enterprise. The DHS enterprise will also benefit from the enhanced research capabilities of MSI schools and universities.

C. Methodology:

In Year 3, the Center will actively participate in DHS OUP hosted MSI events and will leverage its existing MSI contacts and partners to enhance the engagement of students from underrepresented communities in the Center's Summer Research Institute and the MSC Fellows program.

During Year 3, the Center also plans to host on-campus Dr. Sang-Yeon Cho, Associate Professor, Klipsch School of Electrical and Computer Engineering, New Mexico State University, and his graduate-level student Mr. Charles Pelzman, as part of the DHS MSI Summer Research Team Program. Throughout the ten-week MSI SRT program, Dr. Cho and Mr. Pelzman will conduct research in collaboration with Dr. Barry Bunin, Research Professor and Chief Architect, Maritime Security Laboratory on an Electro-Optic beam control system for underwater threat detection.

The goal of the DHS summer research project is to initiate a feasibility study of a new electro-optic (EO) underwater target detection method that can be integrated into a multi-modality intruder detection system at the Maritime Security Laboratory (MSL) at Stevens Institute of Technology.

D. Project milestones:

1. Students from underrepresented communities (minority students, women and MSI enrolled students) participate in the Center's annual Summer Research Institute. (6/6/16 – 6/30/17)
2. MSI participation in MSC research activities/programs. (6/1/16 – 6/30/17)
3. MSI summer research team to conduct research on-campus at Stevens Institute of Technology in conjunction with MSC and Stevens faculty. (6/2016 – 8/2016)

E. Project Performance Metrics:

1. Diversity in the SRI program will reflect a minimum of 50% of students from underrepresented communities. (e.g. minority students, women and MSI enrolled students.)
 - 1a. MSC's MSI outreach and recruitment efforts will be assessed by the Center's participation in MSI events, the number of targeted email

communications and personal conversations with MSI representatives, and by MSI student opportunity announcements distributed through the DHS OUP MSI contact channels.

2. MSC will host one MSI Summer Research Team.

- 2a. Research outcomes will be measured by the ability to receive DHS OUP follow-on funding and reports produced during the MSI SRT program..

F. Outputs/Outcomes:

MSC will provide a rigorous and intensive summer research experience for MSI students and faculty to engage in hands-on HS-STEM focused research. MSI faculty and students will work in collaboration with MSC researchers and Stevens faculty members and will engagement in meetings and field-based activities with the Center's stakeholders. Outcomes from the program will include student and faculty exposure and awareness to maritime and homeland security concerns, enhanced research skills and project teamwork, and research reports and posters articulating the MSI/MSC research activities and knowledge learned.

G. Transition Plans:

The MSI SRT team final summary research report and presentation slides will be made available on the MSC website. The Center will also actively pursue post-program opportunities for the MSI SRT team to present their work at national conferences and events.

H. Stakeholder Engagement:

The MSI SRT program will be held concurrent to the Center's Summer Research Institute. The Center will leverage stakeholder engagement in the SRI, to also facilitate engagement in the MSI SRT research project.

I. Potential Risks to Completion:

The MSI SRT program occurs over a ten-week period. Team research progress will rely upon the ability of the visiting research team to settle in and begin building a rapport with the MSC based team. Outcomes from the ten-week research project will also rely upon the availability of research assets (e.g. working and available equipment (passive acoustic systems and electro-optic cameras).

Project 1.4 - USCG Auxiliary University Programs – Stevens Institute of Technology

A. Project Description:

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 twelve 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. Since 2013, 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.

B. Benefits to DHS Stakeholders:

HS-STEM Students: HS-STEM students enhance their experiential learning and professional development by engage in USCG training courses and field-based activities with USCG Auxiliary members and USCG active duty personnel.

U.S. Coast Guard: The USCG Auxiliary assists Coast Guard missions related to safety, security, homeland security and marine environmental protection.

C. Methodology:

Through student membership attrition and changes in USCG Auxiliary Flotilla administrative support, participation in the Stevens detachment has declined. During Year 3, MSC will identify a new local Flotilla collaborator and will seek opportunities to collaborate with other universities in the metropolitan area (e.g. John Jay College of Criminal Justice), to enhance student membership and participation.

MSC has initiated communications with USCG Auxiliary Lower Manhattan to identify opportunities for Stevens Detachment members to participate in Auxiliary meetings, trainings and Flotilla events. As activities and opportunities are announced, MSC's director of education notifies Stevens Auxiliary members for their information and participation. MSC will continue to engage in conversations with John Gallagher, USCG Auxiliary Division 8, for guidance in working with other local university groups and engagement with other Flotilla units.

D. Project Milestones:

1. USCG Auxiliary member retention and recruitment. (7/1/16 – 6/30/17)
2. USCG Auxiliary administrative and training support. (7/1/16 – 6/30/17)
3. USCG Auxiliary/Stevens Detachment member activities. (7/1/16 – 6/30/17)
4. Recruit new Stevens Detachment members once new Auxiliary administrative support has been identified and confirmed. (12/1/16 – 6/30/17)

E. Performance Metrics:

1. Maintain student/faculty active membership in the Stevens Auxiliary Detachment.
2. Engage Stevens Auxiliary members in a minimum of two Auxiliary related activities on-campus and at local Flotilla events (e.g. Flotilla 5-3 Lower Manhattan)
3. Confirm new USCG Auxiliary administrative support.
4. Recruit a minimum of two new student members.

