Arctic Domain Awareness Center (ADAC)
A DHS Science and Technology Office of University Programs,
Center for Maritime Research

ADAC Workplan for Program Year 3:
1 July 2016-30 June 2017
VERSION FINAL

Submitted by ADAC leadership team to DHS S&T OUP,
23 September 2016

Douglas Causey, PhD, Principal Investigator, University of Alaska, Anchorage (UAA)
Larry Hinzman, PhD, Research Director, University of Alaska Fairbanks (UAF)
Randy Kee, Maj Gen (Ret) USAF, Executive Director UAA
Heather Paulsen, MBA, Finance Director UAA
Clarice Conley, MFA, CRA, Education Outreach and Workforce Director, UAA
LuAnn Piccard, MSE, PMP, Project Management Director UAA
Elyce Hackley, Communications and Administration Associate Director, UAA
Arctic Domain Awareness Center Workplan 1 July 2016-30 June 2017

Contents

I. INTRODUCTION................................................................. 5

Arctic Domain Awareness Center (ADAC) Objective and Purpose.............. 5
Overview of ADAC Leadership Team.............................................. 7
ADAC Management Strategy...................................................... 10
ADAC Information Management and Communications Plan....................... 14

II. USCG AND KEY STAKEHOLDER ENGAGEMENT................................................. 15

III. ADAC PROGRAM BASELINE............................................................... 17

ADAC Evaluation Plan and Transition Plan...................................... 17
ADAC Project Evaluation Plan to assess program activity:....................... 19
Transition Plan:................................................................................................. 23
Workforce Development Strategy (coupled with Integrated Education Outreach, further described under Section V “Theme 4”)... 25

IV. PURPOSE: ADAC’s Research Thesis in support of USCG and other DHS maritime missions and the Center’s specific approach.................. 27

ADAC’s Description of the Capabilities Sought and Reasons for seeking Support of USCG and DHS Maritime Missions............................... 27
Support of the Operator: Advancing Domain Awareness in the Arctic, through Sensors, Models, Autonomous platforms, Visualized Information and Data, Appropriately Fused for the Decision Maker................................. 29
ADAC Field/Research Operations Safety and Risk Management Plan........... 34

V. ADAC PROJECT DESCRIPTIONS................................................................. 35

Theme 1 – Maritime Domain Awareness.............................................. 35
PROJECT: Community Based Observer Networks for Situational Awareness (CBONS-SA) ................................................................. 35
PROJECT: High-Resolution Modeling of Arctic Sea Ice and Currents....... 43
PROJECT: Arctic Oil Spill Modeling (Updated Title)............................. 49
PROJECT: Real-time Storm Surge, Coastal Flooding, and Coastal Erosion Forecasting for Arctic Alaska......................................................... 58
PROJECT: Identifying, Tracking and Communicated Sea-Ice Hazards in an Integrated Framework................................................................. 63
PROJECT: Ice Condition Index (ICECON) for the Great Lakes............ 71

Theme 2 – Maritime Technology Research.............................................. 80
PROJECT: Arctic Information Fusion Capability (AIFC)....................... 80
PROJECT: Low Cost Wireless Remote Sensors for Arctic Monitoring and Lifecycle Assessment................................................................. 99
PROJECT: Development of Propeller Driven Long Range Autonomous Underwater Vehicle (LRAUV) for Under-Ice Mapping of Oil Spills and Environmental Hazards................................................................. 106

Theme 3 – Production Transition Strategy.............................................. 116
Theme 4 - Integrated Education Outreach (and Workforce Development).... 116

PROJECT: Arctic Education Implementing the Arctic Strategy in Training 116

PROJECT: Minority Serving Institution (MSI) and Significant Minority Enrollment (SME) ......................................................... 121

Project: Integrated Arctic Maritime Education (Principally oriented via Summer Research Interns) ........................................... 125

PROJECT: DHS Career Development Grant (CDG) program ................ 125

PROJECT: Arctic-related Incidents of National Significance (IoNS) and Arctic Medium and Long Term Environment (MaLTE) Workshops ............ 130

Appendix A. Budgetary Information .............................................. 137

BUDGET AND JUSTIFICATION ...................................................... 137

Year Three Arctic Domain Awareness Center (ADAC) Financial Summary.... 137

Summary for Center: ................................................................. 137

Management of Center Costs: ................................................... 141

Budget and Justification by Theme by Project: ................................. 143

Appendix B. Arctic Information Fusion Capability Team specific tasks.... 185

Appendix C: Acronyms .............................................................. 194
Illustrations/Figures

Figure 1 ADAC Key Engagement Forums.................................................. 16
Figure 2 End to End Process........................................................................ 20
Figure 3 ADAC Proposed Transition Plan..................................................... 25
Figure 4 Inter-relation of ADAC Projects and Orientation to USCG............. 34
Figure 5 Integration of Community Based Observations............................ 36
Figure 6 Observations and Variables Collected.......................................... 37
Figure 7 Arctic Oil Spill Calculator............................................................... 53
Figure 8 Depiction of Oil Plume and Buoyant Density Current on Underside of Ice, Assuming Smooth Ice, and Stagnant Ice and Water...................... 55
Figure 9 Barrow Sea Ice Radar Depiction.................................................... 67
Figure 10 Image of decision tree concept from October 2015 USCG D-9 White Paper on Ice Condition Index.......................................................... 75
Figure 11 Examples of Fusion from AIFC..................................................... 96
Figure 12 AIFC Planned TRLs.................................................................... 97
Figure 13 Two Tethys Long Range AUVs.................................................... 109
Figure 14 Polar Code Requirements as of January 1, 2017......................... 119
Figure 15 Arctic-related IoNS and Arctic-Focused MaLTE Workshops........ 132
Figure 16 AIFC Structural Overview (Axiom Data Sciences)....................... 185
Figure 17 Nova Corporation’s Available Capabilities to Potentially Support Deployable AIFC................................................................. 190
I. INTRODUCTION

Arctic Domain Awareness Center (ADAC) Objective and Purpose

U.S. Department of Homeland Security, Science and Technology’s Office of University Programs (DHS S&T OUP) established the Arctic Domain Awareness Center (ADAC) in summer 2014 to research and provide a scientific basis to address the challenges faced by USCG and other DHS maritime missions in the Arctic region. ADAC was also chartered by DHS S&T OUP to contribute towards the education of both university students and mid-career professionals in maritime security. In accordance with USCG’s 2013 Arctic Strategy and 2015 Arctic Strategy Implementation Plan, ADAC seeks to conduct relevant research and development that benefits USCG operations as USCG supports the peaceful opening of the Arctic, with particular emphasis in mission areas of high consequence: Search and Rescue (SAR) Humanitarian Assistance (HA) and Disaster Response (DR).

The research and development conducted in ADAC will not only serve USCG and other DHS maritime missions, but will also benefit an array of ADAC partners, collaborators and support the public good.

The following briefly outlines the Center’s vision, mission and strategy for the coming program year:

**Vision:** The DHS Center of Excellence providing networked and mission focused support to the USCG Operator in the High North.

**Mission:** Through an inclusive approach, ADAC advances research in science and technology in order to develop and transition capabilities and products that support USCG and other DHS maritime missions in the Arctic region.

**Strategy:** The Center’s strategy for program year starting on 1 July 2016 is to advance knowledge in relevant science and technology through conducting research and development in close collaboration with mission agencies’ end users. The center will also develop future leaders for the DHS enterprise through structured and well-led programs.
Strategy implementation: ADAC plans to conduct the following steps in order to implement the above strategy:

- Finalize a new Center management construct;
- Solicit specific inputs from customers and partners on a scheduled basis;
- Enlarge the number of Center partners and collaborators, which may allow for expanded opportunities of research and development;
- Conduct Arctic Related Incidents of National Significance (Arctic IONS) workshops to support USCG and Canada first responders with “operator driven research.” Arctic-related IONS workshops, will result in solicitation for onward requests for proposals in the quarter that immediately follows the workshop;
- Solicit and provide White Papers that advance science and technology relevant to the Arctic region to address DHS mission knowledge gap;
- Execute projects to advance Maritime domain awareness, develop maritime technology, and Arctic specific education;
- Conduct Education Outreach and Workforce Development; which includes a quarterly review with DHS S&T OUP Education Outreach and Workforce Development program managers;
- Prepare for an anticipated DHS S&T biennial review mid-way through project year.

ADAC will substantially broaden the network of ADAC partners and contributors, in order to transition the Center to better become a hub for research and development in science and technology for the Arctic domain.

The “hub” of ADAC is hosted by the University of Alaska (both Anchorage and Fairbanks campuses) and connected to an array of partnered and contributing universities, industry, federal, state, local and tribal agencies and appropriate international counterparts. The reason for such an approach is simple: a Center of Excellence will more readily achieve “excellence” by connecting efforts in a networked approach to the best and brightest in Arctic related research and development.

ADAC’s plan for the coming program year will be to further establish efforts from the Year 2 management changes to achieve
an “open architecture collaborative construct” for specific projects and overall program development.

As such, the role of ADAC leadership will be to serve as enterprise leaders and managers, in order to facilitate needed exchanges of research. ADAC seeks a progressive approach in research and development in order to elicit effective collaboration and teamwork.

In order to make project work in program year 3 more meaningful and useful, ADAC will invest considerable time and effort to cultivate appropriate partnerships with Federal departments and agencies, fellow DHS S&T OUP Centers of Excellence, Arctic oriented universities and academic institutions, State of Alaska government representatives, industry and counterparts in Canada. These activities will be purposely pursued in order to inform and develop a broader and diversified approach and research oriented organizations in the projects proposed.

Overview of ADAC Leadership Team

ADAC’s leadership team reflects a broad approach to represent a broad University of Alaska-wide “hub” for the center. In accordance with specific direction by the University of Alaska System President, Dr. Jim Johnsen, ADAC has Center leadership serving at the University’s campuses in Anchorage and Fairbanks. This distribution is intended to leverage key programs at both locations to the benefit of the Center and to access a wider swath of students and research within the State of Alaska. Further, through a planned “ADAC Research Network” (ARN) management approach, Center leadership will leverage existing communications technology to collaborate across the array of teams that are contributing to ADAC research and development.

In accordance with the DHS award, the University of Alaska Anchorage hosts the Principal Investigator and Executive Director. However, the ADAC Research Director is located at the University of Alaska Fairbanks campus, while also serving as the Vice Chancellor for Research at the University of Alaska Fairbanks.

In sum, the ADAC team comprises a diverse blend of academic Arctic science and technology research, Arctic-related strategy
and policy expertise, with deep organizational and fiscal leadership credentials.

In the coming program year, a dedicated effort is planned to substantially advance in student related programs, particularly in Education Outreach and Workforce Development. Accordingly, a new position provided principally through University institutional support is planned to be added to the ADAC leadership team.

The details of the ADAC leadership team are provided below:

**Principal Investigator (PI), Douglas Causey, PhD, University of Alaska.** The ADAC PI is responsible to guide the Executive Director and the Research Director to achieve ADAC mission goals. ADAC PI will seek to connect ADAC with partners and opportunities. The ADAC PI is responsible to report to the University of Alaska System Leadership and DHS program sponsors on a regular basis. Ultimately, the ADAC PI is responsible for program execution and accomplishment to DHS.

**Executive Director (ED), Randy Kee, Maj Gen, USAF (Ret), University of Alaska.** The ADAC ED provides day-to-day direction of all Center activities and ensure COE goals are met, milestones achieved, technology development is proceeding, and the end users are appropriately satisfied with the results. The ED will organize site visits for demonstrations, interface with the end users, and will work with ADAC leadership to ensure the Center is in compliance with federal regulations and reporting. In concert with the ADAC PI, the ED will regularly meet with DHS staff at DHS headquarters and represent the program at meetings required to support the needs of DHS management and the greater DHS enterprise. The ADAC ED will work closely with U.S. Coast Guard (USCG) stakeholders, to include USCG District 17 and the USCG Research and Development Center (RDC) to ensure that the USCG expectations of the center are being met. Finally, the ED will ensure ADAC internal processes, in particular assessment meetings, engagement forums and DHS sponsored workshops, are appropriately conducted.

**Research Director (RD), Larry Hinzman, PhD, University of Alaska, Fairbanks.** The ADAC RD provides leadership for the
center in establishing research concepts and follow-on proposals. The RD also provides leadership to support research theme leads, and individual project leaders and researchers. ADAC’s RD is responsible to address and guide scientific quality for the individual projects and the overall program. The ADAC RD where appropriate, will interact with DHS and stakeholders and will interface with other DHS COEs and research centers to identify and formulate additional research projects. The ADAC RD will be a key leader for the Center to identify when research projects are ready to transition to the next TRL and suitable for transition from research to development.

**Finance Director, (FD), Heather Paulsen, MBA, University of Alaska, Anchorage.** The ADAC FD is responsible for management and oversight of administrative operations of the Center of Excellence (COE) and group of associated subcontracts. The ADAC FD will provide program/project planning, budgeting, and implement operational policies and processes to support the COE. Further, the FD will work in close collaboration with the ED and the Project Management Director to develop budgets aligned to program and project planning objectives and to manage expenditures as aligned with the research mission of the Center.

**Education Outreach and Workforce Development Director (EO&WFDD), Clarice Conley, MFA, CRA, University of Alaska, Anchorage.** The new EO&WF Director will work in partnership with the ADAC ED in creating an “ADAC Fellows program” from DHS Career Development Grant Scholarships, and student research interns, (including students from under-represented classifications) connected with the ADAC Research Network. This reconstituted position proposes to advance education outreach and workforce development by further developing the ADAC Fellows Program and managing outreach to ADAC connected Minority Serving Institutions (MSI), or which have Federal Tribal Designation (FTD) or have Significant Minority Enrollment (SME). Accordingly, the EO&WFDD will manage under-represented student recruitment at MSI, FTD and SME to connect with ADAC programs. The EO&WFDD will lead developmental mentoring and professional networking among all ADAC Fellows, including CDG Scholarship students and student research interns. Lastly, the EO&WFDD serves to collaborate with
the ADAC’s Associate Director to develop the communications and information plans and actions for the center.

**Project Management Director (PMD), LuAnn Piccard, MSE, PMP, University of Alaska, Anchorage.** In partnership with ADAC ED, Finance Director and Project PIs, PMD will lead effort to integrate project plans into a cohesive program with phased solution and technology deliverables aligned with ADAC strategic mission and outlined in ADAC research-to-development process. This includes managing document progress of projects relative to established ADAC program execution. The Center PMD efforts include coordinating and documenting regular team meetings and facilitate project communication within the Center team and with partners and external stakeholders.

**Communications and Educational Support Associate Director (C&ES AD), Elyce Hackley, University of Alaska Anchorage.** In collaboration with the ADAC EO&WFDD, ADAC’s C&ES AD supports both educational outreach and workforce development, and the communications, information plans and associated actions for the Center. This will include ensuring that ADAC on-line materials remain current and focused on providing relevant communications of center activities and preparing Fact Sheets. These include highlighting research success stories of ADAC Fellows, as well as supporting quarterly newsletters to the ADAC community of interest.

**ADAC Management Strategy**

The USCG Arctic operator is the key end user driving research for ADAC. For the project year on 1 July 2016, ADAC will conduct fundamental and applied research in Maritime Domain Awareness and Maritime Technology. Specifically:

- Advance the Arctic Domain Awareness research areas by increasing the science of knowledge and understanding, in order to improve USCG Arctic operator coordination, control and decision making;
- Conduct research in Maritime Technology that will provide needed capability to support and effect increased Domain Awareness;
• Conduct forums and solicit science and technology communities to generate ideas and then turn those ideas into research proposals and projects.

As a complement to the Center’s research, ADAC will accomplish Integrated Education Outreach and Workforce Development. Following the guidelines of the DHS S&T OUP program, ADAC’s investment in students is a critical mission and a remarkable opportunity to generate new professionals to the DHS enterprise.

Accordingly, the Center’s management strategy seeks a “first principle” approach to align efforts to meet needs of the USCG operators. We envision much of the ADAC’s work to complement USCG Research and Development Center (RDC), aligned with USCG Districts 1 and 9, closely aligned with USCG District 17’s operational needs, while addressing USCG Capabilities (HQ USCG CG-7).

ADAC’s research will leverage technology and collaborative communications to create synergies in research and development in the following ways:

• Researching and appropriately advancing the established projects of the center will invest approximately 45% of the Centers management focus;
• Identifying and investigating gaps in Arctic operator mission capabilities through the development of White Papers and research proposals is a needed complement to existing efforts. We plan to invest 5% of ADAC Center leadership focus in this area;
• Planning the next Arctic-related Incidents of National Significance (IoNS) workshop to gain Canada-US operator-driven research conducted in advance on an approximate annual basis. This effort will require 3% focus of Center leadership;
• Planning and Conducting an Arctic-focused Medium and Long Term Environment (MaLTE) workshop. This workshop will seek to understand the medium-and long term research needs specific to the Arctic environment in support of USCG. This workshop will be conducted on an approximate annual basis and will require 12% focus of ADAC leadership;
• Undertaking education outreach and workforce development is anticipated to require 15% of center leadership focus;
• Advancing partner networks, center management, socializing with other maritime related research centers and soliciting white papers will require the remainder (15%) of leadership focus.

ADAC leadership plans to advance “End-to-End” (E2E) processes for research transition to actual capability, via a partnered approach with DHS and US Coast Guard acquisition professionals. This transition effort will seek industry support as appropriate. Accordingly, research to transition is structured in two parts:

• Each quarter, ADAC leadership will conduct a comprehensive program review and detailed projects progress reviews. Among tasks of the ADAC quarterly review, will be to identify programs that are ready to transition;
• As projects are ready and so designated for transition, ADAC will initiate a task organized approach to accomplish transition, investing USCG, DHS acquisition professionals and industry as appropriate. These aspects will be described later in the Year 3 plan.

As ADAC commences project work for the program year 3, the University of Alaska is pleased to announce the proposed establishment of the “ADAC Research Network” (ARN) comprised of an array of partners and collaborators to advance center research and development.

Through a comprehensive management approach, ADAC leadership will gain needed details of the work being accomplished across the ARN. This includes: ADAC’s Arctic Information Fusion Capability (AIFC) Management Plan teleconferences, weekly ADAC “all hands” teleconferences, Approximately bi-monthly customers and partner’s roundtable, quarterly ADAC Review Group, annual ADAC Meeting focused on USCG Project Champions and annual Executive Counselor’s Board (in conjunction with a Quarterly Review). This management approach will help to ensure needed collaboration on projects and execution progress, and will enable appropriate engagement with the collective enterprise to address on-going and emerging needs of DHS and USCG (and/as appropriate, other key stakeholders).

ADAC will concentrate management of a diverse and dispersed enterprise via structured on-line meetings and chat room protocols to gain synergy across the researchers supporting work
for the center. Our leadership efforts to simplify and structure management processes will include forming calendar driven forums which “feed” from operator-researcher exchanges, comprehensive quarterly assessments, and annual advisory forums and boards that gain insight from established and credentialed experts.

The following teams comprise the ARN:

**Academic Institutions:**
- Maine Maritime Academy (MMA);
- Texas A&M University (TAMU);
- USCG Academy Center of Arctic Study and Policy (CASP);
- University of Alaska Anchorage (UAA);
- University of Alaska Fairbanks (UAF);
- University of Idaho (UoI);
- University of New Mexico (UNM);
- University of Texas, El Paso (UTEP);
- University of Washington (UW);
- Woods Hole Institution (WHOI).

**Industry Partners** planned to contribute to Year 3 project work via the ARN include:
- ASRC Federal Mission Solutions (ASRC FMS);
- Alaska Ocean and Observation System (AOOS)/Axiom Data Sciences;
- Dubay Business Solutions;
- Marine Exchange of Alaska (MXAK);
- Nova Dine and Kestrel Corporations.

ADAC is planning to add the following participants as **Collaborative Organizations** the center will seek advice from over the course of Year 3 project work:
- DHS Centers of Excellence (COE) at Rutgers University, University of Houston and Stevens University;
- North American Aerospace Command/U.S. Northern Command;
- National Aeronautics and Space Administration (NASA)-Office of Secretary of Defense Arctic Collaborative Environment;
- Office of Naval Research;
- Chief Oceanographer’s office of the Navy;
• Canada’s Department of National Defense Research and Development;
• US Coast Guard Academy and its associated Center of Arctic Study and Policy (CASP);
• National Oceanic and Atmospheric Administration and National Weather Service (NOAA/NWS);
• National Science Foundation (NSF).

ADAC Information Management and Communications Plan

For the program year commencing on 1 July 2016, ADAC will re-establish a DHS S&T OUP compliant website highlighting center projects, education outreach and workforce development and important projects (such as Incidents of National Significance and Medium and Long Term Environment workshops) and ADAC in the news. This website will include special highlights focusing on student-related success stories, project submissions to peer review journals, and quarterly newsletters. The ADAC information and communications plan also includes DHS S&T OUP required postings (such as project abstract information) to www.hsuniversityprograms.org. The information management and communications plan will also include creating Fact Sheets highlighting details and progress of ADAC projects.

Certifying data management protocols. ADAC acknowledges the center and associated activities sponsored by ADAC will comply with the University of Alaska Data Information Protection Plan (DIPP) certification for Federal Institutions as approved by DHS CMR requirements and will review annually. This Information Protection Plan includes protocols to safeguard “sensitive or classified information” including any information that has been determined by the United States Government pursuant to an Executive order, statute, or regulation to require protection against unauthorized disclosure for reasons of national security, and any restricted data as defined in paragraph r. of section 11 of the Atomic Energy Act of 1954 (42 U.S.C. 2014 Y9)”, and any Personally Identifiable Information (PII), as defined by HIPPA/HITAC and PCI. In addition, projects may require protection of other data sets for a variety of reasons.
specific to the project. Further details are included in the ADAC DIPP, filed at the University of Alaska Anchorage.

II. USCG AND KEY STAKEHOLDER ENGAGEMENT

As described throughout the upcoming year’s planned activities, ADAC Center leadership and project teams have significant and many faceted engagements with USCG. The collaboration with USCG at Headquarters, Research and Development Center and USCG District 17 established in Year 2 sets a trajectory of operator-academic integration will be continued in the coming program year.

This approach takes advantage of three new forums planned for the coming year: A periodic “Customers and Partners Roundtable” (conducted on an approximate bi-monthly basis). An annual ADAC meeting focused on USCG Project Champions, and an “Executive Counselor’s Board” to be held a minimum of once per year in association with a quarterly ADAC Review Board will be conducted. A separate ADAC information forum will be also conducted as an outreach event to a broad array of ADAC collaborators, with the event planned to be hosted in Alaska. Details:

**Customer’s and Partner’s Roundtable:** presents projects, with “in progress” reviews by project Principal Investigators (PIs) and provides an open forum to review areas of interest in achieving Arctic Domain Awareness from operators, researchers and industry. The Customers and Partners Roundtable is planned to be conducted via webinar protocols and, in keeping with a roundtable/Town Hall format, will be an open invitation for participation with schedules published by the reconstituted ADAC Web Portal and linked to other web pages/media as appropriate. ADAC will leverage this forum to generate ideas for Research White Papers.

**Annual ADAC meeting.** In accordance with prior DHS approved ADAC work plans, the Annual ADAC meeting is a forum where
ADAC project leads across the ARN, present their current projects and planned future activities to an array of invited guests. The Partners meeting consists of presentations by Project Leads, and presentations as appropriate by invited partners to the meeting.

**ADAC Executive Counselors Board.** This board is intended to be a focused executive panel to critically examine the projects and overall program execution, separate and distinct to the wide ADAC Advisor’s Forum. The ADAC Executive Counselors Board will meet at a minimum once per year during one of the ADAC Quarterly Review Group sessions, and provide critical assessments of the center’s research projects, program planning and execution.

The ADAC Executive Counselors Board is designed to elicit inputs from highly qualified senior leaders and/or research professionals. Names of ADAC’s Executive Counselor’s Board will be provided via a separate document.

---

**ADAC Key Engagement Forums**

<table>
<thead>
<tr>
<th>ADAC Creditors Board</th>
<th>Customers &amp; Partners Roundtable</th>
<th>Bi-monthly</th>
<th>Operator Input and Technical Exchange</th>
<th>Videoconference &amp; webinar</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADAC Annual Meeting</td>
<td></td>
<td>Annual</td>
<td>Comprehensively review Project work to ADAC Project Champions</td>
<td>In-person meeting, while also supporting remote participation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annual</td>
<td>Small, executive panel to critically examine ADAC Projects and overall Program</td>
<td>In conjunction with a ADAC Quarterly Review Group</td>
</tr>
</tbody>
</table>

*Figure 1 ADAC Key Engagement Forums*

**ADAC Information Forum.** As a complement to the ADAC Annual Meeting, the University of Alaska will plan to host a broad level engagement forum of a multi-disciplined panel of academic, government and industry to inform about ADAC program activities.
In addition to project program collaboration, and the above described engagement forums, ADAC plans the following systemic engagement with USCG for the coming program year:

- Initiate planning for an Arctic IoNS Workshop. Plan and conduct in coordination with DHS S&T OUP, Arctic MaLTE workshop involving USCG HQ, USCG RDC, and USCG District 17;
- Collaboration with USCG Academy’s Center for Arctic Study and Policy center for their Congested Waterways Workshop;
- Participate as appropriate (on a non-interference basis) to USCG Arctic Shield Exercise Series (which includes USCG Exercise Arctic Chinook);
- Participate via appropriate coordination with USCGS Healy Research projects as allowable with USCG.

III. ADAC PROGRAM BASELINE

ADAC Evaluation Plan and Transition Plan

ADAC leadership seeks a straightforward approach in organizing the evaluation of Center projects and transitioning research to capability, while also seeking to connect with proven practices that align with DHS capability development professionals, in particular, U.S. Coast Guard Research and Development Center in New London, Connecticut and Headquarters USCG in Washington.

ADAC proposes an evaluation plan that includes forming calendar driven forums which “feed” from operator-researcher exchanges. As such, Center management will conduct overall program assessment and conduct careful project examination a quarterly basis. Through the engagement plan just described, ADAC will solicit input from a wide array of established & credentialed experts.

Central to ADAC’s Evaluation Plan is establishing a comprehensive review of the center’s work on a quarterly basis. Consequently, the Center will schedule the convening of the ADAC Review Group, as the Center’s principal project review forum,
investing Center leadership and periodic assessments from experts to assess and manage research projects, in accordance with End-to-End processes and established evaluation criteria. The ADAC Review Group is also charged with reviewing, planning and directing new initiative proposals, principally from Arctic-related Incidents of National Significance Arctic-focused Medium and Long Term Environment workshops and ADAC Research Network provided White Papers.

The ADAC Review Group will be Co-Chaired by the ADAC Principal Investigator, Research Director and Executive Director. The remaining ADAC Center leadership, e.g. Finance Director, Education and Workforce Development Director, Project Management Director and Associate Director for Communications and Education Support, will complete the ADAC Review Group. As determined by Co-Chairs, additional Subject Matter Experts may be invited to assist ADAC Review Group in conducting overall E2E and project examination. Once each year, the ADAC Executive Counselors Board will be invited to join the ADAC Review Group to provide critical assessments of project utility and performance.

ADAC proposes for the coming project year to structure projects underway and in establishing new proposals in accordance with normative DHS “End-to-End” Process approaches.

ADAC’s definition of the End to End Process (E2E) is as follows:

1. **Research Topic selection.** As an operationally driven research center, ADAC seeks topics that are requested by USCG and other DHS maritime missions as priority. Every quarter, ADAC Review Group seeks to leverage Arctic Incident of National Significance (Arctic IONS) workshops or a White Paper solicitation as the principal generator of Research Topics.

2. **Topics-to-Proposal review** (accomplished via quarterly ADAC Review Group). On a quarterly basis, this group will assess the merit of proposals based on relevant science, gap or shortfall in technology and the Research proposal’s ability to successfully address the gap/shortfall. The ADAC Review Group, principally through ADAC PI and RD, will
solicit abstracts of relevant science from the target research community, with the planned purpose of gaining a minimum of three outside agency assessments review of a draft proposal.

3. **Draft Project Plan.** Moving a proposal to a draft plan involves the following: Describing relevant science, schedule & milestones, metrics, desired outcome and intended customer. Key to the project plan is utility to intended customer...if the project does not have an operational champion/advocate, ADAC will not intend to pursue the research.

4. **Assess proposal** legal viability and patent possibilities.

5. **Market assessment.** Important to determine if the project not only has an operational champion (principally USCG or other DHS maritime user advocate), but to understand if there is a potential commercial market for the research.

6. **Project execution.** Through the ADAC Review Group, ADAC leadership assesses plan vs actual performance if project is accomplishing intended research. As described in the project evaluation section, ADAC will apply specific criteria to assess project performance. Failure to meet criteria will result in programmatic decision to restructure or process for project termination.

7. **Transition.** Once a project successfully accomplishes planned objectives, demonstrates readiness to transition to development and/or acquisition, ADAC will initiate a Transition task team to conclude research, accomplish documentation and hand over to developmental agency. This is principally oriented to USCG Research and Development Center and USCG Acquisition directorate.

In sum, ADAC is a research and development enterprise that principally leverages academic universities and institutions. Accordingly, Center leadership believes it will be more useful to establish E2E approaches through ADAC Review Group. Center leadership will conduct E2E with project teams to evaluate and assess project work and program advancement.

**ADAC Project Evaluation Plan to assess program activity:**
ADAC proposes the following plan to evaluate center projects, while also gaining insights to stakeholder concerns and requests for potential ADAC research. As stated, the ADAC Review Group is the intended forum to assess and manage the Center’s projects, and will use the evaluation plan to examine project performance and direct changes in accordance with the terms described in the following paragraphs. This group will be the quarterly venue where ADAC meets the intent of “E2E processes” for the Center. The review group is also charged with initiating appropriate research to capability transitioning process.

**ADAC’s Evaluation Plan Criteria.** ADAC plans to conduct evaluation and assessment on a quarterly basis leveraging the DHS End to End process approach as envisioned by DHS S&T Directorate. Once each year, the ADAC Executive Counselor’s Board will be asked to contribute their assessments of projects as well as overall program management.
Accordingly, ADAC Project Evaluation seeks to accomplish the following specific points of assessment:

1. Examine carefully the science and technology advances made by individual project measured against utility of the research for ADAC’s goals and objectives. ADAC seeks to determine if project research has discovered and/or determined science and technology advances that will be useful to merit resourcing onward research. Center leadership seeks to learn from such examination of the research, in order to understand and/or prove the project is of appropriate utility to advance ADAC’s goals of supporting the Arctic operator.

2. Assess project resourcing versus project execution. This approach seeks to determine if project plan and resources are appropriately aligned. If project importance/priority and performance measures warrant additional resourcing during “in-year execution”, ADAC leadership will highlight the need and seek to address or mitigate via appropriately coordinated cross level of funding from projects that are under-executing (according to project planned schedule and milestones) in resource expenditure. Important to emphasize, any movement of resources between projects are accomplished and compliant with terms and conditions of DHS S&T - ADAC cooperative agreement protocols.

3. Assess each project’s ability to communicate current findings and projected research trajectory. Essentially, this is to understand: does the project have information/insights that need to be shared with the greater community of interest? Accordingly, ADAC leadership seeks to determine through examination, if project discoveries and/or development warrant, pursuit of publishing to appropriate media, in particular, scientific journals.

4. Assess project Technology Readiness Levels (TRLs). In sum, examination of the actual vs planned TRLs at given milestones for a project indicate the research is progressing as planned. Additionally, assessment will seek to determine if research indicates planned TRLs are
on a trajectory to produce a useful capability for the Arctic operator.

5. Determine actual program execution versus planned, in terms of schedules and milestones and metrics. In essence, ADAC seeks to learn if and how the project is measuring according to ADAC’s submitted plan to DHS for the project year.

6. Require, if the project is substantially off schedule, the Project Lead to present a “Get-Well-Plan” to re-establish conformance to the prior approved Project schedule, milestones and metrics.

7. Determine if the Project PI is able to present an acceptable approach to Center leadership. If necessary, the ADAC Review Group Co-Chairs will restructure of Project leadership, team, and/or project plan as needed, properly informing DHS S&T OUP PM in accordance with DHS S&T OUP - ADAC Grant Terms and Conditions. If a project is unable to proceed acceptably, ADAC Review Group Co-Chairs will consult with DHS S&T OUP PM to submit proposals to close the project. Following such a decision, Center leadership will conduct appropriate documentation and return unexecuted funding to DHS/USG or reprogram to other projects as permitted that can appropriately utilize the resourcing.

8. Examine effectiveness of overall Education Outreach and Workforce Development and effectiveness of student support to project research. As an integral component of ADAC Review Group assessments, ADAC Education Outreach and Workforce Development Director will present assessments of Center performance in successfully conducting recruitment of under-represented students and performance of ADAC Fellow performance objectives and planned projects for the program year (DHS Career Development Scholars, and Student Research Interns).

9. Evaluate Education Outreach and Workforce Development will be conducted by assessing schedules and milestones and planned metrics for the overall program (as described later in this plan).

10. Education Outreach and Workforce Development Director will provide recommendations to address any deficient areas of performance, ADAC Review Group Co-Chairs will
examine performance and provided recommendations to determine suitable corrective actions.

Transition Plan:

Research-to-Capability Process is a key outcome of E2E. As ADAC is a research and development enterprise that principally leverages academic universities and institutions, Center leadership plans to provide a practical and sustainable approach to transitioning research to actual capability to benefit USCG and other DHS maritime missions.

ADAC believes that transitioning research to capability is a core function for Center leadership (and responsibility should not be delegated to a project PI). ADAC has reviewed practices from U.S. government to include consultations with U.S. Coast Guard Research and Development Center (USCG RDC). Consequently, the Center will execute a structured, task organized process to transition research to onward capabilities to the USCG and other DHS maritime missions. Additionally, ADAC’s approach is to orient transition planning in a coordinated and partnered approach with DHS S&T and U.S. Coast Guard research, development and acquisition professionals, and appropriate collaboration with industry partners.

As part of the ADAC Review Group protocols, Center leadership seeks to comprehensively review project technology levels. Once these forums have validated that a particular project has reached an appropriately mature technology readiness level (TRL), ADAC Center leadership will initiate a “Research-to-Capability Process” action where ADAC partners with DHS S&T OUP, USCG Research and Development Center, Headquarters US Coast Guard Acquisition (and industry partners as appropriate), to move research from academic led entities to U.S. DHS government development protocols.

When decisions are reached to proceed with the research to capability process, the ADAC Executive Director and Project Management Director will execute a task team effort to organize appropriate support, (which will include University of Alaska
Business Enterprise Institute) to effect the transition of mature research from ADAC to DHS owned transfer protocols. This task team approach includes careful handling of transfer for appropriate documentation and patent initiation. The following describes the process in greater detail:

1. Assessment by the ADAC Review Group that a given project has completed planned course of research and demonstrated planned technology levels, warranting transition from research to capability/acquisition. Assessment will include consultation with planned recipient of the completed research and other research professionals as needed to conclude Center assessment and confirm transition decision.

2. ADAC PI, RD and ED determine Center Task organization, needed to migrate research to receiving development and acquisition professionals. ADAC ED will lead with PMD serving as deputy lead for the Task Organized Team. This team will normally include project PI, center support personnel and supporting institutions if the project is co-led by PIs at a separate university/institution. Task organized team will ready transfer of research materials, associated physical hardware, software, and intellectual property. Transfer preparation will include review of financial accountability, DHS S&T OUP-ADAC Grant Terms and Conditions, onward disclosure notifications to DHS S&T OUP Program Manager and appropriate public announcements.

3. Project PI(s) completes documentation, fully describing research, completed milestones, objectives, and project research conclusions while also initiating science review, and preparing journal submissions. Project PI(s) team in coordination with ADAC leadership will initiate patent application with University of Alaska as appropriate.

4. Following internal center preparations, ADAC ED and PMP then lead the task organized team to contact and interact with receiving agency/organization to conclude transfer.
**Workforce Development Strategy** (coupled with Integrated Education Outreach, further described under Section V “Theme 4”)

**Mentoring and career development.**
The ADAC Fellows Program is comprised of DHS CDG Scholarships and ADAC Research Interns. As ADAC initiates project work starting on 1 July 2016, Center leadership plan to comprehensively advance a new approach in supporting students in mentoring and career development.

Seeking to establish a structured and scheduled approach and leveraging communications technologies so students can plan their calendars with sufficient advance notice, ADAC will unify mentoring and professional development across the ARN for Career Development Grant (CDG) Scholars and Student Research Interns via a combined approach as the ADAC Fellows Program.

As part of ADAC initiatives to broaden outreach opportunities, the ADAC Fellows Program will be paramount to fostering
workforce development. Accordingly, ADAC proposes to commence a substantially more robust ADAC Fellows program that provides bi-monthly mentoring via webinar technologies, with invited speakers to provide leadership, career development perspectives oriented to science and technology careers and/or careers across the DHS enterprise.

The ADAC Fellows Program will be expanded to provide opportunities for undergraduate and graduate students to travel to either the University of Alaska System or our Industry partners for a ten-week long summer intensive science and engineering internship. These internships will focus on providing students workforce development opportunities in operational capacities that will directly benefit the Department of Homeland Security and its components.

In order to have fully synchronized understandings between ADAC and DHS S&T OUP Education Outreach and Workforce Development Program managers, a dedicated quarterly review will be conducted.

**ADAC Fellows Program Professional networking.** Through taking advantage of communications technologies and a hub of Arctic domain interests between Anchorage and Fairbanks, Alaska, ADAC plans to leverage a collaboration and exchange with the University of Alaska Fairbanks Emergency Management Professional Course, NOAA, and State of Alaska Emergency Managers. This collaboration will assist ADAC Fellows in support of professional/future career networking. This program will be part of the ADAC outreach initiatives.

**ADAC Affiliated Faculty/Researchers (in particular, NOAA/NWS).** Currently ADAC has two NOAA/NWS with appropriate PhD credentials to serve as ADAC Affiliated Faculty. ADAC plans to utilize these two PhD NOAA professionals in both education outreach and center efforts on modeling development.

**Compliance with DHS S&T OUP Workforce development criteria.** ADAC leadership (principally through the Center’s Education Outreach and Workforce Development Director) will ensure ADAC
complies with the Homeland Security Act of 2002 to provide U.S. citizens training in homeland security-related science and engineering disciplines to maintain U.S. leadership in science and technology.

IV. PURPOSE: ADAC’s Research Thesis in support of USCG and other DHS maritime missions and the Center’s specific approach.

ADAC’s Description of the Capabilities Sought and Reasons for seeking Support of USCG and DHS Maritime Missions.

“Begin with Why!” The United States is an Arctic nation with associated strategic national interests across the region. As one of eight nations with sovereign territory above the Arctic Circle and one of six nations with national shoreline opening on the Arctic ocean, the United States faces an array of challenges and opportunities in the Arctic and through the National Arctic Strategy released in May 2013, has articulated a comprehensive approach to advancing the peaceful opening of the Arctic. As a principal U.S. operational community in the Arctic, the U.S. Coast Guard (USCG) released a complementary strategy outlining its plans and supporting priorities for the Arctic and has since released a corresponding implementation plan. Important to note is the fact the USCG Strategy and implementation plan, greatly inform ADAC’s focus and approach as a DHS S&T OUP Center for Maritime Research (CMR).

The Arctic is facing an unprecedented amount of change in terms of environment, weather and human activity. As reported through many media sources, in recent years, the Arctic has broken records in amount of melting ice and snow and has seen the icepack covering the Arctic Ocean at the close of the summer season retreat to lowest levels ever recorded.

The Arctic is increasingly dynamic. Understood Arctic warming is creating conditions for increased human activity, in particular, adventure tourism and resource extraction. While recent depression in global crude oil prices as dampened Arctic oil extraction exploration in the Chukchi and Beaufort seas, there is wide-spread belief interests in oil and gas exploration will return, coinciding with higher crude oil prices.
As the Arctic warms, ground that has been frozen for centuries is thawing. This newly thawed terrain is proving to be vulnerable to erosion, which is of particular impact in coastal Arctic Alaska and the people who live across this fragile region. An increasingly dynamic Arctic is impacting populations whose ancestors have inhabited the region generations. Many of these people strive to retain culture and traditional ways of life. However, these ancient traditions are increasingly complicated by a warming Arctic and increased activity arriving from lower latitudes.

Arctic warming is reducing the amount of shore-fast ice that has historically served as a protective barrier from the sea for native villages along the coastal Arctic. Warming in the Arctic has also been attributed to increased weather severity and coastal storm surges. The sum of changing environmental factors of reduced ice and thawing permafrost, coupled with increased storm frequency and severity united with increased human activity...equates to increased demands of urgent and emergency response to USCG and other DHS maritime missions, particularly for Search and Rescue (SAR), Humanitarian Assistance (HA) and Disaster Response (DR).

USCG’s missions across the North American Arctic region are complex, operationally risky and logistically straining. With the bulk of permanently assigned forces stationed in South Central Alaska, USCG faces a “time and distance” problem in anticipating and responding to SAR, HA, and DR crisis in the Alaskan Arctic and to support any joint missions with Canadian first responders. Accordingly, USCG’s ability to gain advanced domain awareness in the Arctic region and to leverage such awareness to increase decision agility, is needed to reduce mission risk and risk of mission failure.

Quite literally, achieving awareness of the Arctic domain for the USCG and other DHS maritime missions is challenged due to lack of Arctic maritime domain knowledge. In particular, imagery, information, environmental data, communications and inputs from an array of sensors monitoring the environment, currently is insufficient to gain needed understanding and orient appropriate responses.
Accordingly, the USCG ability to prepare and respond to SAR, HA and DR missions in the Arctic are complicated by such factors as:

- Lack of permanent and resilient infrastructure;
- Remoteness and austerity (hundreds of miles between small settlements);
- A difficult environment for the ill-prepared and equipped (while warmer, the Arctic maritime cold weather environment is still very dangerous and deadly);
- Anomalies in sea-ice formation and movement, which are yet to be understood with precision;
- Lacking and lagging resources to improve domain awareness and communications.

The above factors provide both a challenge and an opportunity. Through appropriate work in science and technology, these factors can be addressed to good and practical result...through skillful and well-networked research and development.

**Support of the Operator: Advancing Domain Awareness in the Arctic, through Sensors, Models, Autonomous platforms, Visualized Information and Data, Appropriately Fused for the Decision Maker.**

As a DHS Center of Excellence focused in advancing domain awareness for the Arctic, ADAC is presently accomplishing research and development for environmental sensors and sensor arrays, (both in mechanical and human form) autonomous platforms, and environmental models.

ADAC is developing the applied research approach to connect the data from these research projects and also connect with the array of non-ADAC generated Arctic-related data, visualization and networks to accomplish a Fusion of Arctic related Information Capability to support USCG agile decision support. Accordingly, ADAC’s Arctic Information Fusion Capability (AIFC) which was generated by specific request from USCG District 17, and is specified in USCG’s Arctic Strategy Implementation Plan. AIFC is planned to receive data from other center research endeavors and seeks to access authoritative data from multiple Arctic related sources and intelligently fuse the data to create appropriate decision support information.
ADAC’s planned research in Year 3 is intended to advance research in sensors that can operate as an array in harsh weather with no electrical power to collect environmental data, providing USCG and DHS maritime missions a better understanding in an Arctic-related disaster response. Our planned work will provide complementary real-time multi-source sensor correlation via a new industry partner that can provide greater utility to program than prior research efforts.

ADAC’s proposed research in rugged smart cameras for very low wattage power provides applied research to advance potential capability for USCG and DHS maritime missions to have persistent surveillance in SAR, HA and DR scenarios.

Planned work in developing powered long-range autonomous underwater vehicles provides the ability to get “sensors on scene” farther under the icepack more quickly than autonomous vehicles have yet to achieve. This research opens up a potentially very useful USCG and DHS maritime future capability.

Greater efforts to align the work of community based observer networks for situational awareness (CBONS-SA) is gaining increased opportunity through developing partnerships with the Alaska National Guard as they seek greater work in Arctic Alaska, inspired by plans to develop a modern version of the Alaska Territorial Guard.

ADAC’s efforts to provide an array of models to advance key understandings of environmental factors allow domain awareness in the Arctic to advance to more useful levels of understanding for operational utility. Efforts to gain precision forecasts in coastal storm surge, coastal inundation and better understanding in coastal erosion will advance USCG and DHS maritime mission preparedness and response. Similar advances in Arctic oil plume and sea-ice isotope analysis can serve to help respond to oil related disaster responses for USCG. Similarly, our advanced research in precision sea ice movement will benefit USCG preparedness and response.

Sensors, models, unmanned platforms and the array of environmental data serve to add to domain awareness across the Arctic. In order to make the data useful to USCG decision
makers, however, there is a need to provide data and information with appropriate and intelligent fusing. Such an approach will enable USCG decision makers to have information more effectively drive and support operations and operational decision support.

As an unclassified/open source capability, Arctic Information Fusion Capability (AIFC) is intended to connect with a myriad of data feeds to a.) support professionals in the U.S. Department of Homeland Security and b.) contribute to Arctic domain awareness needs at the state, tribal, local and industry sectors to enhance overall resilience.

A vital aspect of AIFC in support of the public good and to support vulnerable populations in coastal Arctic Alaska, is the ability to support/enable Community-Based Observers (CBO). Through developing cross-national partnerships, AIFC could serve to support domain awareness internationally in the North American Arctic and potentially Pan-Arctic.

In the initial iteration of AIFC, three aspects are sought in advancing domain awareness:

- Gain two dimensional geographic orientation of precision mapping data, near-real-time and high resolution satellite imagery incorporated with available modeling, sensors, web-based communications and appropriate social networking feeds to gain domain awareness in support of operational decision making and interface with humans and responders in the field.
  - For clarity, near-real-time products are delivered as rapidly as possible following capture and processing of the observation. Near-real-time is a qualitative descriptor, but generally refers to products delivered between a few seconds up to 30 minutes following capture.
- Identify elements of domain awareness from a 3 dimensional “column view” to gain insights vertically from seabed to surface and surface skyward.
- Achieve a near-real-time and forecast decision support that can transition to intelligent decision support in a follow-on phase (beyond Year 3 planned objectives).
Rather than replicate existing systems, the ADAC AIFC in its early phase planned for work starting on 1 July 2016, will expand Alaskan and Arctic Spatial Data Infrastructure (SDI), and leverage capabilities of non-ADAC generated research sources. These include an Open Geospatial Consortium Web Service (OGCW), near real-time satellite data and high resolution satellite imagery through selected data feeds, and dedicated machine-to-machine access to authorized and approved data sources.

AIFC will identify sources of authorized data, using a “critical indicators system” (CIS) to create user-defined operational visualization and information needs to support scenario-specific decision-making. AIFC plans to export fusion through migration to cloud based infrastructure. Critical in early development is creating the Data Science and computer architecture needed to connect capabilities.

Through an assessment of existing assets, ADAC notes current decision making is generally based on latent or near real-time data refresh rates. Accordingly, AIFC will establish a fusion of prior and near real-time data coupled with appropriate visualization and modeling in order to develop a trajectory of forecast visualization and information. Incorporating applied research in sensors and modeling being developed within ADAC and other applied research is key to provide convergent/forecast decision support.

Armed with such a trajectory of future forecast based on modeled latent and near real-time data and visualization, USCG and other operators and coordinators, will have improved decision support and risk-based analysis, scalable from command centers to field capable. Early development of AIFC will seek, through appropriate consultation, to gain insights and connection to capabilities from Alaska’s Geophysical Institute, Alaska Ocean Observation System, Marine Exchange of Alaska and the National Oceanic and Atmospheric Administration’s (NOAA) Arctic Environmental Response Management Application (Arctic-ERMA). Through mutual interest needs, ADAC will seek a close and collaborative partnership with NOAA/NWS to develop AIFC. Further, exploring a partnership with National Aeronautics and Space Agency’s Arctic Collaborative Environment (NASA ACE) may suitably aide ADAC research in AIFC.
A field capable AIFC is also necessary to enable both USCG responders and to appropriately connect with Community Based Observers. Accordingly, AIFC will conduct applied research to promote a capability to support field operations leveraging and adapting existing capabilities. Through research of existing systems, ADAC has determined systems such as the Field Information Support Tool (FIST), (previously developed in limited bandwidths, for field operators in Afghanistan), is likely a suitable and feasible capability to support AIFC in the field. Frankly, similarities in austerity between Afghanistan and the Arctic, make FIST investigations for the field capable aspects of AIFC, a worthy investment.

The follow-on phase of AIFC will seek to make the capability “intelligent” in operational decision support and incorporate robotics and advanced sensor injects through remote control capability not yet mature enough for the initial phase of AIFC. Building on initial successes, AIFC, with an Artificial Intelligence (AI) component, will be able to “learn” to process data streams, applying previous successes and failures, thus advancing AIFC’s initial fusion capabilities for more agile and intelligent decision support.

In sum, the following diagram provides an overview of ADAC’s planned projects and the orientation of efforts to support USCG and other DHS maritime missions:
ADAC Project Inter-relation

ADAC Field/Research Operations Safety and Risk Management Plan

ADAC and ADAC sponsored researchers certifies that all members associated with the center will comply with previously coordinated DHS-University of Alaska Anchorage Safety and risk management planning and procedures. The prior Safety Plan has been reviewed prior to workplan development and no changes to the DHS approved Safety Plan are requested at this time. ADAC will review this plan annually.

Faculty, staff and research students are mandated to comply with all safety and compliance regulations as described in the safety plan. Students working in laboratories or who intend to work with hazardous materials or equipment must be trained in laboratory safety (and must have read and agree to abide by the Safety Chemical Hygiene Plan, Laboratory Safety and Building Safety Plans) and must comply with all Laboratory specific safety plans and protocols. In addition, students working in the field will be trained for specific conditions as appropriate (e.g., fixed wing or rotor---winged aircraft safety training, wilderness first---responder, survival courses, and bear safety...
training as appropriate for the specific work to be accomplished).

Non-University of Alaska/University of Alaska Anchorage academic and industry institutions will be provided the prior approved DHS-UAA ADAC Safety Plan and provide ADAC written acknowledgement of intent to comply with the established proceedings as pertaining to any ADAC related/sponsored work.

V. ADAC PROJECT DESCRIPTIONS

Theme 1 – Maritime Domain Awareness

PROJECT: Community Based Observer Networks for Situational Awareness (CBONS-SA)

Project PI: Dr. Lilian Na’ia Alessa

Lead Institution: University of Idaho (UoI)

Supporting Team: Dr. Andrew Kliskey (UoI), Ms. Grace Beaujean Aleut International Association (AIA)

Proposed Collaborator: State of Alaska National Guard and Emergency Management (to include collaborating with the AK National Guard as they seek to develop their proposed “Scout” program).

Project Description:

Abstract: This project will establish a community-based observing network and system (CBONS) to acquire fine scale, local data on a range of variables critical to USCG operations (Savo et al. 2016, Alessa et al. 2015). Variables will include those associated with environmental change, subsistence activities/habitats and vessel transits (see Figure 6). A systematic and quality assured CBONS will enhance the Coast Guard’s ability to successfully respond to Arctic-related Incidents of National Significance (Arctic IONS). CBONS data may be used to enhance the preparedness of communities on the ground.
which can greatly increase the effectiveness of USCG in the Arctic while potentially reducing costs in the long term. The data will also generate community maps consisting of areas critical to culture and subsistence which will allow the Coast Guard to operate in ways that protect livelihoods and traditional lifeways. The data will eventually be transmitted via the Arctic Information Fusion Capability (AIFC) in order to promote safer SAR/HADR operations. Finally, the data may be used to enhance the precision of data from other Arctic Observing Networks (AON) by placing them in their social contexts.

Figure 5 Integration of Community Based Observations...Integration into Higher-Level Systems

The integration of CBO into broader systems of environmental change observatories spans satellite observing, airborne observing, terrestrial and marine instrumentation networks, and human observing networks. Data needs to be interoperable if efforts are to contribute to a global understanding of change that can enhance preparedness and adaptive responses in place. (Alessa et al. 2015b).
Baseline: The baseline for this project is the existing data intake forms and database. To date these have demonstrated integration of community-based sea ice observations with NOAA’s Arctic ERMA (Environmental Response Management Application) - a web based GIS tool for emergency responders. This baseline represents TRL 3 for the CBONS-SA. In Year 3 we will aim for two key metrics and milestones: Metric 1: Establish data intake forms that are compatible with hand-held field information devices; Milestone 1: Mini-exercise to take place in either Wales or Unalaska in July or August 2016; Metric 2: Establish streaming reports; Milestone 2: Reports integrated into the AIFC using no more than 3 data transformations.
Relevance to DHS: Accurate, fine-scale, local resolution data on environmental changes, subsistence patterns and habitats and current local conditions will enhance the USCG ability to prepare for and respond to incidents of national significance requiring search and rescue/humanitarian and disaster response. The data acquired from CBONS-SA will also allow the Coast Guard to operate in a manner that protects critical cultural and subsistence habitats. The data may also be used to enhance data from other Arctic Observing Networks (AON) by placing them in their sociocultural contexts (i.e., the consequences and impacts to resident communities).

Key Stakeholder Engagement Plan: The CBONS-SA project team will participate in the planned ADAC “Customers and Partners” Roundtable, in order to inform and receive feedback on project progress and usefulness to USCG mariners and ADAC collaborators.

Chief of Operations at USCG Pacific Area, Alameda California has agreed to serve as a specified project advocate and support overall efforts complementary to a project champion.


CBON-SA project advocates include:

- Assistant Director for Polar Sciences, Executive Office of the President (Office of Science and Technology Policy);
- Senior Advisor to President, Arctic Executive Steering Committee (NOAA);
- Director, Arctic Research Office with NOAA;
- Director, Polar Programs at the National Science Foundation.

Purpose of the Research: The purpose of the CBONS-SA is to utilize distributed human observers as sensors to systematically observe and document Arctic environmental and globalization changes, which are of significance to USCG operations (Illustration 6). By placing them in sociocultural and economic contexts, the Coast Guard will be able to anticipate, plan and respond to these changes through the AIFC.

The project’s primary objectives are:
1. Develop a quality assured and precise local-scale community-based observing network and system to monitor on-going environmental changes, cultural and subsistence habitats and vessel transits.
2. Develop key algorithms necessary for these data streams to be interoperable with satellite and buoy data so that rapid ingests can occur via au used by hand-held field information tools;
3. Assess CBONS communities’ existing response capacity (preparedness) and training/development needed to potentially establish a subset as first responders in a more coordinated fashion than currently exists.

The following science questions are planned to be explored in Project Year 3:

1. Which variables are most amendable to community-based observing? (i.e., which variables are consistently and accurately observed by high fidelity observers?).
2. What are the components of community resilience to critical events? I.e., what are the critical social and technological components for optimal community preparedness for IONS?
3. What scales of data from Arctic Observing Networks (AON) are most applicable to on-the-ground operations? I.e., what types, resolutions and depth of data are best suited to decision support?

**Student Involvement:** A University of Idaho undergraduate, (Navajo Nation and UI Senior) will be engaged in this project. This student will provide a research paper on the transferability potential for community-based observing networks performed via a desk study. There will be no in-field data collection performed by the student.

**Methodology:** The research design of CBONS-SA is based on the prototype Community Observing Network for Adaptation and Security (CONAS) methodology as outlined in the Arctic Council Conservation of Arctic Flora and Fauna (CAFF) Report (Alessa et al. 2015). Specifically, these include several steps: a) Recruiting and training high fidelity observers, b) Coordination of data intake forms with communities, USCG and Kestrel Technology Group (KTG), c) Coordinating native data formats with those from other data streams from instrumented observations and datasets, d) demonstrating data feeds through field-based and
modeling proof-of-concepts. There is a low risk that observing activities associated with expanding and maintaining the observing CBON-SA network could be delayed due to unanticipated extreme weather events. That risk would only affect the timing of milestone completion; completion of milestones remains assured. Project risk to accomplish project goals for the coming year is rated low. Further details include:

1. **Determine, test and develop new data relays with Field Information Support Tool (FIST).** Data intake forms will be developed in coordination with community observers, the ADAC CBONS-SA team, KTG and the USCG. Real-time data streams received via Iridium satellite constellation will be automatically uploaded and populated into a hand-held device compatible with USCG on-scene coordinator information needs. Observations will be geo referenced and immediately accessible. Bi-monthly data intake logs, as well as geo-referenced images will be incorporated into the Arctic Information Fusion Tool. Oversight for ensuring cultural sensitivities and protections will be assumed by AIA.

2. **Perform field-based and model interoperability tests with CBONS-SA data.** Providing high resolution data for model validation for Real-time Storm Surge, Coastal Flooding and Coastal Erosion Forecasting for Arctic Alaska. Working with ADAC’s Project PI for these modeling efforts we will make any modifications to data acquisition protocols in order to ensure the data in interoperable with model validation methodology. We will also demonstrate data submissions from remote locations via the KTG Field Information Support Tool (FIST) in late August 2016.

The project team will employ existing CBONS-SA protocols for maritime observations, including image tagging and systematic description codes; up-loading data via cell-to-satellite phone relays to the central database at University of Alaska; and data provision to the developing Arctic Information Fusion Capability (AIFC) project.
Schedule and Milestones:
3. Demonstrate the utility of a CBONS-SA to field operator decision support in near-real (minutes lag) and real (seconds lag) using a hand-held device. Time to be determined in consultation with USCG Research and Development Center and District 17.

Metrics: In order to demonstrate the reliability, range and applications of CBONS-SA, metrics will measure the number of successfully relayed observations. These include text based and image data relays, which are both real-time observations as transmitted via the Iridium satellite constellation, and delayed-time observations coming in bimonthly through a standardized reporting forms. Additionally, CBONS-SA data will function as model validation for additional proposed ADAC programs. Once such standards of data relay are developed, the later phase of incorporating ND/KTG will be tested in order to determine if they meet the metrics developed for cell to satellite phone relays.

- Number of successful image and data relays, both real-time and delayed-time: 12 images with accompanying observer report, sent via hand-held device, per week across project year. This is research routine reporting.
- Inter-rater reliability of observers across network: Achieve >90% standardization accuracy of reporting through common forms. Research goal is to seek data submitted adhering to the developed reporting form.
- Percentages of successes of integrating HFO data with proposed AIFC to increase the capacity of the larger observational suite: Seeking >90% accuracy from submitted Observer Reports that can be directly populated into AIFC, achieving interoperability without need for intervening algorithm support.
- Percentages of observations (via reporting form) that detect anomalous or unusual events with sufficient information; including photographs, date and time, and precise location: >80% accuracy.
Outcomes/output & Transition Plans: The CBONS-SA network will eventually comprise one Aleutian community, one Bering Sea community, and one Beaufort Sea community that applies standardized protocols for HFOs and demonstrates real-time transmission of observations. (Metrics i. – iv.), this represents TRL 7. For the coming year, Project PI and ADAC leadership will consult with State of Alaska determine if a future Alaska Scouts Program (ASP) could serve as a potentially feasible/suitable transition destination. Coordination of such consultation with Canada’s JTF-N would serve to provide lessons learned from Canada’s development of their Ranger observer program. However, with or without an ASP destination, the applied research in creating three capable CBONS-SA teams in the Aleutian, Bering and Beaufort regions, provides the USCG a small and skilled CBONS-SA team. These teams will be capable to function to USCG observer reporting tasks, and could be a model to replicate beyond the Arctic.

Sustainability of the CBONS-SA network is best served through a shared agency support approach:

- Data which are useful for scientific use, such as assessing environmental change (NOAA);
- Data to support community preparedness /resilience in the face of dynamic weather and weather related impacts across Arctic Alaska (USCG);
- Building a systematic tool that can be used for data acquisition and use by DHS for “see something/say something” that will benefit homeland security (DHS) across agencies. This includes: border transits, suspicious activities near critical infrastructure, and airport security.

CBONS-SA will also contribute to research and development to improve hand-held field information support tools by: a) assessing user feasibility in a range of on-the-ground operators, b) evolving the graphic user interface (GUI), and c) putting hand-held devices in new situations and contexts outside federal and state agency responders. As importantly, the CBONS-SA project is growing the “human-in-loop” (HIL) components of the Observe-Prepare-Respond paradigm which affects all aspects
of USCG operations but is currently poorly articulated and implemented.

To date, several peer-reviewed articles and white papers have been published with attribution to ADAC. In addition to these publications as well as those to be generated by the undergraduate student at University of Idaho, data derived from CBONS-SA will be presented to the public at large through conference papers and presentations.

**PROJECT: High-Resolution Modeling of Arctic Sea Ice and Currents**

**Project PI:** Dr. Jinlun Zhang

**Lead Institution:** University of Washington

**Supporting Team:** N/A

**Project Description:**

**Abstract:** This project will develop an accurate, High-resolution Ice-Ocean Modeling and Assimilation System (HIOMAS) for modeling and predicting sea ice and currents in the Arctic Ocean. This system is to be calibrated and validated using a range of available sea ice and ocean observations and then used for (near) real-time hindcast and daily-to-seasonal forecast of Arctic Ocean currents, sea ice, and change.

Accurate, high-resolution predictions of ocean currents and sea ice conditions will enhance the Coast Guard’s ability to prepare for and respond to oil spills in the Arctic Ocean. The prediction data will also allow the Coast Guard to more safely and reliably conduct search and rescue missions. The data will eventually be transmitted to ship captains via the Automated Identification System (AIS) system in order to promote safer maritime transportation. Finally, the data may be used as forcing to drive other models such as wave models and oil spill models.

**Baseline:** There are sea ice-ocean models on global or regional scales. These models can simulate ocean velocity, temperature, and salinity, and sea ice thickness, concentration, and drift.
Most of the models have relatively coarse horizontal resolution (> 10 km). There are a number of models with higher resolution (< 10 km). A rather common difficulty in high-resolution modeling is the overestimation of ice thickness resulting from the simulation of excessive ice deformation. This would affect the prediction of sea ice and upper ocean currents. Accordingly, the project team aims to develop a robust HIOMAS that will be able to realistically simulate sea ice without causing spurious ice thickness buildup. This has been proven with the latest test results. The HIOMAS is configured such that it can be easily refined to a higher resolution (≤ 4 km) if computing resources permit.

Relevance to DHS: Accurate, high-resolution predictions of ocean currents and sea ice conditions will enhance the USCG ability to prepare for and respond to oil spills in the Arctic Ocean. The prediction data will also allow USCG to more safely and reliably conduct search and rescue missions. The data may be further used as forcing to drive other models such as wave models and oil spill models.

Key Stakeholder Engagement Plan: Project team will participate in the planned ADAC “Customers and Partners” Roundtable, in order to inform and receive feedback on project progress and usefulness to USCG mariners and ADAC collaborators.

Project Champions: HQ USCG-751 (Primary), HQ USCG-255 (Secondary).

Purpose of the Research: The decline of the Arctic sea ice allows greater marine access to the Arctic Ocean than ever before. This presents challenges and opportunities in the region for a variety of economic activities such as fisheries, marine transportation, port operation, and resource exploration. Increased economic activities in the Arctic Ocean in-turn pose challenges to the operations of the US Coast Guard. In order to meet these emerging challenges, it is important to enhance our ability to predict Arctic sea ice and currents over a range of time scales from days to seasons for various Arctic regions. Accordingly, this project will develop an accurate, High-resolution Ice-Ocean Modeling and Assimilation System (HIOMAS) for modeling and predicting sea ice and currents in the Arctic Ocean. Accurate, high-resolution predictions of ocean currents
and sea ice conditions will assist the planning and management of economic activities. It will also enhance the Coast Guard’s ability to prepare for and respond to oil spills in the Arctic Ocean. The prediction data will also allow USCG to more safely and reliably conduct search and rescue missions in the high north.

The project’s primary objectives are:
1. Develop a new high-resolution forecast system to predict Arctic sea ice and currents on daily to seasonal time scales.
2. Assess the system’s predictability through skill evaluation and uncertainty analysis and identify areas for further model improvement.

The following science questions are to be explored in year 3:
- What is the relative importance of initial conditions versus atmospheric forcing in the variability and predictability of sea ice and currents?
- What is the impact of summertime heat storage in the upper ocean on the variability and predictability of sea ice?
- How do Arctic cyclones affect the variability and predictability of sea ice and currents on daily to seasonal time scales?

**Student Involvement:** An undergraduate is initially planned during summer 2016 to assist with data processing in a laboratory setting.

**Methodology:** HIOMAS will be developed based on the Pan-arctic Ice-Ocean Modeling and Assimilation System (PIOMAS, Zhang and Rothrock, 2003). (The Marginal Ice Zone Modeling and Assimilation System or MIZMAS is a variant of PIOMAS). PIOMAS is a well-established modeling and assimilation system with advanced sea ice and ocean model components and is capable of assimilating satellite sea ice concentration. Its realistic sea ice output is widely disseminated worldwide by scientists, sea ice enthusiasts, interested bloggers, and some media organizations. Developed based on PIOMAS, HIOMAS has a high probability of being successful. In addition, HIOMAS will have a much higher horizontal resolution than PIOMAS, targeting 2-4 km for the whole Arctic Ocean, depending on computing resources.
Such high resolution is essential to further improve the prediction of sea ice concentration, thickness, and motion and ocean circulation. Because of the high resolution, many of the model parameters may need adjustment, such as ice strength and ocean viscosities. The HIOMAS forecast will be driven by the forecast atmospheric forcing from the NOAA National Center for Environmental Prediction (NCEP) Climate Forecast System (CFS).