F. Outputs/Outcomes:

The MSC coordinates the meetings and activities of the USCG Auxiliary – Stevens Detachment. Outcomes from the Stevens Detachment include student and faculty engagement in Auxiliary field-based activities and missions, including public outreach events and patrols of the Hudson River.

G. Transition Plans:

MSC has initiated communications with administrators from John Jay College of Criminal Justice in NYC to share it's lessons learned in creating the Stevens-based Auxiliary program.

H. Stakeholder Engagement:

Inherent to the mission of the USCG Auxiliary is the engagement of Auxiliary members in Coast Guard functions including maritime safety and security, and marine environmental protection. Stevens Detachment members have participated in harbor patrols with active duty personnel from Sector New York.

I. Potential Risks to Completion:

Membership attrition due to academic commitments and student graduation pose challenges to MSC's ability to sustain an active and engaged Auxiliary program. Additional challenges include the availability of local Flotilla members to provide mentorship and on-campus support of the program.

MSC Education Area 2: Professional Development Programs

Project 2.1: Maritime Incident Preparedness and Response – Discussion-based Exercises

A. Project Description:

The Maritime Incident Preparedness and Response – Discussion-based Exercise (MIPR-DBE) is an educational initiative that aligns with the Department of Homeland Security’s core mission of ensuring preparedness for and resilience to disasters. Through the MIPR-DBE initiative the MSC will work directly with port facility operators across the country to facilitate and bolster information sharing and collaboration between the public and private sector partners including Federal, state and local officials with requirements to ensure the public safety and uninterrupted operations of the Nation’s Ports. This project will leverage lessons learned from Years 1 and 2 of the MSC professional development program to assist Ports in the design and execution of discussion-based exercises.

B. Benefits to DHS Stakeholders:

USCG: The MIPR-DBE will provide a comprehensive resource to the USCG to aid in the development and conduct of annually required table top exercises that exercise a minimum of two of the four major objectives (Awareness, Prevention, Preparedness for Response, and Crisis Management and Recovery) along with specific core components in order to test the overall effectiveness of the Port’s Area Maritime Security Plans (AMSP).

Stakeholders/HSE: The program will allow the MSC to expand its reach and influence by providing direct support in the development and execution of tabletop exercises with port facility operators across the country. While the Year 1 and 2 work plan focused on the complete development and execution of two discussion-based exercises along with providing assistance in the development of a third discussion-based exercise, this project will focus on developing scenarios and tools that can be used to assist ports in customizing their own discussion-based exercises. Since MSC will not be focused on the complete development and execution of multiple exercises we will be able to lend our expertise and support to port facilities across the nation while using those engagements to continue developing and modifying tools that can be leveraged to meet port facility security plan requirements. In addition to port facilities, the tools will be developed to enable law enforcement, fire, EMS, emergency management, government administrations, and other first responder disciplines to be fully integrated in the design and implementation of the exercise. The MIPR-DBE and direct engagement of MSC personnel with port and maritime stakeholders will help increase the overall resiliency of participating ports.

C. Methodology:

The Year 3 elements of the MIPR-DBE program will be focused on designing additional scenarios to include all the tools that will be needed to integrate applicable core capabilities along with injects to facilitate dialogue and questions designed to encourage and expand participant conversations during the event. The Exercise-in-a-Box scenarios will be hosted on a secured web-based portal by the MSC.

The overall goal of this project is to increase the preparedness and resiliency of ports by providing the MIPR-DBE portal to assist port facilities in gaining access to tools designed to support the development of discussion-based exercises. The MSC will accomplish this by successfully completing the following objectives:

- Integrate lessons learned from cyber and active shooter discussion based exercises into non-port specific tools that can be utilized by any of the Nation's ports.
- Develop a secure web-based portal to host all the tools that will provide exercise design teams with the tools to facilitate the development of their own exercises.
- Identify additional scenarios to develop and make available on the MIPR-DBE portal.
- Expand the network of Ports supported by the MSC through direct engagements and becoming part of their exercise design team. Ports that have been strategically identified to provide direct assistance include the Port's of Houston, Anchorage, and South Louisiana. Additional ports may be added.
- Conduct an extensive outreach program to include direct engagement, conferences, workshops and other facilitated meetings to educate USCG Districts and Sectors, ports and first responders on the availability and usefulness of the MIPR-BDE.

To accomplish these objectives, the project will take place over five phases:

Phase 1 will include consolidating all the lessons learned from the first three exercises that MSC participated in and developing new tools that will assist and enable other ports to develop their own exercises. To assist in the identification of tools to enable exercise designers and practitioners with the development of future exercises, MSC will establish an Advisory Committee for this project consisting of practitioners, port officials and exercise designers. MSC will work closely with the Committee to ensure that it is developing products and providing tools that will assist the port community in developing future discussion-based exercises.