The CFS consists of coupled atmosphere, sea ice, and ocean model components with data assimilation. It is a robust system that was able to capture the “great” Arctic cyclone of August 2012. The CFS forecast ranges from hours to months: there are a total of 16 CFS forecast runs every day, of which four runs go out to 9 months, three runs go out to 1 season, and nine runs go out to 45 days. These runs all create 6-hourly forecast atmospheric data that are widely accessible in real time, thus ideal for forcing the HIOMAS forecast. Using the CFS forecast forcing, we will conduct daily to seasonal forecast experiments on a monthly basis, more frequently if emergencies occur in the Arctic that need a rapid response. Forecast results will be used to explore the above science questions.

The science review for this project is extensive. Short-term numerical forecasts of sea ice extent and concentration have been made for years by the U.S. National Ice Center (NIC) using the Polar Ice Prediction System (PIPS) combined with satellite observations (Cheng and Preller, 1999). PIPS uses forecast forcing from an atmospheric forecast model to drive a coupled ice-ocean model to predict the future state of the ice cover days in advance. The PIPS has been replaced recently by the Arctic Cap Nowcast/Forecast System (ACNFS) developed at the Naval Research Laboratory at Stennis Space Center (NRL-SSC) (Posey et al., 2010). Like the PIPS model, ACNFS also consists of a coupled ice-ocean model driven by forecast forcing from an atmospheric forecast model. Scientists at the NRL-SSC have been conducting hindcasts and short-term and seasonal forecasts of Arctic sea ice using ACNFS (http://www7320.nrlssc.navy.mil/hycomARC/arctic.html). In addition, the Canadian Ice Service is also providing short-term forecasts of sea ice in Canada’s navigable waters.

After the dramatic retreat of Arctic sea ice during summer 2007, the U.S. SEARCH and the European DAMOCLES programs recommended a
community-wide prediction effort — the September Arctic Sea Ice Outlook.

This effort has been ongoing since 2008 with increasing participation and proven to be remarkably successful (Stroeve et al., 2014; http://www.arcus.org/search/seaiceoutlook/ and now http://www.arcus.org/sipn/sea-ice-outlook).

For the September 2014 Arctic Sea Ice Outlook, 23 research groups worldwide participated, employing various methods that combined observations, statistical and numerical models, and empirical analyses. Among the 23 contributions are 10 predictions from numerical models, including coupled ice-ocean models.

Community involvement in the Outlook (as discussed in the previous paragraph) has shed considerable light on the predictability of sea ice. Most of the numerical models participating in the Outlook have a coarse horizontal resolution (> 10 km). These numerical models focus on the predictions of total September Arctic sea ice extent, and few predict ice thickness and ice edge locations, thus not particularly useful for assisting the planning and management of economic activities and Coast Guard’s missions in the Arctic Ocean. Among these numerical models, only ACNFS has a high horizontal resolution (4 km) comparable to HIOMAS. However, HIOMAS has a different sea ice model. The HIOMAS sea ice model is adapted from PIOMAS which has proven to be able to realistically simulate ice thickness with low mean bias and high model-observation correlation (e.g., Schweiger et al., 2011). This is why PIOMAS sea ice output is widely used worldwide, and it is our hope that the high-resolution HIOMAS results will also be widely used. Risk in not accomplishing project goals for the coming year is rated low.

**Schedule and Milestones:**

1. Develop HIOMAS with even higher horizontal resolution, targeting 2–4 km for the Arctic Ocean, depending on computing resources; conduct extensive calibration and validation using various available sea ice and ocean observations to reduce model errors (12/31/2016).
2. Conduct near real-time or real-time hindcast and seasonal forecast of Arctic sea ice and ocean currents; examine HIOMAS skills in (near) real-time hindcasts and forecasts (06/30/2017).

**Metrics:** The key output of HIOMAS forecast includes sea ice thickness, concentration, velocity, snow depth, and ocean velocity. We will improve prediction accuracy through extensive model calibration and validation using corresponding observations, such as NASA Ice Bridge observations of ice thickness and snow depth, satellite observations of ice concentration, and buoy observed ice drift (ice motion).

We will use statistical quantities such as model-data correlation, root mean squared error, and mean model bias to quantify and subsequently reduce model misfits through calibration and validation. In particular, we will strive to limit the mean model bias under 20% for ice concentration, 0.4 m for ice thickness, 0.02 meters per second (m/s) for ice drift velocity and surface ocean velocity.

- Range of mean prediction error in ice concentration percent): 0% to 30%; range of mean prediction error in ice (thickness (m): 0 m to 0.4 m; range of mean error in ice drift estimates (m/s): 0 m/s to 0.02 m/s.
- Appropriately connect the model to the developing Arctic Information Fusion Capability to support USCG and other DHS maritime missions to leverage a useful model as an aid to decision support.

**Dissemination Plans:** In addition to planned incorporation to AIFC, results from this project will be disseminated through journal publications and conference presentations. Hindcast and forecast data will also be stored in a web site for wide public access. Animations of predicted sea ice thickness and ice edge locations will also be shown to the public in a web page (see http://psc.apl.uw.edu/research/projects/mizmas/hindcast-and-forecast/), which is to be updated monthly (and plan to be linked to ADAC website).

**Outcomes/output & Transition Plans:** For the start of Year 3, the project has developed and tested HIOMAS with a 6 km horizontal resolution. In year 3, we will develop and test HIOMAS with
even higher horizontal resolution, targeting 2-4 km for the whole Arctic Ocean, depending on computing resources. We will conduct extensive calibration and validation using various available sea ice and ocean observations to reduce model errors. After the calibration and validation, we will perform near real-time (1-3 days behind real-time) or real-time hindcast and seasonal forecast of Arctic sea ice and ocean currents. HIOMAS forecast skills will be evaluated.

Development of HIOMAS will include advanced sea ice and ocean modeling and assimilation capabilities. Output of HIOMAS hindcasts and forecasts, will include sea ice thickness, concentration, velocity, and deformation, snow depth, sea surface height, ocean temperature, salinity, and velocity, and surface heat, salt/freshwater, and momentum fluxes. TRL 3 is to be achieved with this project. Transitioning a refined TRL 3 level HIOMAS as a contributing model in AIFC is planned. This work will transition to USCG RDC and through USCG Acquisitions Directorates to the operational environment at USCG District 17, and others as appropriate.

PROJECT: Arctic Oil Spill Modeling (Updated Title)

Project PI’s: Dr. Tom Ravens and Dr. Scott Socolofsky

Lead Institutions: University of Alaska Anchorage and Texas A&M University (TAMU)

Supporting Team: Dr. Jifeng Peng (UAA), Dana Brunswick (UAA), and a Postdoctoral researcher (TAMU).

Proposed Collaborator: NOAA/NWS

Project Description:

Abstract: The team will work to develop techniques to estimate the spreading of oil that has been released under ice (due to a well blow-out or due to a ruptured pipeline) or among ice (due to a ship grounding). For the under-ice oil release from a well blowout or a ruptured pipeline, the approach will involve coupling output from the oil plume model developed by Texas A&M University with simple analytical density current models to
arrive at forecasts of oil spreading. For oil released near the surface, project team will adopt approaches derived from the research literature that are compatible with NOAA’s GNOME oil spill model (General NOAA Operational Modeling Environment).

The goal is to develop a tool to forecast the spreading of oil in the immediate aftermath of a spill event (i.e., within 24 or 48 hours of the spill), accounting for the character of the spill (e.g., well blowout or pipe rupture), the release rate or amount, and the environmental conditions (ice concentration, water depth, water velocity, salinity). The tool produced—referred to as the “Arctic Oil Spill Calculator”—will be housed in the Arctic Information Fusion Capability, and we will work to include it in NOAA’s Arctic ERMA program.

**Baseline:** The USCG relies on the General NOAA Operational Modeling Environment (GNOME) oil spill model and NOAA for expert guidance when responding to an oil spill. The existing GNOME oil spill model is not Arctic-capable (e.g., it does not yet account for sea ice). The existing GNOME oil spill model also does not yet include an oil plume module so that it cannot readily address sub-surface well blow-outs and sub-surface pipeline ruptures. The new GNOME model, under development, deals with ice by assuming if the coverage is 20% or less, the oil moves with winds and currents. If the coverage is 80% or more, then it moves entirely with the ice. For concentrations between 20% and 80%, it interpolates linearly.

ADAC has engaged with NOAA’s leading oil spill modelers and has provided guidance and suggestions on general ways to incorporate ice into GNOME. ADAC has also engaged with NOAA and now plans to partner Texas A&M University to provide GNOME-compatible guidance on fate and transport of both surface and under-ice releases of oil and gas—realistically accounting for under ice roughness—with a focus on the first 24 – 48 hours.

One of the key and unique features of this project is the realistic accounting of under-ice roughness. The Arctic under-ice roughness data available to this project was originally provided by Shell Corporation, but it has also benefitted from significant analysis and processing by collaborator Andy Mahoney (UAF).
The plume modeling expertise developed by Texas A&M University (co-PI Scott Socolofsky) also constitutes significant baseline data. Over the last five years, Dr. Socolofsky has developed the Texas A&M Oil Spill Calculator (TAMOC), a comprehensive model for predicting the nearfield behavior of subsea oil spills (Socolofsky et al., 2015), through funding from an array of sources, including the U.S. National Science Foundation, the Gulf of Mexico Research Initiative (GoMRI), the Bureau of Safety and Environmental Enforcement (BSEE), Chevron Energy Technology Company, and Shell Oil Company.

When oil and gas are released below the surface, they rise and entrain ambient seawater to form a plume; the nearfield region of a spill extends until the buoyant effects of the oil, gas, and seawater mixture are exhausted. For the Deepwater Horizon accident, the nearfield dynamics were responsible for the deep intrusion layer that formed at 1100 m depth in the Gulf of Mexico (Socolofsky, et al., 2011), as well as for transport of oil to the surface close to the response zone (Ryerson, et al., 2011). In shallow, ice-capped regions such as the Arctic, the nearfield plume will extend from the spill to the ice bottom surface. The plume model will predict the mixture density of oil, gas, and seawater that will intrude laterally under the ice. It will also predict the mass flow rate of oil and gas.

Relevance to DHS: The USCG relies on the GNOME oil spill model and NOAA’s support in the event of an oil spill. This project directly supports NOAA’s Office of Response and Restoration and its need for an Arctic Oil Spill Calculator that can provide short term spreading estimates in the immediate aftermath of an oil spill. USCG seeks advance oil spill modeling for the Arctic region to aid in preparedness and response.

Key Stakeholder Engagement Plan: The project team will participate in the planned ADAC “Customers and Partners” Roundtable, in order to inform and receive feedback on project progress. Further, the project team will engage with key stakeholders at the NOAA Office of Response and Restoration.

Project Champions: HQ USCG-MER (Primary). HQ USCG-255 and USCG District 9 (Secondary).

The following are acknowledged as project advocates:
- NOAA/NWS;
- USCG RDC;
The research developed in this project will be disseminated through various venues including the Alaska Marine Science Symposium. In addition, the Arctic Oil Spill Calculator will be a part of the Arctic Information Fusion Capability, and it will be incorporated into NOAA’s Arctic ERMA (Environmental Response Management Application).

**Purpose of the Research:** The objectives of the proposed research are to develop an “Arctic Oil Spill Calculator” (AOSC) that provides short-term (24 and 48 hour) forecasts of an oil spill event in the Arctic. Such forecasts are currently not available to first responders. The oil spill forecasts will provide projections of the location of the spill, the extent of oil spreading (longitudinal and transverse spreading), and the oil plume density and thickness as a function of the nature of the spill event (e.g., well blowout, pipeline rupture, ship grounding), the oil release rate or amount, and the environmental conditions (e.g., ice concentration, water depth and velocity, etc.).

Illustration 7 provides a schematic illustrating the concept and operation of the Artic Oil Spill Calculator. In the event of an oil spill event, the emergency responder will enter in various input data (e.g., time and location of the spill event, the event type, spill rate or amount, etc.; Illustration 7). Then, the Arctic Information Fusion Capability will automatically supply the relevant environmental data. Finally, the Calculator will execute a series of algorithms leading to the 24 and 48 hour forecast.
**Student Involvement:** The project will support a Postdoctoral researcher and a graduate student. The Postdoctoral researcher will work with co-PI Scott Socolofsky (Texas A&M Univ.). He will modify the Texas A&M University oil plume model (TAMOC) to include surface buoyant plume dynamics and will work on the coupling between TAMOC and both the GNOME model and the new Arctic Oil Spill Calculator (AOSC). The graduate student will work with PI Ravens and will have primary responsibility for the intermediate and far field oil transport calculations within AOSC.

**Methodology:** In this project, we will develop a forecasting tool – the Arctic Oil Spill Calculator – which will forecast critical oil spill information (e.g., location, horizontal extent, thickness, and concentration) 24 and 48 hours into the future. The Calculator will account for sub-surface releases due to well blowouts and pipeline ruptures as well as near-surface releases due to ship groundings. It will account for the presence of ice and the under-ice roughness. It will accommodate oil spill events in the Chukchi and Beaufort Seas.
In order to estimate the horizontal spreading of near-surface oil spills in seas with ice concentrations between 0% and 100%, a random walk oil spreading model will be developed in MATLAB, initially ignoring the presence of ice. The random walk model will be a function of the ocean horizontal diffusivity, wind speed and direction, and ocean surface velocity at the spill location. In the second step, the spreading will be reduced in accordance with the ice concentration, incorporating rules of thumb developed in the oil spill literature (e.g., Dickins and Buist 1975).

For a subsurface oil release due to a well blowout or a pipeline rupture, a different methodology will be employed. First, the Texas A&M University Oil Plume Model will be used to generate the initial condition of the oil plume, covering the period from the oil release from the blowout or pipeline rupture to the arrival of the plume at the underside of the ice. As appropriate, Chukchi Sea or Beaufort Sea oil reservoir properties and hydrocarbon constituents will be input into the model ensuring realistic plume simulations. The Texas A&M model will generate the plume density, plume volumetric flow rate, plume horizontal extent, and oil mass flow rate all as a function of vertical position. The model will also determine the plume momentum and the likely reflection at the under-ice surface.
Based on the plume model outputs, a density current model will be developed to forecast the subsequent spreading of the oil plume (see Illustration 8). A key parameter of the density current model used to forecast oil plume spreading will be the frontal velocity, \( u_f \), for which a nominal estimate can be obtained from the classical result (Meiburg and Kneller 2010, Meiburg et al. 2015):

\[
 u_f = Fr \ (g' h)^{1/2}
\]

where \( Fr \) is the Froude number (a function of \( \rho_o/\rho_i \) and/or \( h/H \)), \( h \) is the density current front height, \( H \) is the total fluid depth beneath the ice, \( g' \) is the reduced gravity (\( = g \Delta \rho/\rho_o \)), \( g \) is the gravitational acceleration, \( \rho_i \) is the density of the plume, \( \rho_o \) is the ambient density, and \( \Delta \rho \) is the difference between the ambient density and the plume density.

In order to determine the variation in density current velocity and height in the flow direction, a depth-averaged or shallow water (SW) density current model will be employed. The type of SW density current model will be dependent on the plume model.

---

**Arctic Domain Awareness Center Workplan 1 July 2016–30 June 2017**
output. For example, if the plume model indicates that the thickness of the buoyant plume is relatively small compared to the thickness (or depth) of the water column under the ice, then a "one-layer" analytical model will be developed and employed. In the one-layer model, the thickness of the buoyant density current is sufficiently small that impacts on the velocity of the ambient fluid can be neglected. If, on the other hand, the density current thickness is on the order of half of the fluid depth beneath the ice, then a two-layer analytical model is appropriate and velocity of both the density current and the ambient current are accounted for (Baines 1995, Ungarish 2010, Meiburg and Kneller 2010).

For a subsurface oil release into stagnant water under smooth and stagnant ice, the plume will have radial symmetry. Plume spreading (at 24 and 48 hours) will be estimated based on the frontal velocity and the elapsed time. For a subsurface oil release into stagnant water with significant under-ice roughness (defined as roughness greater than the steady state density current thickness), spreading extent will be determined based on ice cavity volume and plume volumetric flow rate, following Cox and Schultz, 1981). In the event of a subsurface release into moving water/ice, the plume will be elongated and relatively narrow. The longitudinal spreading will be estimated based on the water/ice velocity and the elapsed time. The lateral spreading will be estimated based on the frontal velocity described above.

Completed work will be connected to AIFC, models also will be available to ADAC website and research appropriately published to professional journals.

**Schedule and Milestones:**

1. Develop the Arctic Oil Spill Calculator algorithms for near-surface oil releases due to ship groundings and similar events, accounting for different concentrations of sea ice. (7/1/16 - 10/30/16).

2. Develop the Arctic Oil Spill Calculator algorithms for subsurface oil and gas releases making appropriate use of the Texas A&M University plume modeling, incorporating appropriate Arctic reservoir data and oil pipeline data,
and using appropriate density current models (7/1/16 - 10/30/16).

3. Estimate the accuracy and precision of the Arctic Oil Spill Calculator (AOSC) using available field data on oil spills and using the GNOME model (11/1/16 - 3/30/17).

4. Implement the AOSC within the Arctic Information Fusion Capability (AIFC) and within Arctic ERMA (3/1/17 - 6/30/17).

**Metrics:**

- Accuracy of AOSC relative to the existing GNOME model in instances where AOSC and GNOME overlap (e.g., with low (<30% ice concentration) for selected surface oil spill scenarios at specific times (e.g., 24 and 48 hours after spill event). The target accuracy is for the AOSC output to be within 50% of the GNOME result for 80% of the scenarios considered.
- Accuracy of the Arctic Oil Spill Calculator (AOSC) using available field data on oil spills at specific times (when measured data is available). The target accuracy is for AOSC output on oil spreading (at particular times) to be within 50% of observed spreading for 70% of the data sets considered.
- Accuracy of the Texas A&M Oil Spill Model (TAMOC) relative to measured data in shallow water applications. The target accuracy is for TAMOC plume density calculations to be within 50% of measured data for 70% of the data sets considered.
- The Arctic Oil Spill Calculator is implemented within the Arctic Information Fusion Capability to support USCG and other DHS maritime missions and to provide decision support.

**Outcomes/output & Transition Plans:** Development of an Arctic Oil Spill Calculator to estimate the spreading and thickness of released oil 24 and 48 hours after the initial release. Successful execution of the project is equivalent to reaching a TRL of 4. Transitioning the Arctic Oil Spill Calculator to a contributing model in AIFC is planned. ADAC also plans to provide access to the Arctic Oil Spill Calculator via Arctic ERMA.
PROJECT: Real-time Storm Surge, Coastal Flooding, and Coastal Erosion Forecasting for Arctic Alaska

Project PI’s: Dr’s. Thomas Ravens & Craig Tweedie

Lead Institutions: University of Alaska Anchorage (UAA) and University of Texas El Paso (UTEP)

Supporting Team: Dr. Jifeng Peng (UAA), Graduate Student Jon Allen (UAA), Graduate Student (Seth Campbell), and Axiom Data Sciences

Proposed Collaborator: NOAA/NWS (to include potentially sponsoring a Post-Doctoral researcher)

Project Description:

Abstract: In this project, we will work in collaboration with NOAA’s National Weather Service (NWS) to develop a high (1 km) resolution storm surge forecasting model for the north coast of Alaska between Cape Lisburne and the US/Canadian Border (a distance of 1000 km). Currently, the NWS operates a ~ 5 km resolution forecasting model (ET-Surge). The storm surge modeling will be conducted with NWS-compatible software (either the SLOSH model or the ADCIRC model). Water level forcing data, applied on the ocean boundary, will come from National Weather Service’s Extra Tropical (ET)-Storm Surge model. Bathymetric and topographic data will be gathered from NOAA sources.

In addition to the storm surge forecasting, we will develop a preliminary coastal erosion forecasting model for the Barrow area. The coastal erosion model will be a semi-empirical model that computes erosion rate based on environmental data including surge height, wave condition, water temperature, and nearshore ice condition. Nearshore wave data for the erosion model will be estimated based on NOAA’s operational Wavewatch III model or the Nearshore Wave Prediction System (planned to be operational in September 2016).

The storm surge and coastal erosion models will be calibrated and validated using available data including NOAA water level
data collected at Prudhoe Bay and shoreline change, wave and water level data available by Barrow. Co-PI Craig Tweedie will assist with the gathering of Barrow data for model calibration/validation. Time permitting, the team will include an Xbeach model to explicitly include the contribution of wave run-up to the coastal storm surge (following Erickson et al. 2015). The suite of models will forecast storm surge, coastal flooding, and erosion risk and they will be included in the Arctic Information Fusion Capability (AIFC).

Baseline: The National Weather Service (NWS) currently operates a storm surge forecasting model referred to as ET-Storm Surge (Extra Tropical Storm Surge model). ET-Storm Surge provides projections of surge several days into the future.

However, the model has a relatively coarse grid (about 5 km resolution) and, therefore, it is unable to provide the high resolution forecasts needed by coastal communities in Alaska and by USCG in making timely evacuation notice decisions.

In project years 1 and 2, ADAC developed high resolution, nearshore forecasts of storm surge, coastal flooding, and wave conditions at two sites on the West Coast of Alaska – the Yukon Kuskokwim river delta and Norton Sound. The Delft3D and SWAN models were used for the storm surge and wave modeling, respectively. The modeling system has been validated with the use of nearshore water level measurements. In addition, satellite data has been used to help assess the model’s ability to calculate coastal inundation.

While coastal erosion models have been developed for non-Arctic locations, relatively few Arctic-capable models have been developed. Coastal erosion researchers in non-Arctic settings have recognized some of the contributing factors to coastal erosion including alongshore variation in alongshore sediment transport (due to alongshore variation in wave climate) and the incidence of aggressive storm-driven waves during storm surges (e.g., Ruggiero et al. 2001).

Some of the limited work on Arctic coastal erosion has been performed by PI Ravens. Ravens developed a process-based coastal erosion model for Western Alaska’s Drew Point area where coastal erosion proceeds via a series of processes including storm
surge, niche erosion, block collapse and erosion of the fallen blocks (Ravens et al. 2012). Ravens has also developed a semi-empirical coastal erosion model for the Drew Point area finding that coastal erosion rates could be reasonably well predicted based on the water level, the nearshore wave height and the nearshore water temperature.

**Relevance to DHS:** FEMA acts to “Prepare, Plan, and Mitigate before, during, and after a Disaster”. Many western and northern Alaska coastal communities are vulnerable to coastal flooding and erosion during storms. The city of Barrow in Northwest Alaska has been particularly vulnerable to storm surges and coastal erosion in the past few summers.

The proposed work will provide a higher resolution storm surge and flooding forecast, and it will forecast the erosion risk associated with particular storm events. This capability will equip emergency responders with relevant and improved fidelity information about severe natural hazards allowing proactive emergency management.

**Key Stakeholder Engagement Plan:** Project team will participate in the planned ADAC "Customers and Partners" Roundtable, in order to inform and receive feedback on project progress.

HQ USCG Assistant Commandant for Capabilities (USCG CG-7) serves as the overall project champion.

**Project Champions:** TBD.

ADAC acknowledges the following project advocates:
- DHS FEMA;
- USCG D-17;
- NOAA/NWS.

While ADAC strives to gain a partnered approach with NOAA on this particular project, a decision for full partnership will be made between federal departments /agencies.

In any case, NOAA has expressed significant interest in this project, and/as such, is a collaborator with whom project team plans to collaborate and partner as much as possible.
**Purpose of the Research:** The objectives of the proposed research are to:

- Expand the high-resolution projections of storm surge and coastal flooding to the north coast of Alaska (including Barrow);
- Work more collaboratively with NOAA, in part by using the NOAA-supported ADCIRC or SLOSH storm surge model;
- Include a coastal erosion forecast for the Barrow area in addition to the storm surge forecast.

**Student Involvement:** The project will support two graduate students (including a PhD candidate). One of the students will develop the storm surge model. The other student will develop the coastal erosion model. An ADAC undergraduate scholarship recipient will also work on the project. Support for a Post-Doctoral researcher is sought to enhance the collaboration with NOAA.

**Methodology:** Storm surge modeling/forecasting: bathymetry and topography will be obtained for the north coast of Alaska. A 1 km-resolution circulation model (SLOSH or ADCIRC) will be developed. The circulation model will be forced with offshore water level data from ET-Surge. Forecasted water level conditions will be validated using NOAA observations at Prudhoe Bay and using local observers at Barrow with assistance from Craig Tweedie (UTEP). No other environmental data is currently available.

Coastal erosion modeling: historic data on beach profiles and shoreline position will be obtained from Craig Tweedie (UTEP, Barrowmapped.org). Calculations of water level and nearshore wave condition (see above) and nearshore water temperature (from the Office of Naval Research (ONR) Lab’s Hybrid Coordinate Ocean Model (HYCOM) constitute the input parameters to the coastal erosion forecast model.

A semi-empirical coastal erosion algorithm will be developed based on these input parameters. The algorithm will be calibrated and validated using observed erosion data. The validated model will be used to forecast coastal erosion rates. Completed work will be connected to AIFC, models also will be available to ADAC website and research appropriately published.
to professional journals. Risk to conclude project goals for the coming year is rated low to medium.

Schedule and Milestones:
1. Gather data on beach profiles and shoreline position for the past several years (7/1/16 – 8/30/16).
2. Generate data on storm surge and nearshore wave condition for the past several years (7/1/16 – 10/30/16).
3. Develop the high resolution circulation and nearshore wave models (7/1/16 – 12/30/16).
4. Develop and test the coastal erosion algorithms (7/1/16 – 12/30/16).
5. Develop forecasts of storm surge, coastal flooding, nearshore waves, and coastal erosion (1/1/17 – 6/30/17).
6. Connect working models to AIFC, date to be determined.

Metrics:
- Accuracy of surge and flooding forecasts relative to measured data. Surge calculations currently have errors in the range of 0.5 to 1.0 m. The target error is 0.25 m to 0.5 m. Surge calculations will be assessed relative to measurements at the NOAA tide gage at Prudhoe Bay. Surge calculations will also be assessed at Barrow, with the assistance of local observers (automated time-stamped photos of a graduated staff).
- Accuracy of the coastal erosion modeling at Barrow on a per-storm and on an annual basis. Annual erosion rates of 1 to 3 m have been observed at Barrow in the past several years. The goal is to generate model calculations of erosion that fall within 30% of measurements at multiple locations in the Barrow area.
- Number of months (or storms) for which surge and erosion model is operational in year 3. The number of operational months will range from 12 months (meaning the model was operational for year 3) to 0 months (meaning we did not succeed in making the model operational). Accuracy of the models is addressed in the first metric.

Outcomes/output & Transition Plans, (advance or impact policy, procedures, technologies or capabilities):
A. In Project Year 3, develop, validate, and assess a National Weather Service-compatible storm surge model for the north coast of Alaska. Achieving output “A” is equivalent to reaching a TRL of 6. Time permitting, operate the model in forecast mode generating up to 5 day forecasts of storm surges.

B. In Project Year 3, develop, validate, and assess a semi-empirical coastal erosion model. Achieving output “B” is equivalent to reaching a TRL of 6. Time permitting, operate the model in forecast mode generating forecasts of the coastal erosion up to 5 days into the future.

C. Transitioning storm surge and coastal erosion forecasting capabilities within AIFC is planned following further refinement to reach TRL 7 in Project Year 4.

PROJECT: Identifying, Tracking and Communicated Sea-Ice Hazards in an Integrated Framework

Project PI: Dr. Andrew Mahoney

Lead Institution: University of Alaska Fairbanks (UAF)

Supporting Team: Co-investigator Dr. Hajo Eicken (UAF), Technician Josh Jones (UAF)

Proposed Collaborator: NOAA/NWS

Project Description:

Abstract: The overarching objectives of this project are to identify, track and communicate hazards associated with ice in the ocean such as the entrapment of vessels; structural damage to vessels and infrastructure; risk to personnel and assets due to detachment of landfast ice; and the limitation of oil spill response. These objectives are directly motivated by input from USCG D-17 and review of USCG Arctic Information Needs workshop report. The proposed work addresses several of the 20 US MDA challenges identified by the USCG.

Our approach is two-pronged and involves 1) the development of technology to identify and track ice-related hazards; and 2) the creation of an Arctic MDA testbed located in Barrow, Alaska, to
assess the value of available met-ice-ocean data streams and test strategies for effective communication in an Arctic emergency response setting.

The outcomes of this work will include i) the development of software products for deriving ice motion and deformation from land-based and ship-based radar platforms; ii) baseline coastal sea ice motion data for long-term hazard assessment and model validation; iii) assessment of a new satellite-based methodology for assessing ice stability and trafficability; iv) a leadership role in the development of an Arctic MDA testbed.

**Baseline:** Sea ice information for maritime activity relies heavily on satellite data and much of the attention given to hazards posed sea ice has been focused toward thick ice and extreme ice features that can be identified from space [e.g., Barber et al., 2014]. Currently, sea-ice hazards are evaluated based on available remote sensing data and ice charts, both of which have been shown to lack the temporal and spatial resolution to identify and track major sea-ice hazards (such as those listed above) at the tactical and operational level. Here, we consider a broader set of hazards related to sea ice, including those that require observations at higher temporal resolutions than can be achieved by polar orbiting satellites [Eicken et al., 2011; Eicken and Mahoney, 2014].

Past work by the investigators and industry partners has focused on the development of hardware and software solutions to extract relevant information about ice hazards from marine radar and other sensors available to or in use on USCG vessels and in coastal settings [Jones, 2013; MV et al., 2013]. Marine radar is a robust technology that has been a mainstay of navigation for several decades and is capable of providing continuous situational awareness independent of weather or daylight. UAF researchers pioneered the use of coastal radar systems to study ice motion [e.g., Shapiro, 1975; Shapiro and Metzner, 1989] and through numerous iterations of system design have continued to use a coastal radar in Barrow to improve our understanding of the dynamics of landfast sea ice [Mahoney et al., 2007; Druckenmiller et al., 2009; Druckenmiller et al., 2010; Jones, 2013; Mahoney et al., 2015]. Recently, the Finnish Meteorological Institute (FMI) has pursued a parallel line of research using both coastal and ship-based marine radar to track
ice motion and deformation in the context of ice engineering and MDA [Karvonen, 2016]. (FMI has invited project PI Mahoney to visit them later in 2016 to discuss opportunities for sharing data and methods and extended collaboration in the future).

In order to support USCG and other DHS maritime missions, these tools need to integrate into broader situational or maritime domain awareness contexts, connect to stakeholder decision-support frameworks, and tie into ice-ocean models relevant for emergency/spill response.

Relevance to DHS: Based on input from USCG D-17, review of USCG Arctic Information Needs workshop report, and published guidance from USCG RDC, the ice hazards information products and the framework of a North Slope/Barrow ADAC Testbed developed through this project will meet urgent information needs arising from increases in maritime and offshore resource exploration activities.

The proposed work addresses established information needs within the broader emergency and spill response community, including entities such as NOAA’s Office of Response and Restoration (ORR) with a mission to support USCG/DHS with respect to spill response. Moreover, interfacing observing system infrastructure with local and regional first responders directly addresses the needs of DHS’ “Responders of the Future” concept identified as a top challenge for the next decade.

Key Stakeholder Engagement Plan: Project team will participate in the planned ADAC “Customers and Partners” Roundtable, in order to inform and receive feedback on project progress.

Project Champions: HQ USCG-751 (Primary). HQ USCG-255 and USCG RDC (Secondary).

ADAC acknowledges the following as project advocates:
- USCG RDC;
- USCG D-17;
- NOAA/NWS.

Additionally, the project team plans specific, coordinated discussions with the following personnel:
• Planned End user: USCG District 17;
• USCG R & D Center;
• NOAA Office of Response and Restoration;
• National Weather Service Anchorage Ice Desk and NOAA-NWS Regional Scientist’
• Eskimo Walrus Commission: Executive Director President;
• Chair Research & Development, Alaska Clean Seas;
• Finish Meteorological Institute (Head of Marine Research Unit).

Purpose of the Research: The overarching purpose of this research is to develop new science and technology to identify and track sea ice-related hazards and allow this information to be distributed efficiently to emergency responders and planners. To achieve this purpose, our research will address the following questions:

• What ice conditions or events can represent hazards?
• How can we detect and track these ice hazards in an operational situation?
• How can we synthesize ice hazards data streams and communicate the information to stakeholders?

By providing answers to these questions, our research will enhance operational MDA in the Arctic will advancing our scientific understanding of small-scale sea ice dynamics.

In Year 3, our research will continue to address all three questions, though we will focus on questions 2 and 3 by: i) expanding work-to-date to include new radar modalities; and ii) engaging with key stakeholders to develop plans for an MDA testbed in Barrow, Alaska, respectively.

Student Involvement: Project team plans to have half-time support for one graduate student in the planned project year. Student will support Project PI in data analysis and algorithm development in office settings.

Methodology:
1. Ice hazard tracking with marine radar
In March 2014, ice velocity information shown below from a coastal ice radar system operated by UAF in Barrow, Alaska directly aided a successful search and rescue operation to recover personnel and equipment set adrift during a landfast ice detachment event. Our research methodology builds on the hardware and software developed through CIMES, by developing new post-processing steps to enhance the MDA content of the ice velocity data and to improving the usability of the data products. To enhance the MDA content of the data, we will develop new data products such as ice divergence maps, which will be designed to identify regions where the ice cover is breaking apart or converging on itself. We will improve the usability of all data products by releasing them as near-real time (< 1hr) feeds and providing georeferenced USCG/ERMA compatible data products (KML and Shapefiles). For integration into AIFC, all data products will be “regridded” and resampled as necessary to match the model grid.

**Barrow Sea Ice Radar Depiction**

In year 3, we will continue to refine the ice divergence data product, which requires careful treatment of errors and uncertainties in the ice velocity data. We will also apply the processing software developed for the Barrow coastal radar system to other modalities including ship-based marine radar, a
land-based weather radar in Barrow and spaced-based synthetic aperture radar.

The scientific review for this approach is extensive.

2. Detection of small-scale movement of landfast ice
Small-scale motion of landfast ice may be undetectable by conventional remote sensing techniques (including sea ice radar) but can still render ice roads unsafe or cause damage to coastal and sub-sea infrastructure. Small-scale motion may also be a precursor to landfast ice detachment.

In our initial work plan, we planned to use COTS Differential Global Positioning System (DGPS) receivers to evaluate whether they have required precision to detect small-scale deformation events indicative of landfast ice instability and potential threats to infrastructure. Due to insufficient resources, this work did not progress as planned in project years 1 and 2. For year 3, we will instead build on an alternative approach developed under other NSF-funded research activities. This approach uses interferometric synthetic aperture radar (InSAR) to measure cm-scale ice motion associated with cracking and destabilization of sea ice. We will combine this with estimates of surface roughness derived using polarimetric synthetic aperture radar (PolSAR) to produce maps of ice trafficability and identify regions of sea ice that are safest for surface travel, including the landing of aircraft.

3. Synthesizing and communicating sea ice and other Arctic MDA hazards information.

In order to assess the value of hazards-related data products and to test methods for effectively communicating the information they contain, we will develop a framework for an Arctic-specific MDA testbed in Barrow, Alaska. This ADAC testbed will leverage existing community and scientific observing assets to develop a hybrid research-operational framework that addresses major challenges to MDA and effective emergency response in Arctic regions. Our approach will be to first produce a whitepaper that will bring together stakeholders as co-authors to identify key gaps in Arctic MDA and the resources required to close them.
Having prepared a white paper outlining an MDA testbed in Barrow (Eicken et al, 2016), our approach in year 3 will be to start acting on its key recommendations. Specifically, we will start by seeking participation in Arctic-related Incident of National Significance (IONS) workshops and surveying stakeholders to identify needs and assets. We will also develop a plan for a tabletop exercise based around the ADAC testbed to assess and inform design of AIFC infrastructure.

**Schedule and Milestones:**

Note: Milestone 4 for program year 2 (July 2015 to 30 June 2016) will not be completed due to late reprogramming of funds. Program review conducted in February 2016 identified shortfall, and recommended a restructure for the next program year to account for the missed milestone. Accordingly, Milestone 4 has been modified for coming program year to reflect change in focus to satellite based methods for measuring small-scale ice motion. Other milestones have been updated to reflect achievements 1 July 2015 to 30 June 2016 program year.

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Description</th>
<th>Projected achievement date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Development of ice velocity and hazards data products from additional radar-based modalities using algorithms and processing streams developed in years 1 and 2</td>
<td>12/31/2016</td>
</tr>
<tr>
<td>1b</td>
<td>Assessment of MDA relevance for each data product with recommendations for further development</td>
<td>3/31/2017</td>
</tr>
<tr>
<td>2</td>
<td>Integration of ice radar-derived data feeds (ice velocity, divergence and ice edge position) into ADAC data fusion architecture for model validation</td>
<td>6/30/2017</td>
</tr>
<tr>
<td>3</td>
<td>Development of plan for tabletop exercise in Barrow Testbed region to assess and inform design of ADAC data fusion infrastructure</td>
<td>6/30/2017</td>
</tr>
<tr>
<td>4</td>
<td>Development of decision-ready ice stability data products from satellite-based measurements of small-scale sea ice motion</td>
<td>6/30/2017</td>
</tr>
</tbody>
</table>
Metrics:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Development and assessment of new ice hazards data products from additional radar-based sensors. Target: 2 new demonstration products</td>
</tr>
<tr>
<td>2</td>
<td>Degree of overlap between ice hazards data products and model grid cells during validation time periods of interest. Team anticipates an overlap of &lt;25% (with &lt;10 days of overlap in time) after the first version of the grid has been set up and will begin to work towards overlap &gt;75% (with &gt;100 days’ overlap in time; both being constrained by coastal bathymetry and model resolution) after model grid is finalized.</td>
</tr>
<tr>
<td>3</td>
<td>Planning document for ADAC Testbed planning providing implementation steps for key recommendations contained in year 2 whitepaper. Target is implementation plans for 5 out of 9 recommendations developed with input from stakeholders and ADAC partners.</td>
</tr>
</tbody>
</table>

Outcomes/output & Transition Plans:

1. **Radar ice-tracking technology:**
The software and hardware development underlying the ice-hazard tracking capability developed through this work is a primary outcome that will represent one possible answer to research question 2 (How can we detect and track ice hazards in an operational situation?). The full system will be described in peer-reviewed literature and specific lessons learned through deployment of technology on USCGC Healy will be documented and shared with partners at USCG RDC.

2. **Mean velocity fields for model validation:**
A significant outcome of this research is the continuously growing archive of ice velocity data generated by the coastal radar system in Barrow. This represents a key analytical tool for understanding what types of ice event can be hazardous (research question 1), particularly when integrated into the AIFC. The archive also represents a significant body of data for validating the HIOMAS ice-ocean model and for developing tools for USCG and other first responders to draw on in case of emergency or to increase MDA. Tracking the relevant metrics will help ensure that the data pool available for validation of the model is sufficiently large to capture complex ice motion patterns in potential spill response areas. Data will be documented and publically available to the broader research community.
3. **North Slope/Barrow ADAC Testbed:**
The development of an Arctic-specific MDA testbed will leverage existing observing and logistics resources to create a framework for hard/software, sensor and system evaluation and operational testing in a representative Arctic setting that meets needs of USCG and other response organizations. This outcome will help answer research question 3 by identifying high-value data streams and successful strategies for synthesizing them and communicating results to stakeholders. White papers and plans developed in the process will provide a road map for extending the scope to other regions in the U.S. Arctic and beyond.

As research continues, project will seek to appropriately connect with to the developing Arctic Information Fusion Capability to support USCG and other DMS maritime missions to leverage a useful model as an aid to decision support.

**PROJECT: Ice Condition Index (ICECON) for the Great Lakes**

**Project PI’s:** Dr. Tom Ravens and Dr. Andy Mahoney

**Lead Institutions:** University of Alaska Anchorage (UAA) and University of Alaska Fairbanks (UAF)

**Supporting Team:** graduate student (UAA).

**Proposed Collaborators:** US Coast Guard Districts 1, 9, and 17; US Coast Guard R&D Center

**Project Description:**

**Abstract:** In collaboration with the US Coast Guard and others, an ice condition index (ICECON) will be developed for the Great Lakes. The index will be forecasted up to 120 hours into the future making use of circulation and ice models developed by National Ocean and Atmospheric Administration’s (NOAA’s) Great Lakes Environmental Research Laboratory (GLERL). Icebreaker activity and its impact on ICECON will also be accounted for in ICECON nowcasts and forecasts. In parallel with the development of ICECON, ADAC will work to identify and adopt a vessel classification system which will define a number of vessel
classes and the ice-capability of ships in those classes (in terms of ICECON). The system will help the US Coast Guard provide guidance and decision support to vessels (of a given class) which are planning a given transit. The overall Work Plan consists of 6 Tasks. Three of these will be conducted during year three of ADAC starting in July 2016. The development of ICECON for the Great Lakes is intended to be an inclusive and iterative process. Accordingly, there is a need to schedule one or more workshops in which to engage with ice and maritime transportation experts from a range of organizations including (not exclusive): NOAA, the National Ice Center, the US Army Corps of Engineers Cold Regions Lab, the US Coast Guard, Transport Canada, the Canadian Ice Service, the Finish Meteorological Institute, and the University of Alaska.

Baseline: About thirteen years ago, Transport Canada developed the “Arctic Ice Regime Shipping System” (AIRSS, Transport Canada 2003) in order to guide decisions on whether a ship (of a given class) should travel in ice (of a given condition). The system integrates information on Vessel Class (specifically the ice-capacity of ships) and ice condition (referred to as “Ice Regime” by Transport Canada). The suitability of AIRSS as a basis for ICECON was examined in detail by ADAC in a 2015 document entitled: “AIRSS as basis for ICECON.” Briefly, application of AIRSS follows a 4-step process:

Step 1: Define the Ice Regime based on ice conditions (in particular, ice thickness and stage of development).

Step 2: Define Vessel Classes and Ice Multipliers (in which a set of Vessel Classes and a set of class-dependent Ice Multipliers are defined – with positive Ice Multipliers indicating the vessel class is sufficient to handle the ice condition and with negative multipliers indicating that the vessel class was insufficient).

Step 3: Calculate the Ice Numeral (IN, which integrates information about the Ice Regime and the Vessel Class and accounts for concentration of each type of ice in the region of interest as well as the Ice Multiplier for the range of Ice Types for a particular vessel class. A positive Ice Numeral indicates that the ship transit is safe for the ship class in question and considering the ice condition.)
Step 4: Decide whether to proceed or to take an alternative route based on the Ice Numeral (IN).

A close examination of the AIRSS system reveals that the system boils down to a determination of whether the ship in question is rated for the ice present or not. AIRSS fails to take into account ocean/lake surface temperature (which would affect ice hardness and strength) as well as ice pressure (whether ice is diverging or converging). Also, AIRSS does not explicitly include heat transfer calculations which would be useful in an ice-condition forecasting system.

Fortunately, lake surface temperature is currently forecasted by NOAA’s Great Lakes Environmental Research Lab (GLERL). The Finnish Meteorological Institute (a collaborator) currently forecasts ice pressure based on meteorological forecasts so that capability could presumably be transferred to GLERL, as appropriate. Finally, high resolution meteorological and limnologic forecasts for the Great Lakes provide the basis for heat transfer calculations. Hence, for the Great Lakes, data for building a more sophisticated decision support system for ship transit in ice is available.

Both the National Ice Center and the US Coast Guard District 9 have put forward ICECON proposals that merit consideration. Also, Transport Canada is reportedly working on an update to the AIRSS system. These proposals will be reviewed in detail as described in the methodology section below.

Relevance to DHS: The US Coast Guard provides guidance to Great Lakes mariners on the condition of the ice and whether specific ships and ship-classes can transit safely given the ice conditions. In response to the ice conditions and the need for maritime transit, the US Coast Guard manages a fleet of icebreakers. The work described in the plan will provide the US Coast Guard the tools they need to manage vessel traffic in the Great Lakes and their fleet of icebreakers, when ice is present.

Key Stakeholder Engagement Plan: The project team will participate in the planned ADAC “Customers and Partners” Roundtable, in order to inform and receive feedback on project progress. In addition, a critical component of the project is one in-person meeting and follow-up video conference meetings with US Coast Guard officials, Great Lakes Mariners, and ice experts.
The project champion is Headquarters US Coast Guard Office of Waterways Management (CG-WWM). The following are acknowledged as project advocates:

- USCG RDC.
- USCG D-1.
- USCG D-9.
- USCG D-17.

The research developed in this project will be disseminated through various venues including the Alaska Marine Science Symposium. It is expected that the ICECON forecasting tool will eventually be operated by NOAA’s Great Lakes Environmental Research Lab or by the US Coast Guard District 9.

**Purpose of the Research:** The main objective of the proposed research is to develop an ice condition index (ICECON) and a corresponding vessel classification system that will provide the US Coast Guard decision support for the management of winter maritime transit in the Great Lakes. The decision support system will also serve as a maritime transportation management system as it will account for the effect of ice breaker activity on the ice conditions and serve as a tool for managing the deployment of ice breakers.

**Student Involvement:** The project will support a graduate student. He/she will assist with the evaluation of the ice condition indices that have been proposed and with the design of the ice index that ADAC will put forward.

**Methodology:**

The Year 3 ADAC project to develop the ice condition index (ICECON) consists of three tasks, which focus on the development of the ICECON and vessel classification system:

**Task 1. Develop algorithm/decision tree for determining the ICECON as a function of ice type, ice thickness, temperature, pressure and ice concentration.**

At least two ICECON-like proposals have been put forward – one by the National Ice Center and one by US Coast Guard District 9. In addition, Transport Canada is reportedly working on a next
generation AIRSS system. In this task, the ADAC team will evaluate the ICECON or ICECON-like systems that have been put forward. Based on the evaluation of the existing systems, ADAC will either support an existing system or, more likely, propose a new system that (a) addresses the US Coast Guard’s needs for decision support and management to the extent possible, (b) takes maximum advantage of the data that is currently available or will soon be available, and (c) is well-informed by the sciences of thermodynamics and heat transfer.

The ICECON concept originating from District 9 of the US Coast Guard is displayed in Figure 1 (from the District 9 White Paper 2015). Illustration 1 demonstrates, for example, that 2 feet of brash ice presents a range of possible ice conditions depending on the surface temperature and pressure.

![ICECON Decision Tree](image)

*Figure 10 Image of decision tree concept from October 2015 USCG D-9 White Paper on Ice Condition Index.*

The ICECON concept developed by District 9 does include data on surface temperature and pressure. Thus, it does include more environmental data than the AIRSS approach. As we review this approach, we will emphasize a physical understanding of the
relevant mechanical and thermodynamic properties of lake ice. For example, the surface temperature will be used to estimate the compressive strength of ice of a given thickness, which will in turn feed into the calculation of the ice pressure index term. Wind conditions – causing either ice convergence or divergence – will also contribute to the pressure term. Investigation is needed into other parameters not included in Figure 1, such as ice concentration and snow depth. Ice concentration affects the ability of the ice pack to exert pressure on a vessel, while the presence of snow on the ice surface can significantly increase the coefficient of friction between ice and hull. Given the limits of current abilities to observe and model the necessary processes, ADAC investigators do not expect to practically derive absolute physical values for ice pressure. Instead, the Center would further investigate how to derive an index based upon theory and empirical data that can be validated using existing ice encounter data, as described in Task 2.

An alternative approach to developing an ICECON system for the Great Lakes would be to try to build on the Arctic Ice Regime Shipping System (AIRSS) developed by Transport Canada (Transport Canada 2003). According to Darlene Langlois, (Canada’s Chief of the Meteorological Service) Canada produced a chart for the Great Lakes based on AIRSS system, and could add weather factors once those factors are known. A significant amount of effort went into the AIRSS, as such, ADAC recommends that US Coast Guard seriously consider using AIRSS as a starting point. Note, a preliminary assessment of AIRSS and its suitability as a basis of ICECON has been prepared (ADAC 2016).

A third approach to developing an ICECON has been suggested by the National Ice Center (NIC 2015). The National Ice Center employs a point system to account for the contribution of different factors (ice thickness, ice concentration, temperature, etc.) to the severity of the ice conditions. The NIC-based ICECON approach is currently being validated in the Great Lakes.

USCG District 9 provided a spreadsheet to the cutters to collect ice and environmental data, compute the corresponding ICECON, in order to collect ship performance data relative to the ICECON level. The effort to develop an ICECON based on the NIC approach should be considered a short term effort. An ADAC-lead effort on ICECON, as tasked by the Department of Homeland
Security and the US Coast Guard, should be considered longer term work.

In addressing Task 1, ADAC would provide a detailed review of the existing three alternatives, and investigate other approaches. Then, the Center proposes to make recommendations to a council of experts, in order to decide which approach would be most suitable to pursue. Note, evaluation of the approaches will account for the data discussed in the tasks described below (e.g., Great Lakes ship-ice encounter data, ice and environmental data available through the Great Lakes Environmental Research Lab and other sources, etc.).

**Task 2. Identify, adopt, or define a system of vessel types similar to that used in the Arctic Ice Regime Shipping System (AIRSS).**

District 9 Action officer has stated the Great Lakes vessels (the “Laker fleet”) do not have an ice classification system that defines their ice capability. Instead, the USCG District 9 uses several “rules of thumb” to determine ice capability of vessels. For example, one rule of thumb is that vessels need to have a horsepower to length ratio of 6 to 1 in order to transit in ice that is 12 inches thick or more. Accordingly, ADAC plans to develop a system of vessel types, based in part on the existing rules of thumb. The system would be calibrated using ice-encounter data from Great Lakes vessels and/or using ice-encounter data available through the Finnish Meteorological Institute. The system developed will be vetted through the council of experts created to review Task 1.

**Task 3. Use available ice-encounter data from Great Lakes vessels from previous year or two and other data to help develop and validate ICECON. Define the vessel types (classes) in terms of their ability to transit through different types of ice as characterized by ICECON**

District 9 Action officer lead has begun to collect data to validate the NIC-based ICECON and to assess ship performance in ice relative to ICECON. District 9 Action officer has sent a spreadsheet to the cutters to collect ice and environmental data, compute the corresponding ICECON, and collect data on ship performance relative to the ICECON level. In this Task, ADAC would examine the data collected through District 9 Action officer lead’s initiative as well as other available data.
including AIS information and data obtained from Government of Canada and U.S. Coast Guard sources. It is noteworthy that the Finnish Meteorological Institute (FMI) has collected 9 years of AIS ship data from the Baltic Sea that they plan use to validate their ice forecasts and ice charts based on transit times of vessels through different classes of ice. Through collaboration with FMI, we anticipate that their data and findings could help develop and validate ICECON. Task 3 will deliver a validated ice condition index with a demonstrated relationship between ICECON levels and vessel performance.

In Year 4 of ADAC (year 2 of ICECON project), we plan 3 additional tasks, which focus on making the ICECON system operational:

Task 4. Use the GLERL numerical models and ICECON decision tree (Task 1) to provide now-casted and forecasted ICECON.

The Great Lakes Environmental Research Lab (GLERL) uses a computer model to predict ice formation and breakup. This model is used by the NWS to forecast short term (5-7 day) ice concentration, thickness, and velocity. GLERL also produces winter wave forecasts. GLERL is also developing a Great Lakes Ice-Circulation Model (GLIM). This model calculates water velocity and temperature. Ice products for the Great Lakes (provided by NIC) are based on satellite imagery with resolution down to 50 meters. Ice and environmental data forecasts provided by GLERL and NIC will be used to forecast ICECON within ADAC’s Arctic Information Fusion Capability. The ice forecasts provided by GLERL and NIC will be validated by comparing them with ice charts (based on real-time data).

Task 5. Develop algorithms that allow us to use the “now-time” and forecasted data on icebreaker activity to adjust the now-casted and forecasted ICECON distribution, and identify the entity that will enter the icebreaker activity and operate the ICECON decision support tool.

The ICECON nowtime/forecasting system will be programmed to incorporate reduced ICECON values in the path of icebreaking ships. Heat transfer principles will be used to forecast the refreezing of the ice and the consequent change in ICECON in the track broken by icebreakers. The position of ships will be accounted for within the ICECON system using AIS data.
ADAC will engage with NOAA and with the US Coast Guard to determine who is best situated to operate the ICECON nowtime/forecasting system given that icebreaker activity will be accounted for within the ICECON nowtime/forecasting system.

**Task 6. In “beta” test mode and in partnership with District 9, demonstrate the use the ICECON forecasting system to provide decision support to vessels (of a given class) who are considering transit from A to B over a given time period.**

In this task, we will work in partnership with the US Coast Guard to test the ICECON system. It is expected that the system will be operated within ADAC’s Arctic Information Fusion Capability during this testing phase. However, the US Coast Guard will be able to operate the ICECON system from the Great Lakes area.

**Schedule and Milestones in Year 3:**

1. Assessment of two to three contending ice condition index approaches, formulation of a recommended ICECON approach, formulation of a vessel classification approach, and presentation to a council of experts (7/1/16 – 10/30/16).
2. Revisions to the ICECON approach and the vessel classification approach in the aftermath of meeting with the council of experts, and continued dialog with the council via phone calls and teleconferences (11/1/16 – 1/30/17).
3. Determine accuracy of ice forecasts by comparing them with post-forecast ice charts and continued calibration/validation of the ICECON system and the vessel classification system using ice encounter data collected during the 2016/2017 winter (1/30/17 – 4/30/17).
4. Assessment of the proposed ICECON/vessel classification system and reporting (5/1/17-6/30/17).

**Metrics:**

- Accuracy of forecasted ice conditions - thickness, concentration, and type - determined by comparison with post-forecast ice charts. Ice charts depict the distribution of ice thickness, ice concentration, and type using classes. It is expected that 80% of the surface area of the Great Lakes will have reasonably accurate ice thickness and ice concentration calculations (thickness and concentration projections within 1 thickness/concentration
class of the ice chart thickness/concentration class). It is expected that 70% of the forecasted ice type data is in agreement with the ice chart ice type data.

- Consistency of ICECON assessment and ship performance. The goal is to demonstrate higher ICECON levels correspond to increased transit times in at least 80% of cases.

**Outcomes/output & Transition Plans:** In the first year of the ICECON project, ADAC will develop an ICECON / vessel classification system. Key component outcomes of the system include:

(a) An ice condition index (ICECON) based on the environmental parameters currently being forecasted by GLERL (or could readily be forecasted) including: ice thickness, ice concentration, ice type, lake surface temperature and meteorology, and ice pressure.

(b) A practical vessel classification system in terms of ICECON.

(c) A system linking the ice condition index ICECON, the vessel classification system in terms of ICECON, and the projected vessel transit time.

As discussed above, during year 2 of the ICECON project, the focus will be on making the ICECON system operational (see tasks 4-6 in the methodology section).

Following year 2 of ICECON, the ICECON system will be supported by an entity other than ADAC. The entity could be the US Coast Guard District 9 or it could be the NOAA GLERL. Details of the transition plan need to be worked in a collaborative session between USCG RDC, USCG District 9 and other key project stakeholders. If/as ICECON project is approved, these transition details can be worked out in the envisioned fall 2016 council of expert’s workshop.

**Theme 2 - Maritime Technology Research**

**PROJECT: Arctic Information Fusion Capability (AIFC)**

**Project PI:** Dr. Kenrick Mock

**Lead Institutions:** University of Alaska Anchorage
Supporting Team: “AIFC Network”

Axiom Data Sciences: Mr. Rob Bochenek, in association with Alaska Ocean Observation System (AOOS)
ASRC Federal Mission Solutions: Mr. John DeLaurentis, Mr. Eric Velte, Mr. Mark Rowan and Mr. Thomas Mogck
Alaska Marine Exchange: Mr. Ed Page
NOVA Corporation: Mr. Brian Conroy
University of New Mexico: Dr. Rebecca Koskela
University of Texas El Paso: Dr. Craig Tweedie

Proposed Collaborators: NOAA/NWS and NASA ACE

Project Description:

Abstract: Arctic Information Fusion Capability (AIFC) seeks to support operational decision makers in the maritime domain ranging from operational commanders to tactical operators to community-based observers. AIFC strives to gain two dimensional geographic orientation of precision mapping data, near-real-time and high resolution satellite imagery incorporated with available modeling, sensors, web based communications and appropriate social networking feeds to gain domain awareness in support of operational decision making and interface with humans and responders in the field.

Further, AIFC will provide elements of domain awareness from a 3 dimensional “column view to gain insights vertically from seabed to surface and surface skyward. AIFC seeks to achieve a near-real-time and forecast decision support that can transition to intelligent decision support in a follow-on phase. AIFC near-real-time products will be delivered as rapidly as possible following capture and processing of the observation. In general, near-real-time is a qualitative descriptor. In the AIFC context it refers to products delivered between a few seconds up to 30 minutes following capture.

In Phase 1, AIFC will leverage and fuse existing sources, capabilities, and models to provide operational decision support. This includes visualization and mapping of sensor output, marine systems modeling, communications, appropriate social networking feeds, and other information required for Arctic maritime situational awareness. This also includes a
deployable/field capability to support USCG emergency on-scene coordinators and community-based observations. In **Phase 2**, AIFC will transition to provide intelligent decision support and prototype the automatic control of sensors and robotic systems.

**Baseline:** In Year 1 we developed a prototype interface between ADAC systems and the end user. This effort was called the Integrated Intelligent System of Systems (IISOS) at the time. The prototype ingested and visualized data from community-based observers, a high-resolution coastal storm surge model, AIS vessel tracking, a H20 and CO2/CH4 isotope detector, and a variety of environmental feeds (Extra-Tropical Storm Surge model, Global Hybrid Coordinate Ocean Model, NCEP Global Forecast System, NWS NDFD and NAM-12 for Alaska, WaveWatch III, and the AOOS real-time catalog, among others). Demonstration scenarios were developed in support of SAR operations, an interactive oil spill response simulation, and coastal surge forecasting and response for the Yukon-Kuskokwim Delta using Delft3D. These demonstrations in sum, presented an index of existing modeling and data, providing a limited view of potential fusion future opportunities.

In Year 2 we restructured the project as the Arctic Information Fusion Capability, a partnered approach to comprehensively support maritime situational awareness in support of Arctic operators. We established partnerships that presently include Axiom Data Science, Alaska Ocean Observing System (AOOS), University of Texas El Paso (UTEP), NOVA Corporation and Kestrel Technology Group, ASRC Federal Mission Solutions, NOAA’s Arctic Environmental Response Management Application (ERMA®), NASA Arctic Collaborative Environment (NASA ACE), DataONE, and National Weather Service (NWS). These partners bring a diversity of talent and expertise to generate, store, manage, visualize, and analyze data and models related to Arctic situational awareness.

We have established a management structure in order to:

- Leverage NOAA’s Arctic ERMA, which is based on open-source software, and couple it with an array of Arctic data feeds to transition the existing NOAA system from latent environmental analysis to become an agile Arctic-oriented
decision support tool for use by USCG and other high north operators for applications beyond oil spill response;

- Build a working group focused around use of Nova Dine-Kestrel’s FIST (Field Information Support Tool) to enable a user-defined field capability for both USCG on-scene coordinators and community-based observers.

- Leverage additional value from existing data providers such as the Alaska Ocean Observing System, NOAA National Center for Environmental Prediction (NCEP), and academic activities such as University of New Mexico’s DataONE program.

- Contribute value added and fused products back to established interface providers including AOOS, NASA’s Arctic Collaborative Environment, and the National Weather Service; provide similar products for use in model initialization and validation to groups including University of Alaska and NOAA NCEP modelers.

Relevance to DHS: AIFC is a core effort for the Arctic Domain Awareness Center. Leveraging available data, connecting with sensors, platforms and models to provide operator decision support is needed for the Arctic region and is potentially useful to other mission areas. HQ USCG in their Arctic Strategy Implementation Plan (released in December 2015) specifically called out the requirement for an Arctic Fusion Center as an operational requirement and one of 13 articulated initiatives. Accordingly, a major purpose of this project is to deliver capabilities and demonstrations commensurate with available resources and past work, which satisfies the DHS and Coast Guard missions, and realizes the particular USCG requirement for Arctic Fusion.

Key Stakeholder Engagement Plan: The project team will participate in the planned ADAC “Customers and Partners” Roundtable, in order to inform and receive feedback on project progress.

In developing the plan for the upcoming project year ADAC consulted an array of stakeholders and partners, including: Headquarters USCG, USCG District 17, USCG RDC, Rutgers University, DHS Data Analytics Engine, NOAA/NWS, NOAA Office of Response and Restoration, Alaskan Command, Marine Exchange of Alaska, Alaska Ocean and Observation Center, UAF Geophysical
Institute and Institute of Marine Science, and the Community Based Observer Coalition.

These consultations outlined the need for the project team to conduct structured engagement in addition to the planned ADAC Customers and Partners Roundtable. This will ensure appropriate connection and access to developing ADAC models, platforms and sensor outputs, as well as authoritative Arctic-related data.

**Project Champions:** USCG CG-7 is deliberating on formal project champion assignment (primary). Confirmed is USCG RDC (Secondary). Project is authorized per 12 July 2016 communication from HQ DHS S&T OUP Project Manager to ADAC Center leadership to proceed in Year 3 tasks.

We acknowledge the following project advocates:
- U.S. Interagency Arctic Research Policy Committee;
- U.S. Arctic Research Commission;
- NOAA/NWS;
- NASA Arctic Collaborative Environment;
- USCG RDC;
- USCG Pacific Area;
- USCG D-17.

ADAC plans to seek a close consultation with NOAA for this particular project and will continue to investigate partnering opportunities with NASA ACE. NOAA’s Arctic ERMA program provides a great forum to collaborate and orient AIFC to advancing ERMA to the benefit of both USCG and NOAA.

Consequently, the year-by-year development of the AIFC technology, contents, and functions will depend on satisfying the needs the stakeholders, as then reflected in the demonstrations. In addition, ADAC will seek a collaborative effort with HSARPA, Big Data and Analytics, to use HSARPA’s data fusion software on the various sensor data received into the AIFC. This approach will provide new data types for HSARPA to test their systems.

**Purpose of the Research:**
The strategic research question addressed by AIFC is to determine if fusing multiple sensors, models, observations, and data streams can improve decision support in the maritime domain. In order to answer this question requires answering additional research questions:

1. What is the best way for an operator to visualize and interact with specific sets of data or specific models and simulations?
2. What architecture should be used to integrate multiple existing information systems?
3. What ontologies and metadata is needed to facilitate information retrieval?
4. What machine intelligence can be utilized to support human decision making and demonstrated within an “Observe, Orient, Decide and Act” (OODA) loop?

Specifically, as flow of data can be highly constrained in remote and austere locations in the Arctic, the ability to scale and adapt to user-defined needs is an essential element in crafting an AIFC.

Consequently, ADAC will seek to incorporate data fusion expertise from a variety of sources such as DHS Science and Technology Data Analytics Engine, DataONE at University of New Mexico, DHS Data Center of Excellence at Rutgers University, NOVA Corporation (for deployable AIFC research and development collaboration via their existing “FIST” capability) and others through a coordinated research discovery process.

The research discovery process will seek to answer the question in Phase 1, project Year 3: What data available today is of maximum use to DHS operators? AIFC will work with end users, the USCG in particular, to understand which existing data sets and how they are presented is most useful to operators and decision makers. This activity will build through partnership upon existing, extensive operations-supporting work performed by NOAA/NWS and Arctic ERMA.

The AIFC effort is needed to provide an interface to many ADAC research projects and Arctic-related data sources. It will allow researchers and operators to evaluate and make informed decisions. In the project year the research will focus on methods for data visualization, establishing an information
architecture, and also establishing initial requirements for intelligent decision support.

Secondary research questions to investigate include:

- Can AIFC decision support products be synthesized from varied unmanned platform data (i.e., from satellites, unmanned aircraft vehicles (UAVs), unmanned ground vehicles (UGVs), unmanned surface vehicles (USVs), and unmanned underwater vehicles (UUVs) from diverse vendors?
- Can new software code be written, tested, and implemented to integrate the components of the AIFC to support remote data feeds and remote end users?

AIFC in nearer term would seek to capture convergences reflecting either hazards: (e.g., ice movement on vessels underway, oil transit toward especially sensitive habitats, etc.), or opportunity: (e.g., ice movement resulting in stable water or egress for vessels or response forces operationally engaged in search and rescue, humanitarian assistance or disaster response. Specific to this is the need to be able to support decision makers to develop forecasts made from available information to anticipate these negative or positive convergences.

Accordingly, the goal of AIFC Phase 1 is to fuse and visualize information from an array of authorized data sources, coupled with modeling and forecasts, to enable decision support, while also gaining a field capability to enable on-scene coordinator and CBONS-SA participation.