Phase 2 will be conducted in parallel with Phase 1 and will involve the development of a secure web-based portal that will house all the content of the MIPR-BDE. Stevens Institute and LSU will work collectively to identify design requirements and programming the development of the portal.

Phase 3 will begin following the completion of Phase 1 and will focus on adding additional scenarios to the MIPR-BDE. The design team will work with practitioners to identify natural and man-made hazards that are most likely to occur within the port system and that meet the requirements of testing two major objectives of the Area Maritime Security Plan (AMSP). Once the scenarios are identified, the MIPR-BDE team will begin working on developing tools to support the development of future discussion-based exercises.

Phase 4 will focus on bringing in new ports to work with the MSC. Ports will be strategically selected based on geography, function and size. MSC will work directly with these ports in developing discussion-based exercises in order to increase the influence of MSC as well as assist the project team in integrating lessons learned and nuances specific to each port into future exercise tools.

Phase 5 of this project will focus on an outreach campaign designed to reach as many ports as possible. Phase 5 will be conducted throughout the life of the project and will begin with developing partnerships with targeted ports. Once new partnerships have been identified, the outreach initiatives will focus on educating ports, practitioners, and exercise developers of the MIPR-DBE portal and the benefits it brings to these port based groups.

D. Project Milestones:

1. Develop an advisory group of practitioners, port operators, and exercise designers to provide input on scenarios and the MIPR-DBE portal requirements. (7/1/16 – 9/30/16)
2. Develop exercise scenario tools for Cyber Security and Active Shooter TTX. (9/30/16 – 12/30/16)
3. Identify a minimum of one new port to collaborate with to develop a new discussion-based exercise. (9/30/16 – 12/30/16)
4. Finalize new scenarios to be developed for the online exercise portal. (12/16)
5. Design and develop the online exercise portal. (12/1/16 – 3/31/17)
6. Integrate Active Shooter and Cyber Security tools into the online exercise portal. (3/31/17 – 6/30/17)

E. Performance Metrics:

1. Advisory committee established to include representatives from a minimum of two port facilities. Advisory members will also include a representative(s) from the USCG, and other state and local port partner organizations.
2. The MIPR-DBE portal is developed to include a minimum of two “Exercise-in-a-Box” tools available.
3. MSC identifies a minimum of two new port partners to assist and support in their development of customized exercises.

F. Outputs and Outcomes

MSC will leverage its existing partnerships in the maritime domain to conduct outreach and build awareness of the Center’s Maritime Incident Preparedness and Response Discussion-based Exercises. The Center will form a tabletop exercise (TTX) advisory committee to provide guidance in the development of an online Exercise-in-a-Box portal and in the creation of new tabletop exercise scenarios. The Portal will make available the Center’s exercise templates and scenarios, and will include support and guidance for port partners to modify and customize exercises for their own unique needs.

G. Transition Plan:

A major component of this initiative will be an outreach plan to educate the Nation’s port enterprise system and demonstrate the tools established within the MIPR-DBE Portal. The project team will work directly with its partnered ports as a base and conduct outreach programs that focus on direct engagements with additional ports. Leveraging the partnerships and contacts with our base ports, the project team will leverage existing relationships through port administrators, the USCG, and port related organizations to expand the reach of this program. The project team will also seek to participate in various national conferences, workshops and panels to reach as many first responders as feasible in order to introduce them to the discussion-based exercise tools that will be available to assist them in conducting their own exercises. The project team will also seek to educate the various USCG Districts in order to reach as many of the USCG Sectors as feasible and ensure that those at the highest command in the USCG are aware of these tools that will be directly available to the different commands. Finally, the project team will also reach out to the USCG Forces Readiness Command, Exercises Support Branch to ensure that efforts are not being duplicated and the tools developed for this project will complement the work already being conducted by the Coast Guard Exercise Support Branch.

H. Stakeholder Engagement:

While the Project Team will consist of experienced personnel that include FEMA Certified Master Exercise Practitioners and Emergency Managers, the team does not have the complete depth and experience in understanding all port needs. The only way this program will be successful is through the continued engagement of the people and

offices that work directly with the ports. Through Year 1 and 2 of this project, the project team has established strong relationships with key personnel at the Ports of NY/NJ and New Orleans. These relationships include a diverse group of public (e.g., USCG, DHS, PANYNJ, NYPD, NOPD) and private (port and terminal operators, cargo carriers and cruise line operators) among other port partners that are vital to making the ports operate efficiently. Through these relationships, the project team will establish an advisory committee that will help guide the project team to ensure it is meeting the needs of the port enterprise system and ultimately develop tools that will allow stakeholders to create and customize their own discussion-based exercises.

I. Potential Risks to Completion:

The development of new and relevant exercises beyond the Center's current cyber security and active shooter scenarios will depend on MSC's ability to form a dynamic and engaged advisory committee. Organizing the appropriate mix of maritime stakeholders, emergency management practitioners and experienced exercise planners will be key to the Center's ability to develop effective scenarios and exercise templates and for building the exercise resource portal.