In support of on-scene coordinators and community-based observers, AIFC will investigate and develop the ability to capture local place-based knowledge (LPBK) to feed into situational contexts usable by managers, coordinators, and field operators.

AIFC Phase 2 seeks to advance intelligent decision support and intelligently integrate remote sensors, human intelligence, databases, unmanned autonomous vehicles, and communications devices to improve operational decision support.

An integral part of ADAC research will be to partner with USCG to develop AIFC. In accordance with direction and timelines.
from DHS S&T OUP, ADAC will seek to extend the approach to work with the command centers for other DHS components such as Federal Emergency Management Agency and Customs & Border Protection.

The major objective in the later phase of AIFC is to adapt a remotely controlled architecture for the Arctic Maritime domain in order to serve as the controlling core of the AIFC. To date, such control systems have primarily been used to operate land-based robots. ADAC will use similar design principles but modify them to operate as a maritime information and action architecture.

A stretch goal for the latter phase of AIFC would be to develop the means to control the robotic vehicle subsystems in a multi-level array of unmanned vehicles covering space, air, land and sea. The lessons learned from this program will impact the nation’s safety, economy, and environment, including new technology suitable for the Department of Homeland Security. Accordingly, AIFC Phase 2 is a new application of real-time control systems, and one purpose of the research is to advance the state of the technology for autonomous intelligent machines.

**Student Involvement:** The project team anticipates hiring one undergraduate computer science/computer engineering student as an intern for Axiom Data Sciences. The student will develop computer software to implement models and connect or configure data feeds essential to AIFC. A key part of the student’s effort will be dedicated to data visualization and data interoperability with ontological data cataloging. Student research work is planned in office spaces.

**Methodology:** Conduct integrated partnered research across the AIFC network, in order to investigate agile decision support and to iteratively develop the science of Information Fusion through scheduled operator-developer interactions. Data science architecture development will be conducted to fuse data from multiple sources employing the expertise of multiple partners. Software engineering and technical data management research will be conducted that enables data, visualization, model and simulation transfer from dispersed locations to fuse into a decision support architecture and establish user-defined operational information and visual requirements.
In partnership with CBON-SA project team and FIST, conduct research to enable transfer of user-submitted field reports and tailored fused information to remote/austere Arctic locations. Intent of capability is to provide authoritative data, visual information, remote sensor inputs, (all on a near-real-time basis) along with enhanced/precision models, to inform of weather, environmental factors, conditions near and on scene to effect and equip USCG decision makers.

AIFC will enable new research capabilities and new decision-making capabilities in support of Arctic situational awareness in both maritime and terrestrial arenas. AIFC breaks apart research silos. Data sets and models that were once disparate or unavailable to the end user will now be readily accessible, both in the field and in the command center, and will be comparable through a uniform interface. This capability exists today only in a limited form.

Data fusion consists of the integration of knowledge and data into a more useful representation that fosters a greater understanding of the scenario. In the geospatial domain we unify attributes of data sources based on space and time. Some data, such as text messages, social media, images, or video, may be more effectively fused on non-geospatial dimensions.

When fused data streams reference the same observable, such as that made by a community observer vs. a camera or satellite image of the same area, we must address issues that arise with multi-sensor data fusion. For example, we must consider the fidelity of one source vs. another, spurious or conflicting data, data alignment, and data association. We will consider existing data fusion methodologies such as probabilistic fusion or soft + hard (physical and human input) fusion and utilize a hybrid approach that best matches our data streams.

We will utilize common research methodologies in data visualization. This includes prototyping with an emphasis on usability via quantitative (e.g. time to conduct tasks by humans, correctness) and qualitative measurement (e.g. evaluation by human testers). Tufte’s principles of visualization state that the design of a visualization system should focus on showing the data (not the visualization.
technique), support comparing data vs. describing data, have integrity of numerical quantities, support high resolution on demand, and utilize intuitive classic designs. Our design will apply this methodology to visualize the Arctic maritime domain.

The primary operational data and product display interface for AIFC in Year 3 is to leverage Arctic ERMA’s existing capabilities. This approach has several significant advantages: ERMA was tested by USCG during the Deepwater Horizon oil spill. It is built on open standards protocols and uses many of the same open source tools that will be implemented by AIFC.

Similarly, University of New Mexico’s DataONE will provide Arctic data cataloging capabilities, research visualizations, and the ability to experiment with new data sets. A feedback loop will be established between DHS end users and AIFC data providers and fusion product creators. A formal evaluation methodology will be developed and performed to quantitatively and qualitatively document the effectiveness of products and syntheses being delivered.

Management protocols and tasks:

For the upcoming project year, ADAC will establish a “Network” approach in managing AIFC. In order to manage the Network, the ADAC Executive Team seeks to conduct regularly-scheduled meetings, leverage technology such as E-Chat Rooms to facilitate collaboration as a more efficient approach than email communications, and establish a task list among the Co-Principal Investigators, and associated teams that provide support.

Accordingly, AIFC development will be built through an “open architecture” enterprise, using open standards data-serving protocols and high quality metadata. AIFC seeks to connect and incorporate increasing numbers of data and information streams. This approach, when coupled with aforementioned visualization capabilities, provides user-defined operational information needed to aid in decision support.

In the earlier phase of development AIFC needs to have the ability to support and gain from field level inputs, in order to establish connections between command echelons and on-scene coordinators in humanitarian assistance, disaster response and
search & rescue. AIFC needs to be able to develop a proof of principle to connect existing capabilities that provide latent and near real-time input with models/forecasts developed by ADAC and other enterprises that contribute to Arctic Domain Awareness.

Through a structured management approach, AIFC will operate the AIFC network to develop and implement AIFC design architecture. UAA lead investigation and guide research while ASRC Federal Mission Solutions, will provide overall project management. UAA will develop high-resolution coastal models with partners including NOAA/NWS, while ASRC Federal Mission Solutions will seek appropriate connections for satellite imagery and geospatial data. NOVA/Kestrel will implement the ingestion process for CBONS data into their FIST platform. UTEP is driving a Barrow testbed for coastal monitoring while DataONE will focus on data storage and cataloging. Axiom is our primary developer for the end-user interface and will work closely with NOAA to leverage and advance Arctic ERMA as an appropriate data base (and one that is currently leveraged by USCG D-17 for environmental decision support). Additional data feeds and modeling comes from AOOS, and NASA-ACE.

Note that AIFC is not an interface or a destination per se. AIFC is a collection of activities, systems, and standards focused on the complicated process of data transformation that allows ADAC’s operational users to visualize and make tactical decisions informed by Arctic research products such as sea ice and storm surge modeling, community-based observations, sensor and camera feeds, and operational products such as near real-time satellite imagery, trajectory models, and ice/weather forecasts. In Phase 1, AIFC seeks to accomplish research and development that advances Arctic ERMA to a more agile decision support tool, avoiding duplication of effort and leveraging a system already in use by USCG maritime operators. ADAC has established working level agreement with NOAA’s Arctic ERMA developers to contribute to ERMA’s open source architecture to accomplish this goal.

**Stakeholder considerations:** Our client-focused technical teams are building and coordinating complex data transformations, syntheses and services. To that end, our stakeholders will benefit from additional research products and services from ASRC Federal Mission Solutions, FIST and Axiom / AOOS that the AIFC
team has made viewable into an interactive approach leveraging and advancing NOAA’s Arctic ERMA, to effectively create an advanced or “Super ERMA” protocol and platform focused to USCG decision-making support.

Project Lead Dr. Kenrick Mock, University of Alaska Anchorage and Project Management lead by ASRC Federal Mission Solutions, will develop and present a work plan and task list to ADAC Executive Leadership that details planned work by Existing AIFC collaborative members. This work-plan will need to also detail planned work by AIFC member, NOVA Corporation who are planned to participate in creating a field deployable aspect in support of user defined operational needs for AIFC.

**Partnering considerations:** The AIFC deployable aspect needs to enable the Community-Based Observer Network for Situational Awareness (CBONS-SA). CBONS-SA is ADAC’s applied research approach to provide people input for AIFC where technology/sensors are lagging or lacking. Accordingly, PI and program manager will appropriately consult with CBONS-SA Principal Investigator/Project lead to ensure appropriate usefulness of field capability aspects of AIFC to allow connectivity for community based observers.

The State of Alaska’s Emergency Management team and Rescue Coordination Centers have Alaskan legislated responsibilities in mission areas that are coincidental to mission areas conducted by US Coast Guard. As such, appropriate collaboration with these responsible agencies is useful and potentially invaluable. Local partners such as the Alaska Marine Exchange and Alaska Ocean Observation System are vital to incorporate into planning and development.

Federal partners, in particular, National Oceanic and Atmospheric Administration (NOAA), National Weather Service and potentially National Aeronautics and Space Administration (NASA), are critical to the effort and offer the potential to greatly aid useful decision support to the US Coast Guard. NOAA’s Arctic ERMA program provide capabilities that are used by USCG. Partnering with NOAA and potentially NASA in developing AIFC that builds on existing capabilities as opposed to creating new capabilities is a useful approach to gain as much as possible for the USCG and serve the public good.
AIFC is intended to serve as applied research that can ultimately provide the U.S. Coast Guard a decision support capability in humanitarian assistance, disaster response, search & rescue, and other mission areas designated by US Coast Guard. It is important that AIFC comply with all Federal, State, and Tribal regulations, policies and sensitivities as appropriate. As AIFC gains potential for international collaboration, incorporating those additional aspects will also be necessary. Important to note is AIFC is information, not intelligence fusion.

Regularly scheduled meetings are needed to ensure collaboration and understanding within the establishing network of AIFC. Accordingly, ADAC Executive Team will plan to chair weekly updates that are led by the Co-PIs.

A bi-weekly AIFC Network meeting is expected to at a minimum:

- Present progress to date;
- Describe fiscal standing;
- Address customer input from USCG District 17, USCG RDC and community-based observers as appropriate.

These meetings will be conducted via the established ADAC meeting protocols. Utilizing Chat Room capabilities are important to ensure uniform understanding of ADAC approach.

New partners will be added to the network and these partners will need to have designated roles in how they can contribute to the network and enterprise.

AIFC represents an opportunity to connect many streams of data and information in the Arctic region to create useful decision support for US Coast Guard. Only by establishing and managing a coherent network of collaboration, can such a complex undertaking realize the potential. Accordingly, ADAC Executive Leadership will seek to enable the Project Leader and the network of collaborators in order to provide the US Coast Guard the kind of capabilities that will be useful to transition from proof of principal to on-line capability.
End to End considerations: From initial architecture design to a fielded capability for the USCG, AIFC will be conducted through regular developer-user interactions with USCG, NOAA and other partners who align to the project. AIFC will be assessed comprehensively at ADAC’s quarterly review. AIFC will plan to be iteratively reviewed and assessed at USCG Arctic Shield exercises, with the first nominal review conducted during Arctic Chinook in August 2016.

USCG District 17 is the envisioned principal operational user for AIFC. ADAC seeks to provide the District an initial AIFC proof of concept soon following the onset of the new program year. The AIFC management team will routinely consult with USCG RDC and will assure the transfer of a mature capability. Accordingly, close collaboration with both USCG District 17 and USCG RDC is critical to project success. Gaining insights from industry partners such as ASRC Federal Mission Solutions with proven experience in transitioning research to fielded capability will be sought through the AIFC Management construct.

Schedule and Milestones:

MS1. Provide a two dimensional web map presentation of geospatial data, near real-time and high-resolution satellite imagery; incorporate available modeling, sensors, web-based communications and appropriate social networking feeds; enable domain awareness in support of operational decision making and interface with humans and responders in the field. [March 30, 2017]

MS2. Identify elements of domain awareness from seabed to surface and surface skyward. [January 30, 2017]

MS3. Provide near real-time and forecast decision support that can transition to intelligent decision support in Phase 2. [June 30, 2017]

MS4. Through partnerships, and use of commercial off-the-shelf (COTS) products, AIFC will connect with existing capabilities to avoid duplication and wasted effort. [March 30, 2017]

MS5. Design and implementation of the AIFC and its code within the scope of the demonstration scenario. [May 30, 2017]

MS6. Successful completion of the scenario demonstrations [May 30, 2017]

MS7. Document AIFC (e.g., a user's manual). [June 30, 2017]
**Metric**: A series of agile development sprint cycles will be scoped and scheduled early in Year 3 and plans communicated to sponsors.

**Metrics**: The AIFC is core to ADAC’s ability to support Arctic Domain Awareness, and will leverage all other ADAC sponsored endeavors to the practical extent.

Developing AIFC through the two phase approach responsively addresses USCG District 17 for operational fused decision support, and establishes a partner network to needed to create a Phase 1 capability at minimum cost, while setting a foundation for Phase 2 intelligent decision and real time control of sensor platforms in support of USCG Arctic missions.

Specifically:

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Measure</th>
<th>Related Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.1</td>
<td>AIFC products in Arctic ERMA are designed to meet Coast Guard needs</td>
<td>Memorandum from Coast Guard indicating that AIFC products in Arctic ERMA have been planned to meet their requirements.</td>
<td>MS 1,2,3,5,6</td>
</tr>
<tr>
<td>P.2</td>
<td>List of domain awareness elements from seabed to surface and surface skyward captured in consultation with Coast Guard.</td>
<td>Memorandum from Coast Guard indicating that AIFC products in Arctic ERMA have been planned to meet their requirements.</td>
<td>MS 2</td>
</tr>
<tr>
<td>P.3</td>
<td>AIFC populated with supplemental data feeds relevant to Arctic Domain Awareness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P.3.a</td>
<td>Interface developed for community-based observers to access data and submit observations.</td>
<td>Presence in interface.</td>
<td>MS 1,3,4</td>
</tr>
<tr>
<td>P.3.b</td>
<td>Coastal inundation model data feed available via Arctic ERMA</td>
<td>Presence in interface.</td>
<td>MS 1,3</td>
</tr>
<tr>
<td>P.3.c</td>
<td>Oil spill simulation model available via Arctic ERMA</td>
<td>Presence in interface.</td>
<td>MS 1,3</td>
</tr>
</tbody>
</table>
P.3.d | Near real-time¹ weather satellite imagery available in Arctic ERMA | Presence in interface. | MS 1,3
---|---|---|---
P.4 | AIFC demonstration performed that fuses multiple data sources | One drill or table top exercise will be identified during Year 3 and AIFC used and feedback gathered during exercise. | MS 1,3,5,6

### Dissemination and Collaboration Plans:

The “network” approach to managing AIFC requires frequent work and communication with our partners, including USCG, NOAA, NWS, and others. This results in frequent dissemination of progress with stakeholders. AIFC is being constructed in a way to deliver operational capabilities through existing platforms such as Arctic ERMA although underlying models and feeds into AIFC may require their own transition plans. We will share our academic work through appropriate conferences, workshops, and journals. We are collaborating with HSARPA’s big data fusion efforts and UNM’s DataONE project along with other Arctic fusion platforms such as AOOS and Arctic ERMA. We are building on the strengths of these partners already working in the Arctic information fusion space rather than develop in isolation.

---

¹ Near real-time products are delivered as rapidly as possible following capture and processing of the observation. Near-real-time is a qualitative descriptor, but generally refers to products delivered between a few seconds up to 30 minutes following capture.
Outcomes/output & Transition Plans:

Overall outcome: Proof of concept system capable of fusing multiple data sources (CBONS, outputs from environmental models, incident simulations, camera and satellite imagery, socio-cultural and biological data) and providing visualizations to end users in the field or in a center.

The outputs for Phase 1 and 2 will be successful demonstrations. The first benchmark of success is to visualize the identified data feeds in the Arctic ERMA system. The second benchmark of success is defined by the end user, who tests the products during demonstrations. AIFC products are successful if they prove to be an improvement upon the end user’s previous visuals and data products in the metrics of:

- Current data;
- Updated on timely basis;
- Geospatially accurate;
- Provides operational user with previously inaccessible Arctic research & modelling;
• Correctly fuses multiple data products;
• Improves situational awareness.

Through an agile development methodology, ADAC seeks to develop a fusion of data for near real-time visualization that will enable relevant input from people “on-scene,” such as USCG and FEMA on-scene coordinators and community-based observers. The incorporation of models into AIFC that are being developed in other ADAC projects (such as storm surge precision forecast, isotope predictions of sea ice formation, oil plume in/near sea ice and sea-ice movement modeling) can support additional future decision-making capabilities. Further AIFC Phase 1 development can support DHS initiatives to increase resilience in at-risk locations by providing an open /unclassified capability to allow communities in potential peril to act in advance of gathering threats.

Baseline and Target TRL’s for Phase 1 are shown in Illustration 11.

<table>
<thead>
<tr>
<th>Component</th>
<th>Baseline</th>
<th>Target TRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>High Alt.</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Low Alt.</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>UGV</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>USV</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>UUV</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>CBON</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Sensor</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Comm.</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>AI</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>AIFC</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Figure 12 AIFC Planned TRLs
**Transition Plans:** Through the user feedback gathering process, the most impactful products will be identified and be placed into transition planning. Transition steps include:

- Assessing reliability and robustness of source data feeds and fusion product production and distribution.
- Identifying operational entities (such as NOAA) who are capable of fielding operationally reliable data and product feeds.
- Developing partnered approaches with operational entities to document and support relevant Federal security standards and operations procedures.
- Transitioning academic and other research grade feeds to the operational entity.
- Based upon previous experiences, this process is demanding and time consuming--a year or more is typically required to plan, document, and implement transitions.
- The transition to operations will be a multiphase process with a feedback loop in continuous operation with USCG District 17 and USCG RDC for assessment and design of the transition of products into operations in service to USCG Arctic operations.

AIFC has a phased transition plan that takes current iteration of AIFC to a future state integrated with Super Arctic ERMA. This transition plan has the following benchmarks:

- In Year 3, AIFC feeds into Arctic ERMA will be operational.
- In Year 3, a select group of AIFC feeds will be successfully displayed in the to-be-built Super Arctic ERMA.
- In Year 4, all AIFC feeds will be successfully displayed in the “to-be-built” Super Arctic ERMA.
- By end of Year 5, if approved for adoption, the AIFC products could establish security and IT procedures for future ingest into a USCG center deployment.

Transition plans for Phase 2 of AIFC will be determined with the development of the Year 4 work plan.

With this transition plan in mind, AIFC PI and technical team are planning and organizing to ensure compliance of the AIFC products to federal enterprise architecture (FEA).
PROJECT: Low Cost Wireless Remote Sensors for Arctic Monitoring and Lifecycle Assessment

Project PI: Dr. Martin Cenek

Lead Institution: University of Alaska Anchorage, with support project addition provided by industry partner, ASRC Federal Solutions.

Supporting Team: Dr. Aaron Dotson (UAA), and Mr. Eric Velte, Kevin Wainwright (ASRC FS Co-PIs), Mark Rowan (ASRC FS), Christopher Bartley (ASRC FS), and one UAA on-site research assistant.

Proposed Collaborator: ASRC Federal Solutions.

Project Description:

Abstract: The project goal is to develop low-cost wireless sensors for use in remote monitoring, asset management, surveillance, and security, particularly in Arctic and marine environments. We categorize a sensor’s functionality into three areas: detection of an input event, computation of the detected event, and communication of the data. We develop an inexpensive, self-organizing network of devices that can reliably compute and communicate detected events. The computing device for each sensor node is the moteinoRF4 RFM69W. An integrated RFM69 transceiver enables wireless ISM band communications. A software simulator and hardware proof-of-concept consisting of a 7x7 array of nodes has been constructed. Our initial target application is to utilize acoustic and electromagnetic signal detectors to classify human vs. animal traffic in a remote area.

The concurrent phase of the project includes the evaluation of the lifecycle cost (LOC) for the deployed sensor array. The LOC framework will be applied to the monitoring of the US-Canada border for intrusions deployment scenario. Assessment will employ common techniques in life cycle assessment with focus on geospatial array structure associated with terrain and climate as well as overall power requirements, proximity to urban areas and the end-of-life considerations.

ASRC Federal Mission Solutions (AFMS) will identify, from the
mission perspective, the systems involved in the Command and Control and Situational Awareness missions for multiple DHS projects, including USCG and Customs and Border Patrol. Using its experience as the USCG’s National Security Cutter C2/S2 system developer, AFMS will develop an integration strategy that will incorporate data from these sensors into tactical mission components for use by multiple echelons.

The team will initially use its open system architecture (OSA)-based C4 system for prototype component development and initial sensor integration and fusion. After initial integration of sensor data from both simulated and fielded sensors, the AFMS team will fuse the data into a tactical track picture and situational awareness display in order to prove the usefulness of the low-cost remote sensor approach for C2 and SA. The team will develop a set of decision aids to support events detected by the sensor network, including new contacts, lost contacts, indeterminate contact information requiring human-in-the-loop interpretation, as well as network readiness information.

**Baseline:** Low power MoteineoR4 computational module with RFM69W radio antennae and/or Wi-Fi transceiver. The module's detector is Electret Microphone Amplifier - MAX9814 with Auto Gain Control, TTL Serial JPEG Camera, or the readout from the embedded radio antennae. The hardware test bed is arranged on 7x7 regular grid with a custom topology of components' interconnectivity. The deployment and testing will use 3x40 module grid. The readout nodes will be positioned on each edge of the array (4 readout nodes minimum).

The team will integrate low cost wireless sensor data into its command and control framework and present the data to the mission operations community for situational awareness and decision-making purposes. Data will be fused with other components of the system, including:

- Command and Control data - track / contact data, mission planning system, non-real-time networked C2 information
- Situational awareness data: operator decision aids, tactical overlays, cartographic data, and geo-referenced imagery
The integration and fusion will be performed using a custom version of the Mission Solutions Arctic Iri C4 system and support Arctic Information Fusion Capability (AIFC).

**Relevance to DHS:** Border intrusion monitoring, ice breakup monitoring and prediction, event driven intelligence from remote in accessible regions. Fused display of sensor data provided by a single integrated C2/SA view on a user-defined operating picture (UDOP). Capability that can be utilized via C2 Segment 2 systems onboard the USCG National Security Cutter platform and other open systems architecture based applications. Sensor integration for enhanced SAR and USCG statutory missions, such as fisheries protection and environmental monitoring.

The network's decentralized, distributed, asynchronous, locally connected design makes the architecture expendable, robust and redundant. The applied research from this project can potentially support DHS border protection missions as well as HA or DR mission needs in austere Arctic environments.

**Key Stakeholder Engagement Plan:** Project team will participate in the planned ADAC “Customers and Partners” Roundtable, in order to inform and receive feedback on project progress.

**Project Champions:** HQ USCG-751 (Primary), HQ USCG-255 (Secondary).

Additionally, ADAC will seek the following project advocates:

- USCG Pacific Area;
- USCG RDC;
- USCG D-17.

Further US Customs and Border Patrol is potentially a project advocate and potential user of the applied research.

**Purpose of the Research:** The research objective is to develop a non-aggregative sensor network architecture for robust detection of environmental or security breach events in the sub-Arctic region or in other remote regions of interest without reliable source of communication and power infrastructure. The research purpose is to provide a developed sensor capability that can contribute to Humanitarian Assistance and Disaster Response for
the sub-Arctic regions. The applications might include border protection and monitoring, port-security or ice break-up. The goals include detection and processing of signals on each device and conversion of multiple spatial-temporally Robust detection of environmental or adjacent signals into an actionable event that is propagated to the readout nodes.

The potential Disaster Detection and Response in the Arctic region lack reliable communications and power infrastructure to support traditional sensors. Through integrating a set of ad hoc sensors that can self-configure as part of a larger network, DHS could potentially benefit improved situational awareness tactical capability edge that promotes information gathering and eliminates expensive operations and maintenance costs associated with manned sensors of similar capability.

**Student Involvement:**

Graduate research assistant Civil Engineering: develop sensor lifecycle cost framework and apply the framework to the US-Canadian border protection scenario.

One undergraduate research assistant Computer Science and Engineering student will implement and test acoustic signature generation to detect ambient events of interest for the sensor activation.

A second undergraduate research assistant Computer Science and Engineering student will implement and test the sensor peer-to-peer communication protocol.

A third undergraduate research assistant Computer Science and Engineering student will implement and test the decentralized spatial processing of sensor activations to generate a reportable event or drop sensor activations as ambient noise.

ASRC Federal Solutions is offering student interns as part of their involvement in the project. This offer will be further investigated and reported to DHS PM within the coming project year.

All student research will be in laboratory and outdoors locations, but not in austere/remote settings.
Methodology:

**ASRC Federal Mission Solutions:** AFMS will define a set of tactical system interfaces for sensor data provided by the network, and perform sensor array integration into the Arctic “Iri C2/SA” system using sensor smart agent components. These components will be able to determine event feedback from the sensor area and code it in terms that support real-time decision-making and long-term storage.

As part of integration, the system will place the spatially non-explicit events detected by the sensor networks into a geographic coordinate system with Geo-referenced integration protocols.

When the events are detected by the sensor network, the team will fuse them with real-time tactical track picture using simulated real-time USCG C2/S2 format track information.

The team will also optimize the proof-of-concept operating system code deployed on each sensor by performing code compression and “codelet” integration.

**University of Alaska Anchorage:** Project team will investigate sensor network neighbor discovery protocol design and implementation via in-simulator and hardware testbed signal-to-even in-place computation and conversion. Each sensor will be activated from microphone input by comparing the real-time signal with the databased of acoustic signatures. The acoustic signature is generated using discrete Fast Fourier Transforms, power density spectrum and mean selection of the pre-recorded samples of acoustic signals. The real-time microphone input will be processed by the same signal processing stream. A sensor will be activated to send a signal to its neighbors if the cosine similarity between the acoustic signature stored in the database and the real-time microphone signal exceed imperatively established threshold.

The decentralized spatial computation architecture of
Sensor activation into reportable event will be implemented using Hebbian rule inspired Spike-Timing-Dependent Plasticity. The reportable event is propagated to the readout nodes using altered Dijkstra's shortest path algorithm. The neuro-physiology approach converts received peer-to-peer sensor activations into reportable event for the temporally misalignment sensor activation signals and for the accumulation of local sensor activations.

The LCA study will encompass two components: (1) the creation of a GIS model to calculate the ideal spacing of each subarray sensor based off of ecosystem type and topological conditions and (2) the creation of an LCA decision protocol, that contains a life cycle inventory (LCI) in conjunction with the LCA evaluation, that will utilize an extensive database of materials and methods to quantify the costs associated with each sub-array. The LCA will be implemented using ISO 14040 and 14044 with four components: (1) goal and scope, (2) inventory, (3) impact assessment, and (4) improvement assessment.

The sensor network neighbor discovery protocol design and implementation via in-simulator and hardware testbed signal-to-even in-place computation and conversion. This applied research includes device and detector system integration (to also include operating system software layer). Further research includes:

- Testing the robustness of the spatial computation;
- Field deployment and testing: signal-to-every computation, event triangulation from readout nodes;
- Signal's acoustic or antennae signal signature generation and signature classification;
- Application and evaluation of the lifecycle assessment cost framework on the border intrusion detection deployment scenario.

Schedule and Milestones: Risk to conclude project goals for the coming year is rated low. Both project teams hope to complete the following in upcoming project year:
• Identify interfaces for low-cost sensor hardware and software;

• Build input model for sensor data;

• Develop operator-approved visual displays for sensor data and information;

• Develop doctrine-based automation for sensor data qualification and operator alerting;

• Identify sensor and C2 system response for data detection and analysis;

• Field deployment test of the sensor array architecture;

• Initial network triangulation testing;

• Event validation using remote imaging;

• Database design, event and location logging;

• Signal-to-even acoustic and antennae signature generation and validation;

• Device and detector integration; and

• Application and evaluation of the lifecycle assessment cost framework on the US-Canada border intrusion detection deployment scenario.

**Metrics:** Both project teams have the following metrics that will be utilized:

• Geo-referencing within 10-meter margin of error in Cartesian coordinate system, or <= 5% deviation in range/bearing coordinate system;

• Data processing times within operational timeline for singularity events such as new contact detection;

• 110% signal detection in the deployed sensor array;

• 80% signal-to-even detection and propagation in the sensor array;
array;

- Signal, event and validation communication and logging into a database;

- Cosine similarity between the database of recorded acoustic signatures and the real-time acoustic input of 80%+;

- 90%+ event triangulation accuracy from the readout nodes in the deployed sensor array;

- 90%+ signal-to-event conversion accuracy.

Outcomes/output & Transition Plans:

Product 1: Smart agent for low-cost sensor data ingestion and processing.

Product 2: Decision aids in support of integrated and fused low-cost sensor data.

Product 3: Concept of operations for geo-referenced integration and fusion in support of operational capability for USCG systems.

Product 4: Low cost, power-aware, off-the-shelf components with intelligent system design and emergent event detection in non-spatial, decentralized, sensor networks.

Product 5: Design, implement, test and demonstrate 7x7 hardware testbed.

Product 6: Design, implement, test and demonstrate reconfigurable sensor network software simulator.

Product 7: Develop, apply and evaluate the device lifecycle assessment cost.

PROJECT: Development of Propeller Driven Long Range Autonomous Underwater Vehicle (LRAUV) for Under-Ice Mapping of Oil Spills and Environmental Hazards
**Project PI:** Dr. James Bellingham (WHOI PI), Amy Kukulya (WHOI)

**Lead Institution:** Woods Hole Institution

**Supporting Team:** Dr. Chris Reddy (WHOI), Dr. Mike Jakuba (WHOI)

**Proposed Collaborator:** USCG Research and Development Center (USCG RDC)

**Project Description:**

**Abstract:** The increasing level of commercial marine activity in high latitudes creates an ever growing risk of oil spills. Even in logistically accessible, ice-clear oceans, characterizing the extent and nature of a spill can be difficult as the Deepwater Horizon incident highlighted. We propose to develop an AUV-based approach leveraging a small, long-range system developed by the PI, called the Tethys Long-Range AUV (LRAUV). The LRAUV is helicopter-portable, allowing rapid response to incidents to provide situational awareness for first responders.

Outcomes of this project will be construction of a small long-range AUV (LRAUV) equipped with oil sensors and navigation systems, demonstration of the LRAUV survey capability, and creation of a simulator for gaming AUV deployments for oil spills. The resulting capability to survey oil spills at high latitudes and under ice answers an unmet need for DHS and the USCG.

**Baseline:** There is no baseline capability for under-ice oil-spill survey. Currently, the vast majority of remote sensing techniques developed for oil detection in ice-covered waters have focused on airborne or “on-ice” systems. All these techniques rely on the ability to effectively “see” through the ice and snow cover to detect oil trapped beneath the ice. While some of these methods have been moderately successful in detecting oil in ice covered seas, sensors mounted on autonomous underwater vehicles (AUVs) hold the potential to overcome constraints encountered with airborne or surface based methods, such as the need to sense through the ice and snow, and the logistical challenges in varying ice conditions.
AUVs have been operated under-ice and have mapped oil spills in ice-free oceans. However, oil-spill response in an ice-covered ocean remains technically extremely demanding, and has yet to be demonstrated. The unique demands of such operations in the Arctic require a minimal logistical footprint, a small operational team, ability to operate in currents that might exceed a knot, and a combination of autonomy and navigation sufficient to allow operations up to many days under ice. Deployments in excess of a week are a highly attractive goal. For example, the two AUVs used to respond to the Deep Horizon oil spill, Sentry and Dorado, weigh over 1000kg and nearly 700kg, respectively, and both systems operated less than 24 hrs.

The Tethys Long-Range AUV, described below, is the only vehicle with the combination of multi-week endurance, speeds of up to two knots, and small size (120 kg) to satisfy the requirements. Tethys has not, however, been operated under ice, nor has it been used to characterize oil spills. The work planned in this project is to leverage the existing Tethys system to create a rapidly deployable under ice oil survey device, capable of unattended operations for periods of a day to a week. The base platform is the Tethys Long-Range AUV.

The Tethys was created specifically to carry biological and chemical payloads for long distances and times. The vehicles are small, about 30 cm (12 inches) in diameter, and easy to handle (Illustration 10). Deployments range from a few days to over three weeks, and are unattended by ships. The longest range mission to date was over 1800 km at a speed of 1 meter/second (m/s). In that deployment from and to Moss Landing, California, the vehicle operated as far as 500km from shore independent of a ship. Ranges two to three times as great can be achieved by operating at a speed of 0.5 m/s with minimal sensors.

Endurance can be maximized by using the buoyancy engine, which is a shifting internal weight, to trim to neutral buoyancy and drift at zero speed with minimal sensors. The vehicle is typically shore-launched and recovered, using a small boat to tow the vehicle between the harbor entrance and a boat launch ramp. It can also be transported by helicopter to remote areas.
Tethys occupies the design space intermediate between gliders and the current generation of propeller-driven AUVs. While existing gliders such as the Teledyne Webb Slocum, the Scripps Spray, and Kongsberg Seaglider have sufficient operational range to achieve the desired range goals needed by USCG, they do not have the payload capacity or power to carry the chemical and biological sensors, nor can existing gliders operate at higher speeds without redesign. Typical gliders operate at speeds of about 0.3 m/s and with minimal power consumption: a 1W average payload is characteristic.

In contrast, existing propeller-driven AUVs such as those manufactured by Hydroid, Bluefin, OceanServer, and Teledyne Gavia are designed for larger, more power-hungry payloads. As a consequence, their endurance is much reduced - commercial propeller-driven systems operate 24 hours or less at 1.5 m/s, providing ranges of less than 130 km. Consequently, Tethys is uniquely capable in its combination of payload capacity, range, and endurance for remote under-ice oil detection.

Mission-level control of Tethys is achieved using an architecture called 'state-configured layered-control'. This is
an improved variant of the layered control architecture developed by Bellingham (1991) and implemented on vehicles ranging from Webb gliders to the Dorado AUVs. State-configured layered control supports autonomous adaptive operations for long periods. Its building blocks are ‘behaviors’ which are control laws that can be combined to accomplish tasks, which in turn can be conditionally connected to achieve more complex missions or respond to contingencies. Reliability is enhanced as the vehicle software is able to detect faults in critical components and respond appropriately. In some cases, Tethys can be configured to continue a mission even though a component has failed. For example, vertical plane control is redundant: if the elevator actuator fails, the vehicle can continue the mission controlling depth by shifting internal weight.

Operators interact with the vehicle via an Iridium satellite link, recovering data snippets in near real-time and sending new mission commands to the vehicle as desired. Communications with the vehicle are possible when it surfaces, at intervals that are determined by the operator. Over several years of operation, a web-based operator’s portal has been developed (http://aosn.mbari.org/TethysDash/) which includes a display of science and engineering data (http://aosn.mbari.org/TethysDash/data/daphne/realtime/sbdlogs/2012/201211/20121127T053258/). On a secure portion of the site, there is a command interface and a variety of utilities such as an alert page, where operators can configure alerts to be sent to email or mobile phones on certain conditions.

Relevance to DHS: When an oil spill occurs in US coastal waters, the US Coast Guard is expected to manage the response. The ability to manage the response hinges on early information of the nature and magnitude of the spill. Unfortunately, methods for characterizing spills in ice-covered oceans are lacking. The relevance of this project is that it develops and demonstrates logistically manageable methods for under ice oil-spill characterization.

Although routine AUV operations in ice are possible, opportunities to further develop sensor capabilities as well as launch and recovery capabilities, mission strategies (simulator) and navigation in complex ice environments must be taken. The LRAUV vehicle is a proven AUV platform that can solve many of the challenges outlined above for the USCG.
**Key Stakeholder Engagement Plan:** Project team will participate in the planned ADAC "**Customers and Partners** Roundtable, in order to inform and receive feedback on project progress.

**Project Champions:** HQ USCG-MER (Primary). HQ USCH-255 and USCG District 9 (Secondary).

ADAC acknowledges the following organizational project advocates:

- USCG RDC;
- USCG D-17;
- NOAA/NWS;

The following lists the specific program advocates and key stakeholders for this project:

- Key Customer is USCG CG-7;
- Oil-spill response group, Exxon Mobil, held discussion on future Arctic spills and sensors at a meeting and via email/phone;
- Shell Oil corporation corporate leadership are advocates, and seek to improve future responses to oil spills in the Arctic;
- American Petroleum Institute, discussed oil spill response “tool boxes” at their Washington DC headquarters;
- US EPA’s representative in the influential Interagency Coordinating Committee on Oil Pollution Research (ICCOPR);
- NOAA designated lead in oil spill response;
- US Coast Guard Academy, USCG RDC and USCG D-17;

The upcoming fall 2016 demo is designed to engage our key stakeholders (chiefly HQ USCG CG-7). The demo will methodically test and showcase open water AUV capabilities. Lessons learned will drive the further development of the LRAUV. An additional goal of the demo is to coordinate its timing with an industrial oil science and technology meeting being held in October 2016 at WHOI. We are hosting the upcoming ITAC meeting and plan to attend the International Oil Spill Conference in May 2017.
**Purpose of the Research:** The research seeks to address key questions such as: In the Arctic, how do you control the source of an oil spill if you cannot find it? How and where do you place your assets without the necessary and timely intelligence?

Our objective is to develop an Autonomous Underwater Vehicle (AUV) based capability to observe and sample dynamic processes in the Ocean in order to characterize oil spills and other environmental hazards under ice. Creating a baseline of data for Arctic Ocean communities can systematically be carried out with the LRAUV.

Currently, an autonomous underwater vehicle capable of under-ice oil detection that is portable and has long-range endurance and variable speed capability is not available. Our objective is to provide high-value, relevant, and timely observations of dissolved hydrocarbons and oil drops to oil-spill responders using the LRAUV.

Not only is there a void in the available technology for under ice baseline surveys that require minimal resources for launch and recovery, but there is also a lack of a platform with multiple capabilities for navigational accuracy and data transfer.

Accordingly, research aims to improve on this by exploring multiple modes of navigation in order to mitigate complex environmental conditions and changing scenarios. We will use several levels of navigation for the AUV.

First, a GPS system built into the Tethys antenna will routinely obtain GPS fixes when the vehicle surfaces. Second, the vehicle will dead-reckon using a Doppler sonar to measure velocity relative to the bottom, and a compass for heading. Third, an ultrashort baseline (USBL) acoustic system will measure range and direction to a transponder and allow acoustically marking interesting sites for revisit by the vehicle.

Furthermore, due to the small size of our vehicle as outlined above, we can operate minimally in regards to personnel needed for launch and recovery (L&R) as well as being highly portable for L&R from a small boat, helicopter or LRAUV can even be launched from shore.

In the coming program year, project team will focus on three principle objectives toward this goal:
1. Begin fabrication of a Long-Range Tethys AUV working closely with Monterey Bay Aquarium Research Institute (MBARI) which has built 5 vehicles to date; the vehicle will be developed to the extent that funding is available to complete in Year 3, however completion of the vehicle is expected in early Year 4.

2. Further refine software simulator and sensor package with input from response/enforcement agencies and stakeholders, as well as models generated from ADAC.

3. Plan and host an AUV demo designed to educate the latest in Woods Hole portable AUV operations with fluorescence detection, long range data communications, mission planning and launch and recovery capability.

Student Involvement: No Student Involvement at this time.

Methodology: Our approach to developing the AUV under-ice oil-spill survey capability involves identifying the appropriate sensors, integrating that sensor on a long-range AUV, and demonstrating the resulting survey capability. Technical challenges that must be mastered as elements of this effort include the ability to navigate under ice, and the optimization of surveys especially in high current environments.

Observation requirements for the AUV system include
- Ability to map in 3D;
- Detection and quantification of dissolved particles;
- Determine the environment (is it hypoxic?);
- Take CTD measurements.

The development of an oil-spill survey simulator in year 2 was a key stepping stone for the ADAC project. This simulator uses currents obtained from coastal models to simulate the advection of oil, and allows testing of different survey strategies. Ultimately it should provide operators the ability to game different deployment strategies.

Demonstrations are essential components of the project as they simultaneously test the developed systems and provide a forum for engaging USCG stakeholders. The Fall 2016 demonstration will focus on demonstrating core platform capabilities in local (non-Artic) waters with an off-the-shelf AUV. Following this demonstration, starting in spring 2017, an LRAUV will be built. In subsequent years of the program the system will be
incrementally demonstrated for high-latitude under-ice operations.

ADAC’s WHOI project team is also seeking alternate funding opportunities as well as possible project collaboration through the program MOSAIC.

**Schedule and Milestones: (ML=Milestone)**

(ML1) The overall activity spans from identify and test oil detection sensors for under-ice characterization of oil spills appropriate for small, long-range AUV. (June 30, 2015)

(ML2) Completion of augmented AUV simulator and test scenarios addressing high-risk elements, including navigation and sensing systems, demonstrating capabilities in Alaskan waters. (June 30, 2016)

(ML3) Carry out a demonstration of AUV mapping of an oil plume in local waters. (TBD fall 2016)

(ML4) Completed building/acquisition and delivery of a Tethys AUV with high-latitude navigation and oil sensors. (June 30, 2018)

(ML5) Collect navigation performance data at high latitudes

(ML6) Process the data and tune navigation algorithms from the testing mission.

(ML7) Plan and perform adaptive mapping of oil surrogate (low latitudes).

(ML8) Plan and prepare for observation mission in the Bering Sea.

(ML9) Perform the planned observation high-latitude mission.

Year 3 adjusted and additional activities will be to:

(ML3-1): Purchase a sensor package; integrate into a REMUS AUV system and develop software capability for near real time data transfer and adaptive mission sampling. (September 30, 2016)

(ML3-2): Run an AUV Demo in local waters (Woods Hole, MA) demonstrating environmental plume mapping, real time data transfer and visualization and adaptive mission sampling. (October 30, 2016)

(ML4-1): Begin fabrication of the LRAUV, 25-35% of vehicle estimated to be complete in Year 3. (June 30, 2017)

**Metrics:**
Performance of the overall system should be determined via the following metrics:

- **Simulator fidelity for development, mission testing, and operator training**
  - Vehicle hydrodynamics: are submarine equations of motion used? Target: 20% root mean square (rms) error.
  - Operator interaction: is the interface with the simulated vehicle the same as for the actual vehicle? Target: simulated vehicle vs actual vehicle interface is 100% identical.
  - Environmental parameters: what environmental parameters are modeled? Target: 100% of navigational sensors are modeled.

- **Navigation performance**
  - Drift rate: percentage of distance traveled. Target: < 0.5%.
  - Error bounding: can navigation drift be constrained, e.g. by ranging from a fixed beacon.

- **Performance-specific measures**
  - Detection level of oil: measured in terms of minimum sensitivity Target: < 80 ppb.
  - Range and endurance: Target: 300 km on secondary batteries, twice that on primary.
  - Adaptive sampling performance - mapping of spill extent: Target: Area coverage 1000 km2 per vehicle deployment.

- **Operator ease of use**
  - Logistical footprint: number of operators required on site, number of kilograms to be transported. Target: 2-3 and < 600 kg.
  - Ease of mission configuration: time to specify grid survey: Target: < 1 hr.
  - Ease of remote interaction: training time required for operators: Training: < 1 week.

**Outcomes/output & Transition Plans:**
1. Oil detected sensor package will be integrated into a REMUS-100 AUV for a fall 2016 demonstration. Software and visualization capabilities will be further developed with the intent of getting data from the vehicle to the decision maker as fast as possible.

2. WHOI will organize and execute a 1-2-day long demonstration in Woods Hole designated research waters in order to demonstrate environmental sensing, navigation and communication capabilities to USCG stakeholders.

3. Begin building of Tethys LRAUV.

Stakeholders will be invited to the fall demo 2016 for open water testing of front detection and anomaly mapping. Upon completion of the LRAUV vehicle in 2018 an under-ice demonstration will be planned to train USCG District 17, RDC and any additional partners.

ADAC WHOI system is intended to be used by USCG personnel in readiness and in execution of disaster operations. WHOI team members have extensive experience training EOD officers as well as 12 other International Navies in the use of the commercially available REMUS platform. This provides an example of our target transition capability.

**Theme 3 – Production Transition Strategy**

Research to Capability Process. “Research to capability process” included in ADAC Review Group as previously presented in the report.

**Theme 4 – Integrated Education Outreach (and Workforce Development)**

**PROJECT: Arctic Education Implementing the Arctic Strategy in Training**

**Project PIs:** Ms. Susan Hazlett, Ralph Pundt, CAPT, USCG (Technical PI)

**Lead Institution:** Maine Maritime Academy

**Supporting Team:** N/A

**Proposed Collaborator:** Potentially USCG Academy
Project Description:

Abstract: This project includes three courses developed and submitted over three years. Years one and two have involved the construction of the Basic Ice Navigation course, which is complete and is currently being offered as a face-to-face class at Maine Maritime Academy. The course has been submitted to the Coast Guard for approval for Standards of Training, Certification, and Watchkeeping (STCW) certification.

The Advanced Ice Navigation course had been pushed into upcoming program year because of the expanded scope of the basic class. It is in the development phase and we are currently working on building bridge simulations that will be a requirement for the course. In addition, the symposium that was planned for Year 2 will not be held in Year 3.

Baseline: Program year concluding on 30 June 2016 goals will complete as scheduled. Upcoming program year will start with the submission of the basic ice navigation class for certification already completed. MMA plan for advanced ice navigation modules, including bridge simulation models needed to complete the advanced ice navigation course upcoming program year with little to no risk of project delays.

The advanced class is a continuation of the basic class, and builds on the knowledge gained in that course. Since the responsibility level is much higher for the officers taking the advanced class and since some time may elapse between taking the two classes due to the requirement for sea time in polar waters, there is also some necessary review involved. Overall, however, the depth into which this class goes and the knowledge required is at a much higher level.

The symposium that was planned for the program year concluding on 30 June 2016 has been moved into program year starting on 1 July 2016. The original symposium was to have been an Arctic marine awareness seminar but with the announcement of the Arctic Council meeting in Portland, Maine in October 2016, there is now a plethora of such meetings taking place around that time frame.

Rather than becoming another symposium competing for attention prior to the Council meeting, MMA decided to change focus to the one thing the academy does well, which is ice navigation. The seminar will focus on bringing together the world’s foremost ice navigation experts to discuss modern ice navigation, the Polar Code, IMO model courses, and will be of interest not only to ice
navigators and pilots but to government officials working in the polar regions as well as industries that are working in or looking to expand to polar regions such as tourism, shipping, and oil and gas exploration.

**Relevance to DHS:** USCG has the responsibility of ensuring U.S. port compliance with the directives of the International Marine Organization (IMO). This includes ensuring that mariners operating in polar waters have the proper training and certifications. The basic and advanced ice navigation courses satisfy these requirements for U.S. mariners. Upon completion of these courses, American ship’s officers will have met or exceeded all Standards for Training, Certification, and Watchkeeping (STCW) required by international maritime law.

**Key Stakeholder Engagement Plan:** Project team will participate in the planned ADAC “Customers and Partners” Roundtable, in order to inform and receive feedback on project progress. Project team will also participate in Quarterly reviews presented to DHS S&T OUP Education Outreach and Workforce Development program managers.

**Project Champions:** HQ USCG-751 (Primary), USCG RDC (Secondary).

Project advocates include:
- USCG RDC;
- USCG D-17.

Stakeholders engaged will include representatives of USCG (RDC and D-17), and representatives from the Chilean and Canadian coast guards and the IMO as MMA develops the international courses. Further stakeholders include numerous mariners with an interest in the Arctic and Arctic navigation including the mariners who will be able to be certified for ice navigation starting in late 2016.

**Purpose of the Research:** Develop and complete the advanced ice navigation course required by the Polar Code for all masters and chief mates operating in polar waters.
Student Involvement: Students at Maine Maritime Academy are currently being offered the opportunity to take/pilot the beginning ice navigation course during the spring semester of 2016. A number of MMA students will on to co-op with companies operating in Alaska, including the Aleutian Islands and Bering Strait. Other students will get jobs in tourism taking passengers to visit glaciers through ice-laden waters (one of MMA’s current faculty previously held such a position).

Additionally, capable and interested students are assisting with the development and piloting of the ice simulations for the advanced class. In upcoming program year, MMA expects the beginning ice navigation class will become available to students and mariners throughout the country so they can be certified for ice navigation. Finally, the ice navigation seminar will involve a number of students in both the organization and implementation phase, leading to a number of networking
opportunities for both co-op and internships as well as future employment.

Methodology:

The basic and advanced courses will be completed in two formats, a 40-hour classroom-based course and a blended course in which students take part of the class online and then travel to a certified USCG exam center to complete the simulation section and take the final exam. These courses will become the official USCG courses required to achieve a certificate that will put mariners in compliance with the requirements of the new Polar Code (see Illustration 11).

Development and submission of advanced ice navigation courses and cooperation with Canada and Chile, if required, on developing an international ice navigation course sequence for the IMO.

Additionally, organize and implement an international ice navigation symposium of high interest to mariners, students, government, and industry. Risk to conclude project goals for the coming year is very low.

Schedule and Milestones:
1. Submission and acceptance advanced ice navigation courses by USCG (Spring 2017);
2. Ice navigation symposium to be held at Maine Maritime Academy (May 2017);
3. Participation in the development and implementation of the IMO international ice navigation courses (TBD).

Metrics:
- Acceptance of both basic and advanced ice navigation courses by USCG for STCW certification;
- Good attendance and possible proceedings or white papers from the ice navigation seminar
- Successful participation in the development and implementation of the IMO international ice navigation courses.

Outcomes/output & Transition Plans:

MMA will develop two courses for ice navigation, participate in development of international ice navigation courses and hold ice navigation symposium. MMA will conduct incremental growth in
program year as USCG has requested that an advanced ice
navigation course be added and submitted in two formats.

At the request of HQ USCG, MMA will investigate potential
opportunities with Chile and Canada to develop international ice
navigation courseware that is anticipated to become the
worldwide standard for compliance with the new Polar Code.
Lastly, within the upcoming program year, MMA will host an ice
navigation symposium with details to be provided in follow-up
communications with leading experts from the field as well as
USCG and industry representatives. In coordination with ADAC
Center leadership, and Center’s “research to capability
process,” MMA will appropriately prepare to transition concluded
courseware to USCG recipients.

**PROJECT: Minority Serving Institution (MSI) and Significant
Minority Enrollment (SME)**

**Project PI:** Proposed ADAC Education and Workforce Development
Director (TBA)

**Lead Institution:** University of Alaska Anchorage

**Supporting Team:**

**MSI Institutions:**
- University of New Mexico (Hispanic)
- University of Texas El Paso (Hispanic)

**SME Institutions:**
- Texas A&M (Hispanic)
- University of Alaska Anchorage (Native American Indian)
- University of Alaska Fairbanks (Native American Indian)
- University of New Mexico (Native American Indian)

**Industry Partners:**
- ASRC Federal (Tribally owned)
- NOVA Corporation (Tribally owned)

**Proposed Collaborator:** N/A

**Workforce Development Recruitment Efforts and Research Work:** The
focus of this project is to establish a Summer Internship geared
at recruiting for under-represented classifications. The
specifications in expectations for the project are included in...
Project Description:

Abstract: For the coming program year, ADAC seeks to re-establish center initiative in recruiting student summer interns from under-represented classifications through collaborative partnerships with designated MSI and SME institutions. Further, ADAC seeks to leverage partnerships with established industry partners in order to place classifications of under-represented students on meaningful work to advance ADAC research. ADAC will develop and recruit these categories of students to place into Summer Internships that commence immediately following the completion of Spring Semester in 2017.

Additionally, in order to provide more opportunity, ADAC Center leadership will seek to connect these students, once recruited, into the ADAC Fellow Program to advance mentoring and professional development as previously described, to include gaining these students into DHS Career Development Grant Scholarships (as described under CDG Scholarship project).

Baseline: As part of the ADAC student focus presented under the ADAC Fellows Program, ADAC seeks to recruit student summer interns from under-represented classifications. Recruitment will be accomplished as a specific outreach in conjunction with the Fall 2016 Student Research Symposium. Following the Fall Student Research Symposium, (depending on recruitment success), ADAC will assess via the ADAC Review Group if a Spring Semester recruitment program is needed in order to gain a sufficient number of interns to participate in the following summer research season.

These undergraduate and graduate student summer research interns will be provided opportunities for to travel to either the University of Alaska System or an ADAC Industry partners for a ten-week long summer intensive science and engineering internship. These internships will focus on providing students workforce development opportunities in operational capacities that will directly benefit the Department of Homeland Security and its components.

Relevance to DHS: Professionally developing students from under-represented classifications conforms to DHS diversity goals.
**Key Stakeholder Engagement Plan:** Students from under-represented classifications as well as part of the overall ADAC Fellows program will be invited to participate in the planned ADAC “Customers and Partners” Roundtable, as a mentoring and professional development opportunity.

Further, ADAC Center leadership via both the roundtable and the ADAC Review Group will seek to connect with further CDG scholar development opportunities. Finally, ADAC will conduct appropriate dialog with other DHS COE’s in particular, Stevens Institute of Technology in further refining our program. ADAC will present quarterly reviews of the Center’s efforts in Education Outreach and Workforce Development to DHS S&T OUP Education Outreach and Workforce Development program management.

**Purpose of the Research:** Recruiting students from under-represented classifications into ADAC Fellows program and in particular, place into meaningful summer research internships.

**Student Involvement:** Program is 100% focused on students from under-represented classifications.

**Methodology:** Students from under-represented classifications and the overall ADAC Fellows program are a planned particular focus for ADAC leadership.

Accordingly, students from under-represented classifications who focus in science, technology, engineering and mathematics (STEM) fields are most likely the candidates who have interest in connecting with many of the projects the Center is pursuing.

ADAC seeks to recruit and connect with students from under-represented classifications. Consequently, recruitment efforts at Minority Serving Institutions such as University of Texas El Paso and University of New Mexico provide ADAC an opportunity to gain these students into important science research and development projects at the Center. University of Alaska’s Alaska Native Science and Engineering (ANSEP) program provides another venue to recruit students who may have particular interest in advancing work ADAC is conducting for the Arctic operator.

ADAC Students from under-represented classifications will comply with DHS Approved Safety Plan as coordinated with the University of Alaska Anchorage procedures. These DHS approved safety procedures will be applied to all ADAC sponsored academic,
government and industry institutions and be applied in both field and laboratory conditions.

Coach and mentoring of students from under-represented classifications and other ADAC Fellows as described in Education and Workforce Development will be purposely conducted to orient these students to careers in government service across the DHS enterprise as well as science and technology industry.

As much as practical, (and in addition to the specific summer intern focus), part of the professional coach and mentoring will include leadership and management as complimentary aspects apart from STEM courses of study.

University of Alaska plans to support the administration of CDG Scholars and the overall ADAC Fellows program via institutional support resourcing.

Schedule and Milestones: For the program year starting on 1 July 2016 ADAC’s approach is planned as following:

1. ADAC will recruit, assign mentors and student research work and outline expectations and opportunities for students from under-represented classifications.
2. Recruited students will be provided opportunity bi-monthly ADAC Fellows coaching and mentoring sessions via webinar, co-hosted by ADAC Executive Director and Education Outreach and Workforce Development Director.
3. Recruited students will be provided opportunity to participate as available in bi-monthly ADAC Customers and Partners meetings as a way to gain further insights to professional networks.
4. Students from under-represented classifications will be expected to participate in a ten-week summer internship with in academic or industry hosted research.

Metrics: Measures of meaningful performance for program success is principally gained from:

- Recruitment at Fall Outreach to Students from under-represented classifications at ADAC Student Research Symposium.
- Assessed Performance of students from under-represented classifications students in summer research programs.
• Students from under-represented categories who subsequently compete and earn CDG Scholarships.
• Successful entry of students in this category into DHS enterprise careers and/or meaningful science and technology industry careers.

**Outcomes/output & Transition Plans:** Coached, mentored and professionally developed students from under-represented classifications enter DHS enterprise workforce. Transition plans will continue past lifecycle of grant for tracking and job initiatives.

**Project:** Integrated Arctic Maritime Education (Principally oriented via Summer Research Interns)

**Project PI:** Dr. Orson Smith

**Lead Institution:** University of Alaska Anchorage

**Supporting Team:** N/A

**Proposed Collaborator:** N/A

**Project Description:** Master’s in Arctic Engineering degree program at the University of Alaska Anchorage and online course available to public. Courses support maritime workforce development.

**Project Completion:** Project concluded. ADAC will monitor courseware use for life of grant in support of tracking and workforce development initiatives.

**PROJECT:** DHS Career Development Grant (CDG) program

**Project PI:** ADAC Education Outreach and Workforce Development Director, Ms. Clarice Conley, UAA.

**Lead Institution:** University of Alaska Anchorage administers resources and project; open student competition provided they meet DHS criteria.

**Supporting Team:** ADAC Industry Partners
Proposed Collaborator: DHS Marine Security Center of Excellence, Stevens Institute of Technology

Project Description:

Abstract: An important goal of the Center is to foster the next generation of scientists and engineers devoted to the discovery, development and improvement of technologies and applications for Arctic Maritime Domain Awareness, Response, and Resilience. As originally presented by ADAC and approved by DHS S&T OUP, the Center proposes to award four scholarships annually for full time support for both undergraduate and graduate students who will contribute to an essential role for the center’s mission.

Accordingly, with this coming year’s program, ADAC seeks to attract the highest caliber undergraduate and graduate students that are contributing towards ADAC sponsored science and engineering programs. ADAC seeks CDG scholars to be the vanguard of the ADAC Fellows program, which will also include ADAC student researchers/interns in addition to CDG Scholars.

The Center intends to mentor and develop CDG students to be capable of competing for future opportunities in DHS and/or DHS enterprise careers. Center leadership will put a particular focus in connecting CDG students in applied areas of science and technology. Center leadership will also seek to provide CDG students opportunities to connect with research sponsored by DHS and/or USCG.

Consequently, Center leadership will seek to award CDG scholarships to qualified students who are seeking degrees from across academic disciplines related to: Advanced Data Analysis and Visualization, Communications and Interoperability, Community, Commerce, and Infrastructure Resilience, Emergency Preparedness and Response, Maritime and Port Security, Natural Disasters and Related Geophysical Studies, and Decision Sciences.

As described in Education Outreach and Workforce Development, ADAC will mentor CDG Scholars as part of the overall ADAC Fellows program over the course of the planned program year for student enrichment. In particular, events such as the planned Annual ADAC Student Research Symposium, summer interns and research needed in association with Incidents of National Significance Workshops, provide useful opportunities to incentivize CDG productiveness.
Relevance to DHS: As previously presented, CDG scholarships provide resources for education and mentorship (via the ADAC Fellows Program) for undergraduate and graduate students which enables to their successful and timely completion of academic degree useful in DHS S&T areas of concentration. Student research conducted by CDG scholars can meaningfully advance projects within the ADAC portfolio to the benefit of DHS, USCG and other DHS maritime missions.

Key Stakeholder Engagement Plan: CDG Scholars as well as ADAC Fellows will be invited to participate in the planned ADAC “Customers and Partners” Roundtable, as a mentoring and professional development opportunity. Further, ADAC Center leadership via both the roundtable and the ADAC Review Group will seek to connect with further CDG scholar development opportunities. Finally, as ADAC’s CDG scholarship program is relatively new, (less than 6 months in execution at the start of the project year starting on 1 July 2016) ADAC will conduct appropriate dialog with other DHS COE’s in particular, Stevens Institute of Technology in further refining the program.

CDG scholarship program progress will be included in ADAC’s quarterly reviews of the Center’s efforts in Education Outreach and Workforce Development with DHS S&T OUP Education Outreach and Workforce Development program management.

Objectives: DHS Career Development Grant scholars program is planned to provide fiscal resources, substantial mentoring and professional development for openly recruited, qualified students in science, technology, engineering and mathematics disciplines in order to gain useful preparation for careers of substance across the DHS enterprise.

Methodology: CDG Scholars and the overall ADAC Fellows program are a planned particular focus for ADAC leadership.

Accordingly, students who focus in science, technology, engineering and mathematics (STEM) fields are most likely the candidates who have interest in connecting with many of the projects the Center is pursuing.

As described in the Education Outreach and Workforce Development, ADAC seeks to recruit and connect with students from a minority background. Accordingly, recruitment efforts at Minority Serving Institutions such as University of Texas El Paso and University of New Mexico provide ADAC an opportunity to

Arctic Domain Awareness Center Workplan 1 July 2016–30 June 2017
gain minority students into important science research and development projects at the Center. University of Alaska’s Alaska Native Science and Engineering (ANSEP) program provides another venue to recruit CDG scholars who may have particular interest in advancing work ADAC is conducting for the Arctic operator.

CDG Scholars are intentionally planned to be integrally involved in as many projects as practically possible as well as other center tasks such as Arctic related IONS workshops and White Paper development calls/cycles.

CDG Scholars research interests and strengths will be reviewed by the ADAC Education Outreach and Workforce Development Director who will seek to match CDG Scholar strengths with a suitable research professor and center project.

Accordingly, the ADAC Fellows program seeks to invest CDG Scholars as well as ADAC research interns to advance and present their ADAC related/supported research at the planned ADAC Student Research Symposium, Annual ADAC Partners meeting, and research needed in association with Incidents of National Significance Workshops. CDG Scholars will be expected to participate in summer research in support of ADAC projects.

As much as practical, (in order to gain perspective and professionally network), CDG Scholars will be purposely interned with both academic and industry opportunities.

ADAC CDG Scholars will comply with DHS Approved Safety as coordinated with the University of Alaska Anchorage procedures. These DHS approved safety procedures will be applied to all ADAC sponsored academic, government and industry institutions and be applied in both field and laboratory conditions.

Coach and mentoring of ADAC CDG Scholars and other ADAC Fellows as described in Education and Workforce Development will be intentionally conducted to orient these students to careers in government service across the DHS enterprise as well as science and technology industry.

Part of the professional coach and mentoring will include leadership and management as complimentary aspects apart from STEM courses of study. Annual performance review of CDG Scholars and mentors and mentoring program will be conducted prior to the conclusion of the program year. ADAC will appropriately host an awards event at the close of the academic year. Finally, as
discussed, CDG Scholars will be purposely tracked until successfully connected to placement into a DHS careers following graduation.

University of Alaska plans to support the administration of CDG Scholars and the overall ADAC Fellows program via institutional support resourcing.

**Schedule and Milestones:** For the program year starting on 1 July 2016 ADAC’s approach for CDG Scholars is planned as following:

1. ADAC will recruit, assign mentors and student research work and outline expectations and opportunities for CDG Scholars.
2. Scholars will conduct tailored research work during the academic year with schedules as mutually determined by CDG Scholar and Project PI, with appropriate Center leadership overview (normally conducted by the Education Outreach and Workforce Development Director).
3. As previously approved by DHS S&T OUP, CDG Scholars will be expected to participate in a ten-week summer internship with in academic or industry hosted research.
4. CDG Scholars will join planned bi-monthly ADAC Customers and Partners Roundtable in order to gain insights to operator driven research requirements.
5. CDG Scholars will be provided bi-monthly coaching and mentoring sessions via webinar, co-hosted by ADAC Executive Director and Education Outreach and Workforce Development Director.
6. Anchorage-based based CDG Scholars will be expected to present at the annual fall ADAC Student Research Symposium (hosted at University of Alaska Anchorage). ADAC will seek to enable non-Anchorage-based CDG Scholars to present at the symposium and enable their participation via 2-way video conferencing such as Skype.
7. CDG Scholars will conclude the academic year with performance review conducted by assigned mentor, with review conducted by ADAC Education Outreach and Workforce Development Director and join year-end ADAC awards event via Videoconference/webinar.
**Metrics:** Measures of meaningful performance for CDG Scholars program success is principally gained from annual performance review of CDG scholar’s work from assigned mentor. Additional quantitative measures more describe Center’s leadership and management of the Scholars program. Further described as follows:

- Understanding of CDG Scholar fill rates vs unfilled with quality qualified students awarded the scholarship.
- Review of CDG Scholars assigned vs available for assignment to Project PIs for student research during the academic year.
- Number of CDG Scholars assigned vs available for student summer research.
- Number of CDG Scholars assigned vs available for ADAC Student Research Symposium.
- Compilation of assessments for CDG Scholar performance via annual review.
- Aggregation of CDG Scholars graduates accredited to DHS enterprise careers vs graduates who are unable to gain employment in DHS enterprise.

**Outcomes/output & Transition Plans:** Coached, mentored and professionally developed CDG Scholars enter DHS enterprise workforce. Transition plans will continue past lifecycle of grant for tracking and job initiatives.

**PROJECT: Arctic-related Incidents of National Significance (IoNS) and Arctic Medium and Long Term Environment (MaLTE) Workshops**

**Project PI:** ADAC Executive Director Randy Kee

**Lead Institution:** University of Alaska Anchorage

**Partnered team:** USCG District 17 and USCG Research and Development Center, others per individual workshop planning

**Student research work:** ADAC Fellows for preparation and administrative support.

**Project Description:**
Abstract: As previously presented by ADAC and approved by DHS SA&T OUP, the Center will initiate plans for one Arctic-related Incidents of National Significance (IONS) workshop (to be executed in the following program year). ADAC will plan and conduct one Arctic focused Medium and Long Term Environment (MaLTE) workshop to understand and address the medium and long term research needs specific to the Arctic environment. The MaLTE workshop is planned to be accomplished late in Program Year 3.

These Arctic-focused workshops exercise a similar methodology and plan to be conducted in close coordination with DHS S&T OUP, Headquarters USCG, USCG District 17 and USCG RDC. ADAC proposes these workshops pursue research which improve situational awareness, science and technology that support USCG to be better prepared to respond. The principal outcome of these workshops are reports that can instigate onward research and development.

ADAC will plan the Arctic-related IONS workshop with select expert Arctic skilled operator and researchers from both Canada and the United States, based on scenarios and defined operator problems formulated by USCG and Canadian operational counterparts.

Similarly, ADAC will plan and conduct the Arctic-focused MaLTE workshop with well-qualified Arctic researchers from Canada and the United States, based on topics defined by DHS S&T, HQ USCG, USCG RDC and Canadian counterparts.
**Arctic-related Incidents of National Significance (IONS) & Arctic-Focused Medium and Long Term Environment (MaLTE) Workshops**

**Partnerships:**
- IoNS: Canada and US Operators and researchers
- MaLTE: Canada and US researchers

**Goal:** To advance deep thinking and to tackle tough problems with academic rigor

**Workshop format:** Joint Canada-US collaborative forum hosted by University of Alaska

**Context:**
- IoNS: Operator driven research by USCG Arctic mariners to provide research and development ready solutions
- MaLTE: Addressing Science and Technology in future scenarios 10-20 years distant

---

**Figure 15 Arctic-related IoNS and Arctic-Focused MaLTE Workshops**

**Baseline:** During an IONS event, it is normal to assume that an Incident Command System (ICS) based response organization (similar to that set up during the Deepwater Horizon Response) will be activated.

For example, in a major Arctic maritime incident, it is likely USCG will again being called upon to initiate an Inter-Agency Technology Assessment Program (IATAP)-type effort, in order to assist the Federal On-Scene Coordinator (FOSC) with the systematic assessment of technology-based support solutions proposed by/offered from the general public (often including academia).

During a national incident, often technology solutions are offered by the general public (including academia) to the incident commanders to assist in the response. ADAC believes such an approach, while ultimately assisting in a successful outcome, often generates ad hoc solutions suboptimal to capabilities developed by well-planned and researched processes.

The proposed workshops for the upcoming year will pull lessons learned from the Arctic-related IONS workshop planned in program
year ending on 30 June 2016. The Year 3 IONS workshop will identify research and development gaps and research questions aimed at closing the gaps with relevant research to support the USCG mission before an actual Arctic IONS occurs.

In order to complement operator-driven research, the MaLTE workshop will look towards the 10-20-year time horizon to investigate potential mission needs based on projected technology gaps driven by the anticipated Arctic operational environment. Using a “Futures Operating Environment” construct ADAC will consult with designated DHS, USCG and Canadian counterpart leadership to arrange workshops that solicit projected environmental trends to create scenarios for selected workshop researchers. Designed scenarios will map existing and known projected science and technology operator capabilities to determine gaps and shortfalls, and provide questions for research. Following Arctic-focused MaLTE, ADAC will present detailed questions to DHS and seek to investigate solutions.

**Relevance to DHS:** Arctic-related IoNS and Arctic-focused MaLTE workshops provides USCG and other DHS maritime missions unique forums using similar methodologies. The end result for both IoNS and MaLTE is ultimately gaining needed capability to address gaps and shortfalls in relevant science and technology to support the Arctic operator.

**Key Stakeholder Engagement Plan:** Through a series of prior research and coordinating meetings, establish a network of Canada and U.S. operators and researchers tailored to address each individual workshop.

**Project Champions:** HQ USCG-5PW (Primary). HQ USCG-CPE and USCG District 17 (Secondary).

**Objectives:** The objectives of each workshop are to identify research and technology gaps and define research questions for merit competitions conducted by issuing requests for proposals (RFPs). These competitions will be conducted by ADAC. The output of each workshop will be workshop proceedings, relevant research questions, and request for proposals (RFPs)
solicitation addressing specific research relevant to USCG mission needs leading to solutions related to identified gaps.

**Student Involvement:** Center leadership plans that ADAC Fellows will aide preparation and administrative support as part of professional development and opportunity for networking. No laboratory or field work is planned.

**Methodology:** ADAC will work closely DHS S&T OUP PM, Headquarters USCG, USCG RDC and USCG District 17 and Canadian counterparts. For Arctic-related IoNS, ADAC will work with USCG D-17 and Canadian counterparts to create an Operator work group to formulate an Arctic IONS scenario and define specific problems for research. For Arctic-focused MaLTE, ADAC will principally work with DHS, USCG and Canadian counterparts to create the future operating environment parameters and workshop scenarios and define specific problems for research.

In planning Arctic-related IONS and planning plus hosting Arctic-focused MaLTE in Year 3. ADAC will:

- Research and identify leading experts (i.e., university academics, government officials, domestic/international, researchers) engaged in activities related to the scenario.
- Carefully research the landscape of activities and expertise, to invite experts to identify the challenges for USCG posed by the scenario and invite subject matter experts to speak to activities (i.e., research) underway that are addressing the challenges.
- For the actual workshop, invite guests to assess and document the state of current research and technologies related to the scenario and identify research and technology gaps and shortfalls.
- As key themes emerge from the discussion, form break out groups to develop research questions that may address the knowledge gaps. Those questions will be provided to DHS for consideration and determination for the ADAC managed RFPs competition(s) to follow.

**Schedule and Milestones:**
1. Work closely with DHS, USCG and Canadian counterparts on the workshop scenario. For Year 3, this is principally focused on MaLTE, but IoNS planning will also be pursued.

2. Conduct research to identify the universe of SMEs (international, domestic, in/out government, etc.); conduct research to determine what research is underway to address the likely challenges posed by the scenario and those challenges most relevant to USCG.

3. Organize workshop (securing facility, inviting participants, developing agenda etc.)
   - Complete workshop participants’ selection;
   - Complete workshop participants’ invitations;
   - Complete logistics arrangements;
   - Complete workshop announcement;
   - Complete workshop program.

4. Make a determination to identify appropriate SME speakers to discuss relevant research activities across disciplines that likely address USCG challenges relevant to the scenario.

5. Complete panel selection and invitations.

6. Execute workshop – Research Questions developed and provided to DHS.

7. Complete report/proceedings and slides deck representing the workshop discussions and submitted to DHS for review.

8. Publish rapporteurs report/proceedings, including list of participants, and slides deck will be publically posted (website) with the ADAC RFP (as appropriate/approved by DHS).

9. Prepare RFP (as appropriate/approved by DHS).

Outcomes/output:

The planned/envisioned output of a workshop will be the research questions that will lead to a request for proposals (RFPs) addressing specific USCG operational challenges and leading to solutions of the identified gaps. A collateral outcome is to provide USCG with the range of SMEs likely to understand the scope of challenges posed by IONS and range of current ongoing research and expertise so they can develop support plans in the
future to draw upon state-of-the-art technology and knowledge, if needed.

Workshop format:

**Day 1:**
Meeting Product / Agenda / Logistics / Introductions
Presentation and discussion of the IoNS or MaLTE scenario.
Presentations by SMEs on current research underway related to the challenges posed by the scenario including description and analysis of the state-of-the-art. Based on the above presentations, the workshop participates will identify and discuss research gaps related to the scenario.

The day will conclude with the formation of break out groups of experts for each research theme gap related to the scenario and discussions.

**Day 2:**
During the morning period, break out groups will discuss the gaps and formulate research questions to close those gaps. During the afternoon, breakout groups will convene as a general plenary session to discuss each group’s findings. Research questions will be formalized and provided to DHS for final review. Upon review by DHS, research questions will form the basis for an RFP issued by ADAC.
Appendix A.  Budgetary Information.

BUDGET AND JUSTIFICATION

Year Three Arctic Domain Awareness Center (ADAC) Financial Summary

Summary for Center:

Total Budget Request: $2,500,00 (see budget object class and justification below for center composite)

By Themes/Projects/Partner:

- **Maritime Domain Awareness**: $858,776 total among projects
  - Community Based Observer Networks for Situational Awareness (CBONS-SA):
    - Project Total: $163,365
      - **University of Idaho**: $163,365
  - High Resolution Modeling of Arctic Sea Ice and Currents:
    - Project Total: $122,506
      - **University of Washington**: $122,506
  - Oil Spill Modeling for the Bering, Chukchi, and Beaufort Seas:
    - Project Total: $220,421
      - **Texas A&M—College Station**: $92,000
      - **University of Alaska Anchorage**: $128,421
      - **University of Alaska Fairbanks**: $38,516
  - Real-Time Storm Surge and Coastal Flooding Forecasting for Western Alaska:
    - Project Total: $75,689
      - **University of Alaska Anchorage**: $75,689
  - Identifying, tracking and communicating sea-ice hazards in an integrated framework:
    - Project Total: 131,402
      - **University of Alaska Fairbanks**: $131,402
  - Ice Conditions Index for the Great Lakes Region (ICECON):
    - Project Total: $145,393
      - **University of Alaska Anchorage**: $106,877
      - **University of Alaska Fairbanks**: $38,516

- **Maritime Technology**: $1,305,730 total among projects
  - Arctic Information Fusion Capability:
    - Project Total: $718,975
      - **ASRC Federal Mission Solutions, LLC**: $170,000
      - **Axiom Data Science**: $141,507
      - **Marine Exchange of Alaska**: $12,000
      - **NOVA Corporation**: $86,699
      - **University of Alaska Anchorage**: $177,775
      - **University of New Mexico**: $49,000
      - **University of Texas—El Paso**: $81,994
  - Low-Cost Wireless Remote Sensors for Arctic Monitoring:
    - Project Total: $125,863
      - **ASRC Federal**: $33,942
      - **University of Alaska Anchorage**: $91,921
  - New class of propeller-driven Long-Range AUV:
Project Total: $460,892
- Woods Hole Oceanographic Institute: $460,892
  - E2E: $0 (theme is being defunded and reorganized)
  - Integrated Education: $231,845 total among three projects
    - Arctic Education: Implementing the Arctic Strategy in Training
      Total Project: $102,352
    - Maine Maritime Academy: $102,352 (remaining funding)
      - Minority Serving Institutions (MSI) outreach (combined projects)
      - Integrated Arctic Maritime Education
      Total Projects Costs: $129,493
    - University of Alaska Anchorage: $129,493
      - Management: $103,649 total costs borne by the award
        - Arctic Domain Awareness Center
  - University of Alaska Anchorage: $103,649

Budget Request by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$426,630.00</td>
<td>$0.00</td>
<td>$426,630.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$56,697.00</td>
<td>$0.00</td>
<td>$56,697.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$1,518,757.00</td>
<td>$0.00</td>
<td>$1,518,757.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$16,936.00</td>
<td>$0.00</td>
<td>$16,936.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other (Participant Support)</td>
<td>$92,000.00</td>
<td>$0.00</td>
<td>$92,000.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$388,980.00</td>
<td>$0.00</td>
<td>$388,980.00</td>
</tr>
<tr>
<td>Total</td>
<td>$2,500,000.00</td>
<td>$0.00</td>
<td>$2,500,000.00</td>
</tr>
</tbody>
</table>

Budget Allocated to Workforce Development: $233,240 (this number is in direct funding from either the University of Alaska Anchorage or Fairbanks) via the ADAC Fellows program or direct employment of graduate students. This dollar value does not include Post-Doctoral researchers who may or may not go into service for DHS, nor does it include money already provided supplemental via CDG Scholarship funding or the ADAC Fellows Network program. Additional funding is provided by our partners or included in their requested funds via each individual project component. For example, the above number does not include $12,000 in funding in the University of Idaho funding for an undergraduate researcher as part of workforce development. Total money allocated to workforce development is more than $250,000.

Budget Justification:

Senior Personnel Salaries:
PI, Dr. Douglas Causey is requesting five percent effort (104 hours) for scientific leadership of the project as a direct cost on the award. Other effort is being covered via institutional support. Per the University of Alaska Board of Regent’s Policy Manual, PIs must charge a minimum effort of five percent to sponsored research. Dr. Causey is responsible for all associated PI duties of the award to include but not limited to: management of the ADAC team, obtaining institutional support, and reporting required to DHS as per the Terms and Conditions.
Total request for senior personnel salaries for year three is $12,917.

Other Personnel Salaries:
All other salaries on this award are for Research PIs, Post-doctoral researchers, research technicians, and graduate student researchers. These salaries have been identified and explained in detail within each project request. The salaries in this request include both the University of Alaska Anchorage and Fairbanks.

Total request for senior and other personnel salaries for year three is $334,318.

Fringe Benefits:
Benefits are applied according to the University of Alaska's System approved federally negotiated provisional fringe benefit rates for both Anchorage and Fairbanks for FY17. A copy can be provided upon request.

Total request for fringe benefits for personnel for year three is $92,312.

Travel:
Domestic: All travel is for domestic travel; no international has been included in year three activities. Travel has been justified under each project as well as management center.

Total request for travel for year three is $56,697.

Contractors:
Vendors have been identified in each of the specific project requests. Contractual obligations include subaward agreements in the amount of $1,362,750. Contractual costs include Axiom ($141,507), Marine Exchange of Alaska ($12,000), and money for contractors to assist in setting up the ADAC Fellows Network ($2,500) for projects.

Total request for contractual obligations for year three is $1,518,757.

Subawards:
Additional funding is requested in the amount of $1,179,750 for continuation and new partnerships to expand themes and project deliverables in year three. The following subawards are requested for continuation funding:
- Marine Maritime Academy ($102,352)
- Nova-Dine/Kestrel ($86,699)
- University of Idaho ($163,365)
- University of Washington ($122,506)
- Woods Hole Oceanographic Institute ($460,892)
The following subawards are requested for new partnerships:

- ASRC Federal Solution ($203,942)
- Texas A&M University–College Station ($92,000)
- University of New Mexico ($49,000)
- University of Texas–El Paso ($81,994)

Total request for Subawards for year three is $1,362,750.

Materials & Supplies:
Funds are requested for field supplies for projects and have been requested in the individual projects specifically. Additionally, funds are requested for preparation and supplies needed to conduct quarterly and annual meeting(s) and for Center needs to include software licenses.

Total request for materials and supplies for year three is $15,936.

Participant Support:
An undergraduate student fellowship program of $1,000 per month for 12 months is requested. Additionally, funds are requested for a summer internship program with five student interns for four summer months. The funding for this request will be discussed in more detail in each project and workforce development.

Total request for participant support for year three is $92,000.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska’s cognizant federal authority and on sponsored research are calculated at 51.2% (Anchorage) and 50.5% (Fairbanks) of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the rate at time of submission of the original proposal (2013).

Total request for indirect costs for year three is $388,980.

Budget Notes:
- Projects’ Funding have been rolled up in this summary. Most detailed justifications regarding requested budget and expenditures can be found in the individual project analysis.
- Projects that are a subaward are listed as contractual in the composite as they are a procurement action on the part of ADAC.
- Indirect and Facilities and Administrative (F&A) costs are used interchangeably.
- Costs follow 2CFR200 to determine allowability, allocability, and reasonableness. These regulations also determine which costs are allowed indirect and which are not.
- Due to rounding composites might be off +/- $2; however exact costs without rounding are $2.5M.
- Some institutional support is in higher than the normal distribution of returned indirect costs back to ADAC; indirect costs at the University
of Fairbanks are returned based on their model and are not subject to returning funds for institutional support.

Management of Center Costs:

Total Management Budget Request: $103,649 (see budget object class and justification below for management composite)

Management Budget Request by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$12,917.00</td>
<td>$0.00</td>
<td>$12,917.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$40,634.00</td>
<td>$0.00</td>
<td>$40,634.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$15,000.00</td>
<td>$0.00</td>
<td>$15,000.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$35,098.11</td>
<td>$0.00</td>
<td>$35,098.11</td>
</tr>
<tr>
<td>Total</td>
<td>$103,649.11</td>
<td>$0.00</td>
<td>$103,649.11</td>
</tr>
</tbody>
</table>

Management Budget Allocated to Workforce Development: $0

Management Budget Justification:

Senior Personnel Salaries:
PI, Dr. Douglas Causey is requesting five percent effort (104 hours) for scientific leadership of the project as a direct cost on the award. Other effort is being covered via institutional support. Per the University of Alaska Board of Regent’s Policy Manual, PIs must charge a minimum effort of five percent to sponsored research. Dr. Causey is responsible for all associated PI duties of the award to include but not limited to: management of the ADAC team, obtaining institutional support, and reporting required to DHS as per the Terms and Conditions.

Total request for senior personnel salaries for year three is $10,029.

Fringe Benefits:
Benefits are applied according to the University of Idaho's approved federally negotiated fringe benefit rates. Rates are 28.5% for faculty.

Total request for fringe benefits for personnel for year three is $2,888.

Travel:
Domestic: ADAC Executive team is requesting trips for project meetings, outreach, visitors, educational opportunities, symposiums, and DHS directed meetings (Annual Meeting and Biennial Review). The request includes a budget to accommodate economy air travel, governmental
subsistence allowance (GSA) rate lodging, federal per diem for trips, and car rental when necessary.

Total request for travel for year three is $40,634.

Materials & Supplies:
Funds are requested for supplies for printing and materials and preparations needed for the various meetings mentioned above. Additionally, supplies and materials are needed for software licenses not utilized by the University System.

Total request for materials and supplies for year three is $15,000.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska Anchorage’s cognizant federal authority and on sponsored research are calculated at 51.2% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request.

Total request for indirect costs for year three is $35,098.

Management Budget Notes:
• Additional salary and support for Dr. Causey will be reflected in Institutional Support.
Budget and Justification by Theme by Project:

Theme 1: Maritime Domain Awareness Projects

PROJECT: Community Based Observer Networks for Situational Awareness (CBONS-SA)

Project PI: Dr. Lilian Alessa, University of Idaho

Total Project Budget Request: $163,365 (see budget object class and justification below for project composite)

Budget Request by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$31,674.00</td>
<td>$12,998.00</td>
<td>$44,672.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$4,000.00</td>
<td>$0.00</td>
<td>$4,000.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other (Subaward)</td>
<td>$98,331.00</td>
<td>$0.00</td>
<td>$98,331.00</td>
</tr>
<tr>
<td>Other (Student Support)</td>
<td>$12,000.00</td>
<td>$0.00</td>
<td>$12,000.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$17,360.00</td>
<td>$5,888.00</td>
<td>$23,248.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$163,365.00</strong></td>
<td><strong>$18,886.00</strong></td>
<td><strong>$182,251.00</strong></td>
</tr>
</tbody>
</table>

Project Budget Allocated to Workforce Development: $12,000 (Undergraduate student support)

Project Budget Justification and Narrative:

Senior Personnel Salaries:
Research PI, Dr. Lil Alessa is requesting 1.5 months’ effort for scientific leadership of the project and coordination with other observing networks and national programs. Dr. Alessa will be responsible assisting with project evaluation and bringing research to capability process.
Dr. Andy Kliskey is requesting 0.5 months’ effort for coordination and communication with Aleut International Association (AIA) and community observers, and data oversight.

Total request for senior and other personnel salaries for year three is $24,160.

Fringe Benefits:
Benefits are applied according to the University of Idaho's approved federally negotiated fringe benefit rates. Rates are 31.1% for faculty.

Total request for fringe benefits for personnel for year three is $7,514.

Travel:
Domestic: Research PI is requesting two trips for project meetings in Anchorage, AK with UA and AIA personnel. The request includes economy air travel, governmental subsistence allowance (GSA) rate lodging, federal per diem for four days per trip, and car rental. Each trip is budgeted at approximately $2,000.

Total request for travel for year three is $4,000.

Subawards: Additional funding is requested in the amount of $95,681 for Aleut International Association to support the administration and management for expanded village support including hiring high fidelity observers in six communities, and to support additional effort by core project personnel in Anchorage. AIA was selected because of their past experience administering community support for the Alaskan Bering Sea communities.

Total request for Subawards for year three is $95,681.

Materials & Supplies: Funds are requested for field supplies to buy satellite phones, GPS units, and digital cameras for one new observer in network and with an additional set of the same equipment repurposed from an existing community to a new community.

Total request for materials and supplies for year three is $2,650.

Participant Support: An undergraduate student fellowship of $1,000 per month for 12 months is requested. The funding for this request will be discussed in more detail in workforce development.

Total request for participant support for year three is $12,000.

Indirect Costs: Facilities and Administrative (F&A) Costs are negotiated with the University of Idaho’s cognizant federal authority and on sponsored research are calculated at 45.3% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the rate at time of submission of the original proposal (2013).

Total request for indirect costs for year three is $17,360.

Project Budget Notes:
- The first $25,000 of the subaward to AIA is subject to F&A and this was applied in year one of the project. No further F&A will be applied.
- Participant support costs are not subject to F&A.
- Formal carryforward request submitted to DHS for funding in the amount of $18,866 for year three of this project.
PROJECT: High Resolution Modeling of Arctic Sea Ice and Currents

Project PI: Dr. Jinlun Zhang, University of Washington

Total Project Budget Request: $122,506 (see budget object class and justification below for project composite)

Project Budget by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$73,745.00</td>
<td>$17,666.00</td>
<td>$91,411.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$2,165.00</td>
<td>$1,983.00</td>
<td>$4,148.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$3,300.00</td>
<td>$0.00</td>
<td>$3,300.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other (UW-APL Prorated)</td>
<td>$25,496.00</td>
<td>$6,108.00</td>
<td>$31,604.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$17,800.00</td>
<td>$4,379.00</td>
<td>$22,179.00</td>
</tr>
<tr>
<td>Total</td>
<td>$122,506.00</td>
<td>$30,136.00</td>
<td>$152,642.00</td>
</tr>
</tbody>
</table>

Project Budget Allocated to Workforce Development: $0

Project Budget Justification and Narrative:

Senior Personnel Salaries:
Research PI, Dr. Jinlun Zhang is requesting 17 percent months’ effort for scientific leadership of the project and continuation of development and refinement of the coupled High-resolution Ice/Ocean Modeling and Assimilation System (HIOMAS) with even higher horizontal resolution, targeting 2-4km for the Arctic Ocean, depending on computing resources. He will conduct extensive calibration and validation using various available sea ice and ocean observations to reduce model errors. He will perform near real-time or real-time hindcast and seasonal forecast of Arctic sea ice and ocean currents and examine HIOMAS skills in (near) real-time hindcasts and forecasts. Dr. Zhang will be responsible assisting with project evaluation and bringing research to capability process.

Other Personnel Salaries:
Programmer Kay Ruciman is requesting 20 percent months’ effort to assist Dr. Zhang and continue model development, refinement, calibration/validation and analytics.

Total request for senior and other personnel salaries for year three is $48,105.

Fringe Benefits:
The APL benefits and leave rates are applied according to the University of Washington's approved federally negotiated fringe benefit rates. The APL-UW rate for professional staff is 26.7% of salaries. The APL leave rate for professional staff is 26.6% of salaries. The total benefit rate is 53.3%.
Total request for APL fringe benefits and leave rate for personnel for year three is $51,136.

Travel:
Domestic: Research PI is requesting one trip for project meetings in Anchorage, AK with UA personnel. The request includes economy air travel, governmental subsistence allowance (GSA) rate lodging for three days, federal per diem for four days per trip, and miscellaneous expenses and ground transportation. The trip is budgeted at $2,165.

Total request for travel for year three is $2,165.

Contractual/Services:
Publication Costs: one publication cost is requested. The estimated cost is based on the American Geophysical Union published open access APC costs. Amount requested is $3,300.

Total request for contractual/services for year three is $3,300.

Other Direct Costs:
APL Prorated Direct Costs: The University of Washington indirect cost rate applied to APL-UW is lower than the rate elsewhere on campus (17% versus 54.5%) and does not recover the Laboratory’s central costs. These are recovered by applying a Prorated Direct Cost of 53% total salaries. Prorated Direct Costs include such expenses as salaries and employee benefits for central service employees, administrative data processing, communications, and some facilities costs.

Total request for other direct costs for year three is $25,496.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of Washington’s cognizant federal authority and on sponsored research are calculated at 17.0% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current F&A Rate Agreement dated 23 April 2015.

Total request for indirect costs for year three is $17,800.

Project Budget Notes:
• Formal carryforward request submitted to DHS for funding in the amount of $30,136 for year three of this project.

PROJECT: Arctic Oil Spill Modeling

Project PIs: Dr. Scott Socolofsky, Texas A&M University–College Station and Dr. Thomas Ravens, University of Alaska Anchorage

Total Project Request: $220,421 (see budget object class and justification below for project composite)
Texas A&M University–College Station: $92,000
University of Alaska Anchorage: $128,421 (includes indirect earned from the subaward issued)

Project Budget Request by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$76,469.00</td>
<td>$0.00</td>
<td>$76,469.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$92,000.00</td>
<td>$0.00</td>
<td>$92,000.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$51,952.13</td>
<td>$0.00</td>
<td>$51,952.13</td>
</tr>
<tr>
<td>Total</td>
<td>$220,421.13</td>
<td>$0.00</td>
<td>$220,421.13</td>
</tr>
</tbody>
</table>

Project Budget Allocated to Workforce Development: $55,115
- Texas A&M University—College Station: $0
- University of Alaska Anchorage: $55,115

Project Budget Justification and Narrative:

Senior Personnel Salaries:
See individual project components at each institution for request and justification.

Other Personnel Salaries:
See individual project components at each institution for request and justification.

Total request for senior and other personnel salaries for year three is $65,089.

Fringe Benefits:
Benefits are applied according to each institution’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $11,380.

Subawards (listed as a contractual obligation):
ADAC team request to funding to issue a subaward to Texas A&M—College Station for their part of the scope of work for this project. This subaward would be subject to F&A on the first $25,000 per 2CFR200. The budget and budget justification for Texas A&M—College Station is provided below.

Total request for a subaward for year three is $92,000.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with both Texas A&M University’s and the University of Alaska’s cognizant federal authorities. Both institutions utilize an MTDC method for calculation of indirect costs on sponsored research. MTDC includes total direct costs...
costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request.

Total request for indirect costs for year three is $51,952.

**Project Budget Notes:**
- The amount for the University of Alaska Anchorage component does not include F&A ($12,800) for the subaward issued to Texas A&M. This amount is in the total project composite (above) but not part of the individual project since Dr. Ravens does not have access to the recovered F&A.

**Individual Project Budget Components:**

**Texas A&M University--College Station**

**Total Budget Request for Texas A&M:** $92,000 (see budget object class and justification below for project composite)

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$61,953.00</td>
<td>$0.00</td>
<td>$61,953.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$30,047.00</td>
<td>$0.00</td>
<td>$30,047.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$92,000.00</td>
<td>$0.00</td>
<td>$92,000.00</td>
</tr>
</tbody>
</table>

**Budget Allocated to Workforce Development for Texas A&M:** $0

**Budget Justification and Narrative for Texas A&M:**

**Senior Personnel Salaries:**
Research PI, Dr. Scott Socolofsky is requesting one month’s effort for scientific leadership of the project, supervision of post-doctoral researcher, and collaboration with ADAC team. Dr. Socolofsky will be responsible assisting with project evaluation and bringing research to capability process.

**Other Personnel Salaries:**
Post-doctoral researcher, Dr. Chris C.K. Lai is requesting 10.6 months’ effort to assist Dr. Socolofsky and continue model development of TAMOC, validate the model to available data in shallow systems, coordinate with the ADAC and NOAA to couple the combined model with GNOME, and will collaborate on publications as appropriate stemming from the ADAC project.
Total request for senior and other personnel salaries for year three is $45,728.

Fringe Benefits:

Benefits are applied according to the Texas A&M–College Station’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $16,225.

Indirect Costs:

Facilities and Administrative (F&A) Costs are negotiated with the Texas A&M University’s cognizant federal authority and on sponsored research are calculated at 48.5% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current approved F&A Rate Agreement.

Total request for indirect costs for year three is $30,047.

University of Alaska Anchorage

Total Budget Request for the University of Alaska Anchorage: $115,621 (see budget object class and justification below for project composite)

Budget Request for the University of Alaska Anchorage by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$76,469.00</td>
<td>$0.00</td>
<td>$76,469.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$39,152.13</td>
<td>$0.00</td>
<td>$39,152.13</td>
</tr>
<tr>
<td>Total</td>
<td>$115,621.13</td>
<td>$0.00</td>
<td>$115,621.13</td>
</tr>
</tbody>
</table>

Budget Allocated to Workforce Development for the University of Alaska Anchorage: $55,115 (Graduate Student Support)

Budget Justification for the University of Alaska Anchorage:

Senior Personnel Salaries:

Research PI, Dr. Thomas Ravens is requesting one month’s effort (173.33 hours) for scientific leadership of the project, supervision of graduate student researchers, and
collaboration with the Texas A&M team. Dr. Ravens will be responsible assisting with project evaluation and bringing research to capability process. Dr. Ravens will also be responsible for providing workforce development mentoring.

Other Personnel Salaries:
Graduate student researcher, Dana Brunswick is requesting 12 months’ effort to assist Dr. Ravens and continue model development of the arctic-capable oil spill model, validate the model, coordinate with the ADAC and NOAA to couple the combined model with GNOME, and will collaborate on publications as appropriate stemming from the ADAC project. Another graduate student research, TBN, is requested to assist both Dr. Ravens and partner with Dana Brunswick for participation in this project.

Total request for senior and other personnel salaries for year three is $65,089.

Fringe Benefits:
Benefits are applied according to the University of Alaska Anchorage’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $11,380.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska Anchorage’s cognizant federal authority and on sponsored research are calculated at 51.2% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current approved F&A Rate Agreement.

Total request for indirect costs for year three is $39,152.

Budget Notes for the University of Alaska Anchorage:
- The amount for the University of Alaska Anchorage component does not include F&A ($12,800) for the subaward issued to Texas A&M. This amount is in the total project composite but not part of the individual project since Dr. Ravens does not have access to the recovered F&A.
PROJECT: Real-time Storm Surge, Coastal Flooding, and Coastal Erosion Forecasting for Arctic Alaska

Project PI: Dr. Tom Ravens, College of Engineering, University of Alaska Anchorage

Total Project Budget Request: $75,689 (see budget object class and justification below for project composite)

Project Budget Request by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$50,059.00</td>
<td>$0.00</td>
<td>$50,059.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$25,630.21</td>
<td>$0.00</td>
<td>$25,630.21</td>
</tr>
<tr>
<td>Total</td>
<td>$75,689.21</td>
<td>$0.00</td>
<td>$75,689.21</td>
</tr>
</tbody>
</table>

Project Budget Allocated to Workforce Development: $28,705 (Graduate Student Support)

Project Budget Justification:

Senior Personnel Salaries:
Research PI, Dr. Thomas Ravens is requesting one month’s effort (173.33 hours) for scientific leadership of the project, refinement of a model, development of an ADCIRC-based model that includes ice and a SWAN wave model, supervision of a graduate student researcher. Dr. Ravens will be responsible assisting with project evaluation and bringing research to capability process. Dr. Ravens will also be responsible for providing workforce development mentoring.

Other Personnel Salaries:
Graduate student researcher, Jon Allen is requesting 12 months’ effort to assist Dr. Ravens and continue models development, validate the models, coordinate with the ADAC and NOAA, and will collaborate on publications as appropriate stemming from the ADAC project.

Total request for senior and other personnel salaries for year three is $41,937.

Fringe Benefits:
Benefits are applied according to the University of Alaska Anchorage’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $8,122.
**Indirect Costs:**
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska Anchorage’s cognizant federal authority and on sponsored research are calculated at 51.2% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current approved F&A Rate Agreement.

Total request for indirect costs for year three is $25,630.

**PROJECT: Identifying, Tracking and Communicated Sea-Ice Hazards in an Integrated Framework**

**Project PI:** Drs. Hajo Eicken and Andrew Mahoney, Geophysical Institute, University of Alaska Fairbanks

**Total Project Budget Request:** $131,402 (see budget object class and justification below for project composite)

**Project Budget Request by Object Class:**

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$82,869.00</td>
<td>$8,463.00</td>
<td>$91,332.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$3,441.00</td>
<td>$3,470.00</td>
<td>$6,911.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$1,000.00</td>
<td>$0.00</td>
<td>$1,000.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$44,091.55</td>
<td>$6,026.00</td>
<td>$50,117.55</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$131,401.55</strong></td>
<td><strong>$17,959.00</strong></td>
<td><strong>$149,360.55</strong></td>
</tr>
</tbody>
</table>

**Project Budget Allocated to Workforce Development:** $31,010 (Graduate Student Support)

**Project Budget Justification:**

**Senior Personnel Salaries:**
Research PI, Dr. Hajo Eicken is requesting one week’s effort (40 hours) for scientific leadership of the project. Dr. Andrew Mahoney is requesting 1.5 month’s effort (301) hours for leadership of the project and oversee the development of the Barrow MDA Testbed and integration of ice hazards data products into ADAC data fusion infrastructure in partnership with other ADAC team members. Dr. Mahoney will also be responsible for supervision of employees. Drs. Eickens and Mahoney will be responsible assisting with project evaluation and bringing research to capability process. Dr. Mahoney will also be responsible for providing workforce development mentoring.
Other Personnel Salaries:
Request for a programming expert to assist with Geo-spatial visualization of modeling. 82 hours for a TBN employee requested to assist with the refinement of the geo-spatial modeling.

Graduate student researcher, Oliver Dammann is requesting 12 months’ effort to assist Dr. Mahoney and continue development, validation of data, and collaborate on publications as appropriate stemming from the ADAC project. Oliver Dammann will continue his work on high-precision ice deformation.

Research Technician, Joshua Jones is requesting two month’s effort (374 hours) to extend implementation of current ice tracking software to other radar modalities.

Total request for senior and other personnel salaries for year three is $64,520.

Fringe Benefits:
Benefits are applied according to the University of Alaska Fairbanks’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $18,349.

Travel:
Domestic: Research PI is requesting three trips for project meetings in Anchorage, AK (two meetings) with UA personnel and one trip to Seattle to liaise with key stakeholders. The request includes economy air travel, governmental subsistence allowance (GSA) rate lodging for one day, federal per diem for two days per trip, and miscellaneous expenses and ground transportation. Each trip is budgeted at $1,147.

Total request for travel for year three is $3,441.

Materials & Supplies:
Funds are requested for consumable computer supplies (hard drives, external drives, etc.) for the development of ice tracking software.

Total request for material and supplies for year three is $1,000.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska Fairbanks’s cognizant federal authority and on sponsored research are calculated at 50.5% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current approved F&A Rate Agreement.

Total request for indirect costs for year three is $44,092.

Project Budget Notes:
• Formal carryforward request submitted to DHS for funding in the amount of $17,959 for year three of this project.

**PROJECT:** Ice Condition Index (ICECON) for the Great Lakes

**Project PI:** Drs. Thomas Ravens, University of Alaska Anchorage and Andrew Mahoney, University of Alaska Fairbanks

**Total Project Budget Request:** $145,393  
   - University of Alaska Anchorage: $106,877  
   - University of Alaska Fairbanks: $38,516

**Project Budget Request by Object Class:**

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$91,966.00</td>
<td>$0.00</td>
<td>$91,966.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$4,312.00</td>
<td>$0.00</td>
<td>$4,312.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$49,115.00</td>
<td>$0.00</td>
<td>$49,115.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$145,393.00</strong></td>
<td>$0.00</td>
<td><strong>$145,393.00</strong></td>
</tr>
</tbody>
</table>

**Project Budget Allocated to Workforce Development:** $26,410 (one graduate student)

**Project Budget Justification and Narrative:**

**Senior Personnel Salaries:**  
See individual project components at each institution for request and justification.

**Other Personnel Salaries:**  
See individual project components at each institution for request and justification.

Total request for senior and other personnel salaries for year three is $72,469.

**Fringe Benefits:**  
Benefits are applied according to each institution’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $19,497.

**Travel:**  
See individual project components at each institution for request and justification.
Total request for travel for year three is $4,312.

**Indirect Costs:**
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska’s cognizant federal authority. Both institutions utilize an MTDC method for calculation of indirect costs on sponsored research. MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request.

Total request for indirect costs for year three is $49,115.

**Individual Project Budget Components:**

**University of Alaska Anchorage:**

Total Budget Request for University of Alaska Anchorage: $106,877 (see budget object class and justification below for project composite)

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$69,129.00</td>
<td>$0.00</td>
<td>$69,129.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$1,557.00</td>
<td>$0.00</td>
<td>$1,557.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$36,191.00</td>
<td>$0.00</td>
<td>$36,191.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$106,877.00</td>
<td>$0.00</td>
<td>$106,877.00</td>
</tr>
</tbody>
</table>

**Budget Allocated to Workforce Development for University of Alaska Anchorage:** $26,410 (one graduate student)

**Budget Justification and Narrative for University of Alaska Anchorage:**

Senior Personnel Salaries:
Research PI, Dr. Thomas Ravens is requesting two month’s effort (346.7 hours) for scientific leadership of the project, supervision of graduate student, and collaboration with ADAC team at UAF. Dr. Ravens will be responsible assisting with project evaluation and bringing research to capability process.

Other Personnel Salaries:
Graduate student researcher, TBN is requesting 12 months’ effort in support (760 hours during academic year and 560 hours during summer) to assist Dr. Ravens and continue model development, validate the model with available data, coordinate with the ADAC and USCG D-9, and will collaborate
on publications as appropriate stemming from the ADAC project.

Total request for senior and other personnel salaries for year three is $56,319.

Fringe Benefits:
Benefits are applied according to the University of Alaska Anchorage—approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $12,810.

Travel:
Domestic: Dr. Ravens is requesting one trip to Cleveland, OH for project meeting and testing with the U.S. Coast Guard. The request includes a budget to accommodate economy air travel, governmental subsistence allowance (GSA) rate lodging, federal per diem for trips, and car rental when necessary.

Total request for travel for year three is $1,557.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska Anchorage University’s cognizant federal authority and on sponsored research are calculated at 51.2% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current approved F&A Rate Agreement.

Total request for indirect costs for year three is $36,191.

University of Alaska Fairbanks

Total Budget Request for the University of Alaska Fairbanks:
$38,516 (see budget object class and justification below for project composite)
Budget Request for the University of Alaska Anchorage by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$22,837.00</td>
<td>$0.00</td>
<td>$22,837.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$2,755.00</td>
<td>$0.00</td>
<td>$2,755.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other (Tuition)</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$12,924.00</td>
<td>$0.00</td>
<td>$12,924.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$38,516.00</strong></td>
<td><strong>$0.00</strong></td>
<td><strong>$38,516.00</strong></td>
</tr>
</tbody>
</table>

Budget Allocated to Workforce Development for the University of Alaska Anchorage: $0

Budget Justification for the University of Alaska Anchorage:

Senior Personnel Salaries:
Research PI, Dr. Andrew Mahoney is requesting one month’s effort (173.33 hours) for scientific leadership of the project, supervision of research staff, and collaboration with the University of Alaska Anchorage team. Dr. Mahoney will be responsible assisting with project evaluation and bringing research to capability process.

Other Personnel Salaries:
Research Assistant, Josh Jones is requesting 250 hours’ effort to assist Dr. Mahoney and continue model development, validate the model, coordinate with UAA and U.S. Coast Guard, and will collaborate on publications as appropriate stemming from the ADAC project.

Total request for senior and other personnel salaries for year three is $16,150.

Fringe Benefits:
Benefits are applied according to the University of Alaska Anchorage’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $6,687.

Travel:
Domestic: Dr. Mahoney is requesting one trip to Cleveland, OH for project meeting and testing with the U.S. Coast Guard. The request includes a budget to accommodate economy air travel, governmental subsistence allowance (GSA) rate lodging, federal per diem for trips, and car rental when necessary.

Total request for travel for year three is $2,755.
Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska Anchorage’s cognizant federal authority and on sponsored research are calculated at 50.5% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current approved F&A Rate Agreement.

Total request for indirect costs for year three is $12,924.

Theme 2: Maritime Technology Projects

PROJECT: Arctic Information Fusion Capability

Project PI: Dr. Kenrick Mock, University of Alaska Anchorage, project management provided by Mr. John DeLaurentis, ASRC Federal Mission Solutions.

Total Project Budget Request: $718,975
ASRC Federal Missions Solutions, LLC.: $170,000
Axiom: $141,507
Marine Exchange of Alaska: $12,000
NOVA Corporation: $86,699
University of Alaska Anchorage: $177,775 (includes indirect earned from the subawards issued)
University of New Mexico: $49,000
University of Texas—El Paso: $81,994

Project Budget Allocated to Workforce Development: $36,000

Project Budget Justification and Narrative:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$20,161.00</td>
<td>$0.00</td>
<td>$20,161.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$3,000.00</td>
<td>$0.00</td>
<td>$3,000.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$541,200.00</td>
<td>$0.00</td>
<td>$541,200.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other (Participant Support)</td>
<td>$36,000.00</td>
<td>$0.00</td>
<td>$36,000.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$118,614.01</td>
<td>$0.00</td>
<td>$118,614.01</td>
</tr>
<tr>
<td>Total</td>
<td>$718,975.01</td>
<td>$0.00</td>
<td>$718,975.01</td>
</tr>
</tbody>
</table>

Project Budget Notes: Any notes are listed in the appropriate project component.

Individual Project Budget Components:
ASRC Federal Mission Solutions, LLC

Total Budget Request for ASRC Federal Mission Solutions, LLC: $170,000

Arctic Domain Awareness Center Workplan 1 July 2016–30 June 2017
Budget Request by Object Class for ASRC Federal Missions Solutions: (details not provided to University of Alaska Anchorage by time of submission)

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Bene</td>
<td>$161,459.00</td>
<td>$0.00</td>
<td>$161,459.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$8,541.00</td>
<td>$0.00</td>
<td>$8,541.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$170,000.00</strong></td>
<td><strong>$0.00</strong></td>
<td><strong>$170,000.00</strong></td>
</tr>
</tbody>
</table>

Budget Allocated to Workforce Development for ASRC Federal Mission Solutions, LLC: $0

Budget Justification and Narrative for ASRC Federal Missions Solutions, LLC:
Subaward will be providing the program management and the technical expertise to transfer technology from science application to commercialization. Project Management is at $155.00 per hour (fully burdened federal rate) for 1,042 (half time for a year) for a total cost of $161,459. Additional costs are for travel to Alaska to meet with customer and partner and to demo AIFC capability. Total costs requested $170,000.

Axiom

Total Budget Request for Axiom: $141,507

Budget Request by Object Class for Axiom: (details not provided to University of Alaska Anchorage by time of submission)

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Bene</td>
<td>$141,507.00</td>
<td>$0.00</td>
<td>$141,507.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$141,507.00</strong></td>
<td><strong>$0.00</strong></td>
<td><strong>$141,507.00</strong></td>
</tr>
</tbody>
</table>

Budget Allocated to Workforce Development for Axiom: $0

Budget Justification and Narrative for Axiom:
Vendor will be providing the hub for AIFC and all partners for data. Vendor will continue to expand this service to include but not limited to: workforce development and intern opportunities.
for our undergraduates and graduate students, programming, and liaison between all AIFC data partners. Axiom’s billable hourly rates for this project are as follows:

- Project Manager: $97.33
- Software Engineer: $111.23
- Data Analyst: $83.43
- TBN Analyst: TBD

All rates are fully burdened rates. Axiom anticipates to accomplish tasks as outlined in the AIFC project the following number of billable hours per classification (all employees are US citizens):

- Project Manager: 340 hours
- Software Engineer: 838 hours
- Data Analyst: 68 hours

Vendor anticipates the following tasks to be completed:

<table>
<thead>
<tr>
<th>Task Number</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project Management, Meetings and Communication</td>
</tr>
<tr>
<td>2</td>
<td>Ingest Sources of Arctic Science Data (models, GIS, time series, remoteley sensed data sets, sensors and AUVs)</td>
</tr>
<tr>
<td>3</td>
<td>Integrate data feeds across GINA, FIST, ERMA, SAROPS</td>
</tr>
<tr>
<td>4</td>
<td>Develop User Interface and Iterate on User Interface and User Experience</td>
</tr>
</tbody>
</table>

Total costs for year three for Axiom is $141,507.

**Budget Notes for Axiom:**

- UAA is treating this contractor as a vendor; therefore, detailed budget does not need to be provided as time of submission. Contractor’s relationship has been reviewed to see if it meets definition of subaward and it fails; therefore, vendor has been classified as contractor.
- Because this is a vendor relationship, per 2CFR200, UAA will charge full research indirect costs on the contract. This charge will be in the composite of the project and not part of the UAA individual component as Dr. Mock does not have access to this money. Total indirect costs for this vendor is $67,584.

**Marine Exchange of Alaska**

**Total Budget Request for Marine Exchange of Alaska:** $12,000

**Budget Request by Object Class for Marine Exchange of Alaska:**
(details not provided to University of Alaska Anchorage by time of submission)
Budget Allocated to Workforce Development for Marine Exchange of Alaska: $0

Budget Justification and Narrative for Marine Exchange of Alaska: Vendor will be providing real time Automatic Identification System (AIS) vessel tracking information on vessels operating in the Arctic. Vendor will be continuing to provide this data to ADAC on a fee of $1,000 per month for developmental purposes of the AIFC system.

Total costs for year three for Marine Exchange of Alaska is $12,000.

Budget Notes for Marine Exchange of Alaska:
- UAA is treating this contractor as a vendor; therefore, detailed budget does not need to be provided as time of submission.
- Because this is a vendor relationship, per 2CFR200, UAA will charge full research indirect costs on the contract. This charge will be in the composite of the project and not part of the UAA individual component as Dr. Mock does not have access to this money. Total indirect costs for this vendor is $6,144.

NOVA Corporation

Total Budget Request for NOVA Corporation: $86,699

Budget Request by Object Class for NOVA Corporation:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$86,699.00</td>
<td>$0.00</td>
<td>$86,699.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Total</td>
<td>$86,699.00</td>
<td>$0.00</td>
<td>$86,699.00</td>
</tr>
</tbody>
</table>
Budget Allocated to Workforce Development for NOVA Corporation: $0 (NOVA Corporation is willing to partner with the University of Alaska Anchorage to provide ADAC Summer Fellows intern opportunities; the costs for the summer interns is built into the workforce development. These opportunities with regards to stipend, travel, etc. are being provided at the cost of ADAC; however, additional costs not quantifiable at this time are being provided by NOVA Corporation.

Budget Justification and Narrative for NOVA Corporation:

Basic FIST Package - $95,024 (12 months)

- Core Server Application: The FIST system will be placed on the secure and shared ADAC Amazon Web Services cloud computing server. The FIST system core and proprietary code, which will include an instance of the FusionPortal, will be optimized for mobile field collection (Gather), FusionPortal data observations, and two-way tasking/communication between field operatives and HQ observers.

- System Set-Up, Programmer Support, and Research/Development: In order to establish the full functionality of the FIST system within the specific needs and requirements of ADAC, the FIST team will require 20 (twenty) work-hours for the set-up of the FIST FusionPortal and 20 (twenty) work-hours for the customized configuration of the FIST FusionPortal. The FIST team will operate within those specific time-frames in order to ensure an operational FusionPortal is fully setup and properly configured to accommodate the basic FIST package. As part of this project, the FIST team is also assigning 120 (one-hundred twenty) work-hours of programmer support for any custom development and modifications of the Gather application and FusionPortal. These customizations are done in close-collaboration with the ADAC team to determine how best to adapt the system to the desired requirements. These work-hours include the development, testing, regression testing, and patching of any new code, as appropriate. As part of this project, the FIST team is also assigning up to and no more than 20 (twenty) work-hours of analyst support for any consulting, scenarios and/or data management design work.

- Full Research, Development, Testing and Evaluation (RDTE) configuration: This project will adapt the FIST system and functionality to meet the ADAC requirements across multiple mission sets. As such, this FIST package accommodates for the continual evolution of the system through research and development best practices. This will be done through the established partnerships with ADAC researchers and the allotted Programmer Support work-hours, as mentioned above.
• User Specific Forms: The Gather application allows for the collection of survey-based reports in the field. These survey based reports are fully customizable and employ smart-logic capabilities. Under this basic FIST package, the FIST team will create 4 (four) forms, not to exceed 50 questions on each form. This includes the consultation between the FIST team and ADAC researchers on the types of questions that need to be asked, the creation of the forms, the full regression testing and deployment of the forms.

• Tele-Training: In order to ensure the proper usage and understanding of the FIST system, a tele-training option is offered through this package. The FIST team will allow for up to 20 (twenty) users to receive a 1 (one) work-week (or equivalent) training remotely over the Internet. The instruction will be set-up and provided by the FIST Team. This instruction will be provided at the convenience and through the collaboration of the ADAC Team. This training will include the understanding of the full functionality of the Gather application and FusionPortal. This does not include any administrative or data level training.

• Users: Under this package, ADAC may have up to 10 (ten) field user (Gather application) and up to 10 (ten) portal user (FusionPortal) operating the system. This estimate may adjust according to project demand and will prior approval will be necessary for any scaling.

inReach Iridium SatCom Short Data Burst Monthly Plan per transmitter - $3000 (12 months)
• This package includes the usage of 2 (two) inReach Iridium Short data burst transmitter for a period of 12 (twelve) months, with an estimation of up to 80 text reports per month. This is an estimation that may adjust according to demand.

inReach Iridium SatCom Short Data Burst Transmitter - 1 unit - $400
• Funds are requested for the purchase of hardware for the usage of the inReach Iridium SatCom short data burst capability. This is for 1 (one) inReach unit and will be under the ownership of the ADAC team once purchased.

Software / Services Discount - -$11,325
The FIST team is offering ADAC an exclusive discount offers due to its academic, research/development, and enterprise status. This discount applies specifically to this agreement only and may not be applied toward other agreements.

Cost Sharing Opportunities - TBD
As a means to increase the partnership opportunity and to reduce overall cost while limiting excessive hardware/software usage, this proposal assumes access and/or availability to the following ADAC provided resources:

- Hosting Data Service – Amazon Web Services – cloud computing server
- Dedicated server, firewall and bandwidth provided by ADAC
- Map service – access to either Google Maps Enterprise mapping services, MapServer, GeoServer, or equivalent.
- Travel – under this basic FIST package, travel for FIST personnel is not included. All travel expenses will be coordinated and approved between the FIST Team and ADAC Leadership on an as need basis. No specific travel schedule is currently requested. If travel is required and approved by ADAC. Travel will be invoiced on a cost reimbursable basis, in accordance with the Joint Travel Regulations (JTR)
- Internships – the FIST team is willing to accept University of Alaska interns as part of this package, in close coordination with ADAC. Under this 3-month package, the FIST team will be willing to accept 2 (two) interns.
- Exercise Participation – the FIST team will participate in exercises and supply technology as necessary within a reasonable timeline and as part of close collaboration with the ADAC team. This basic FIST package does not include any funding allocation towards exercise participation and/or associated travel. As such, any exercise participation requests will need to include funding for the FIST Team.

**Budget Notes for NOVA Corporation:**
- Subaward is based on fixed price of deliverables as discussed above.
- This subaward is subject to 2CFR200 and will have indirect costs associated with $5,000 of the award as the original $20,000 associated indirect costs have been realized in year two project costs.

**University of Alaska Anchorage**

**Total Budget Request for University of Alaska Anchorage:** $47,019

**Budget Request by Object Class for University of Alaska Anchorage:**
Budget Allocated to Workforce Development for University of Alaska Anchorage: $36,000

Budget Justification and Narrative for University of Alaska Anchorage:
Senior Personnel Salaries:
Research PI, Dr. Kenrick Mock is requesting one month’s effort (173.33 hours) for scientific leadership of the project. Dr. Mock will oversee the activities of all vendors and subawards. Dr. Mock will also be responsible for supervision of undergraduate student and workforce development of that student. He will also be assisting with project evaluation and bringing research to capability process.

Total request for senior personnel salaries for year three is $15,449.

Fringe Benefits:
Benefits are applied according to the University of Alaska Anchorage’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $4,712.

Travel:
Domestic: Research PI is requesting trips for project proof of concept and associated meetings with vendors, the U.S. Coast Guard at D-17, and subawardees to conduct recipient monitoring and to have conduct AIFC roundtable. The request includes economy air travel, governmental subsistence allowance (GSA) rate lodging for two days, federal per diem for three days per trip, and miscellaneous expenses and ground transportation for each trip.

Total request for travel for year three is $3,000.

Participant Support:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$20,161.00</td>
<td>$0.00</td>
<td>$20,161.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$3,000.00</td>
<td>$0.00</td>
<td>$3,000.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other (Participant Support)</td>
<td>$36,000.00</td>
<td>$0.00</td>
<td>$36,000.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$11,858.43</td>
<td>$0.00</td>
<td>$11,858.43</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$71,019.43</strong></td>
<td><strong>$0.00</strong></td>
<td><strong>$71,019.43</strong></td>
</tr>
</tbody>
</table>
Three undergraduate student fellowships of $1,000 per month for 12 months is requested. The funding for this request will be discussed in more detail in workforce development. This undergraduate student will specifically work with the AIFC personnel to assist with programmatic needs.

Total request for participant support for year three is $36,000.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska Alaska’s cognizant federal authority and on sponsored research are calculated at 51.2% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current approved F&A Rate Agreement.

Total request for indirect costs for year three is $11,858.

Budget Notes for University of Alaska Anchorage:
- New subawards are included as part of the composition of this project for indirect costs but are not part of this individual component cost.

University of New Mexico

Total Budget Request for University of New Mexico: $46,000

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$32,450.33</td>
<td>$0.00</td>
<td>$32,450.33</td>
</tr>
<tr>
<td>Travel</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$16,549.67</td>
<td>$0.00</td>
<td>$16,549.67</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$49,000.00</strong></td>
<td><strong>$0.00</strong></td>
<td><strong>$49,000.00</strong></td>
</tr>
</tbody>
</table>

Budget Allocated to Workforce Development for University of New Mexico: $0

Budget Justification and Narrative for University of New Mexico:

Senior Personnel Salaries:
Research PI, Director Rebecca Koskela is not requesting salary; however, she will act as a liaison between the University of New Mexico and ADAC, attending meetings as needed and reporting on the status of the university of New
Mexico’s portion of the project. Director Koskela will also be responsible for supervision of Programmer Analyst. She will also be assisting with project evaluation and bringing research to capability process.

Other Personnel Salaries:
Salary support is requested for a Programmer Analyst (Software Developer) at .30 FTE. The Programmer Analyst will assist with use of DataONE software tools, Member Node development and testing. Principle duties include developing data access and data management to connect AIFC with LRAUV’s array of Arctic environmental data. The Programmer Analyst will support Co-PIs in gaining and ingesting relevant data from UNM’s DataONE Center into AIFC and user defined protocols.

Total request for senior and other personnel salaries for year three is $23,531.78.

Fringe Benefits:
Benefits are applied according to the University of New Mexico’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $8,918.55.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of New Mexico’s cognizant federal authority and on sponsored research are calculated at 51.0% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request.

Total request for indirect costs for year three is $16,549.67.

Budget Notes for University of New Mexico:
- The University of Alaska Anchorage will be required per 2CFR200 to assess indirect costs on the first $25,000 of this subaward in year three ($12,800). This cost can be realized in the project composite.

University of Texas-El Paso

Total Budget Request for University of Texas-El Paso: $81,995
Senior Personnel Salaries:
The following personnel and financial commitment will ensure that the project will be well organized and coordinated, collaboration with ADAC personnel are productive, and that project deadlines and needs are met in a timely manner.

Research PI, Dr. Craig Tweedie is requesting two weeks of summer salary. Dr. Tweedie will oversee all aspects of the proposed activities and will ensure all of the tasks identified in the Scope of Work are undertaken in an efficient and timely manner. Tweedie will also lead the field team in the April and August field trips outlined below.

Other Personnel Salaries: No funds are requested for technicians but this project will leverage the expertise of two GIS technicians, a programmer, and a hardware technician funded on other grants in Tweedie’s lab. These technicians will assist with student training, trouble shooting, and liaison with ADAC collaborators.

Graduate Research Assistants: No graduate student salary is requested for this project — instead, and in accordance with DHS guidelines, one graduate student will receive a stipend as outlined below.

Undergraduate Research Assistants: No undergraduate student salary is requested for this project — instead, and in accordance with DHS guidelines, one graduate student will receive a stipend as outlined below.
Time commitments of research personnel will ensure that there is adequate project coordination and engagement, planning, implementation and reporting of project findings.

Total request for senior and other personnel salaries for year three is $5,044.

Fringe Benefits:

Fringe is calculated at the standard and published University of Texas—El Paso fringe and medical benefits schedule.

Total request for fringe benefits for year three is $1,202.

Travel:

Domestic: Travel funds are requested in order to support two trips to Barrow for Dr. Tweedie. In August 2016, Tweedie and students (supported on participant support awards described below) will travel to Barrow to replace and install new camera systems, collect topobathy data adjacent to these observation points, and service the network of automatic meteorological stations. Support has been budgeted for this 14-day trip to include ELP-BRW return airfare ($1400), lodging and per diem ($95pp/day), ground/marine transportation ($200/day ~ will cover all personnel), and miscellaneous expenses for field supplies, extra baggage, permits etc. ($250). In April, 2017 a field trip for Tweedie and one student will be used to service the network of meteorological stations and camera systems and has been budgeted for 8 days and includes return ELP-BRW airfare ($1400), lodging and per diem ($95pp/day), ground transportation ($200/day ~ will cover all personnel), and miscellaneous expenses for field supplies, extra baggage, permits etc. ($250pp). This travel will support AIFC network in helping to feed additional data from Barrow directly.

Total travel requested for year three is $9,790.

Participant Support Costs:

One graduate and one undergraduate will receive 12 month-long participant support awards on this project ~ $1800/mo. and $1000/mo. respectively. The graduate student will also receive 50% support for annual tuition costs in the Environmental Science and Engineering program ~ $3800. Participant support awards for student travel and capstone field based research experience will be awarded to each student who will accompany Tweedie to Barrow for either the August or April field trips described above. These include support for return ELP-BRW airfare ($1400), lodging and per diem ($95/day), and miscellaneous expenses ($250pp).

Total participant support costs for year three is $44,880.
Consultant: Allison Gaylord, owner of Nuna Technologies, has worked in partnership with Tweedie’s research group since 2000 to promote student learning and the development and maintenance of the Barrow Area Information. Within the proposed award, Gaylord will dedicate 50 hours of her time to student training that will ensure adequate data documentation and a capacity to meet the open source/open access and interoperability standards required by ADAC in order to maximize the potential for data integration, fusion, and discovery.

Other Direct Costs: Materials and supplies are budgeted to cover the building costs of each of the eight cameras ($550/camera), a rugged laptop computer that will be used for field based data acquisition and processing, and external hard drives ($2400); fuel ($500); site permits ($550); and miscellaneous field and office supplies (e.g. fuel, notebooks, tools ~ $550).

Indirect Costs: Indirect costs are calculated at the standard UTEP off-campus rate of 26% on all relevant expenses proposed for the award.

Budget Notes for University of Texas-El Paso:
- This is the first year of the subaward agreement and is subject to 2CFR200. Indirect costs will be assessed on the first $25,000 of the subaward and not part of the individual projects but rather part of the composite.

PROJECT: Low-Cost Wireless Remote Sensors for Arctic Monitoring

Project PIs: Dr. Martin Cenek, University of Alaska Anchorage and Mr. Eric Velte, ASRC Federal Solutions.

Total Project Budget Request: $125,863
- ASRC Federal: $33,942
- University of Alaska Anchorage: $91,921 (includes indirect earned from the subaward issued of $12,800)
Project Budget Request by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$22,273.00</td>
<td>$0.00</td>
<td>$22,273.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$5,310.00</td>
<td>$0.00</td>
<td>$5,310.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$33,942.00</td>
<td>$0.00</td>
<td>$33,942.00</td>
</tr>
<tr>
<td>Commoditys</td>
<td>$936.00</td>
<td>$0.00</td>
<td>$936.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other (Participant Support)</td>
<td>$36,000.00</td>
<td>$0.00</td>
<td>$36,000.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$27,362.82</td>
<td>$0.00</td>
<td>$27,362.82</td>
</tr>
<tr>
<td>Total</td>
<td>$125,823.82</td>
<td>$0.00</td>
<td>$125,823.82</td>
</tr>
</tbody>
</table>

Project Budget Allocated to Workforce Development: $55,826
- ASRC Federal: $19,826
- University of Alaska Anchorage: $36,000

Project Budget Justification:

Senior Personnel Salaries:
See individual project components at each institution for request and justification.

Other Personnel Salaries:
See individual project components at each institution for request and justification.

Total request for senior and other personnel salaries for year three is $17,068.

Fringe Benefits:
Benefits are applied according to each institution’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $5,205.

Subawards (listed as a contractual obligation):
ADAC team request to funding to issue a subaward to ASRC Federal Solutions for their part of the scope of work for this project. ASRC Federal Solutions will infuse their current technology and data sensor capabilities with the University of Alaska Anchorage sensor model to create an array of sensors. This subaward would be subject to F&A on the first $25,000 per 2CFR200. The budget and budget justification for ASRC Federal Solutions is provided below.

Total request for a subaward for year three is $33,942.

Travel:
Domestic: See individual project components at each institution for request and justification.

Total request for travel for year three is $5,310.
Materials and Supplies:
See individual project components at each institution for request and justification.

Total request for materials and supplies for year three is $936.

Participant Support:
See individual project components at each institution for request and justification.

Total request for participant support for year three is $36,000.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with both ASRC Federal Solutions’ and the University of Alaska’s cognizant federal authorities. ASRC Federal Solutions’ applies contractor rates approved for Department of Defense contractors. The University of Alaska Anchorage utilizes an MTDC method for calculation of indirect costs on sponsored research. MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request.

Total request for indirect costs for year three is $27,362.

Project Budget Notes:
- The amount for the University of Alaska Anchorage component does not include F&A ($12,800) for the subaward issued to ASRC Federal Solutions. This amount is in the total project composite (above) but not part of the individual project since Dr. Ravens does not have access to the recovered F&A.

Individual Project Budget Components:
ASRC Federal Mission Solutions, LLC:

Total Budget Request for ASRC Federal Mission Solutions, LLC: $33,942

Budget Request by Object Class for ASRC Federal Mission Solutions, LLC:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$28,677.92</td>
<td>$0.00</td>
<td>$28,677.92</td>
</tr>
<tr>
<td>Travel</td>
<td>$5,263.50</td>
<td>$0.00</td>
<td>$5,263.50</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$33,941.42</strong></td>
<td><strong>$0.00</strong></td>
<td><strong>$33,941.42</strong></td>
</tr>
</tbody>
</table>
Budget Allocated to Workforce Development for ASRC Federal Mission Solutions, LLC: $19,826

Budget Justification and Narrative for ASRC Federal Mission Solutions, LLC:

Senior Personnel Salaries:
Research PI, Mr. Eric Velte is requesting 96 hours’ effort for scientific leadership of the project. Mr. Velte will be responsible for working with the UAA sensor research team and coordinating activities of the development team and oversee the activities of the subaward. He will also be assisting with project evaluation and bringing research to capability process.

Other Personnel Salaries:
Undergraduate Researcher, TBN is requested for 862 hours in total to compile data, perform data analysis and to assist research team across activities. Student is budgeted at 584 hours during academic year and 278 hours for summer at $23 per hour fully burdened.

Total request for senior and other personnel salaries for year three is $28,678.

Fringe Benefits:
Per subaward’s federally negotiated rates, salary was fully burdened.

Travel:
Domestic: Research PI or designee is requesting two project trips for project proof of concept and associated meetings with ADAC team and the U.S. Coast Guard. Additional trip is budgeted to present findings at Arctic Science Summit conference. The request includes economy air travel, governmental subsistence allowance (GSA) rate lodging for two days, federal per diem for three days per trip, and miscellaneous expenses and ground transportation for each trip.

Total request for travel for year three is $5,264.

Indirect Costs:
Fringe and company overhead including facilities and general administrative costs are part of the fully burdened rates. Fringe only is applied to the student research assistant while the other three indirect rates are applied to the PI due to being a full-time employee.

Budget Notes for ASRC Federal Mission Solutions, LLC:
- Benefits are applied according to AFMS’s provisional billing rates.
- Rates have been approved by DCAA for the purposes of federal contracting.
Total Budget Request for University of Alaska Anchorage: $79,006

Budget Request by Object Class for University of Alaska Anchorage:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$22,273.00</td>
<td>$0.00</td>
<td>$22,273.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$5,310.00</td>
<td>$0.00</td>
<td>$5,310.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$936.00</td>
<td>$0.00</td>
<td>$936.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other (Participant Support)</td>
<td>$36,000.00</td>
<td>$0.00</td>
<td>$36,000.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$14,601.73</td>
<td>$0.00</td>
<td>$14,601.73</td>
</tr>
<tr>
<td>Total</td>
<td>$79,120.73</td>
<td>$0.00</td>
<td>$79,120.73</td>
</tr>
</tbody>
</table>

Budget Allocated to Workforce Development for University of Alaska Anchorage: $36,000

Budget Justification and Narrative for University of Alaska Anchorage:

Senior Personnel Salaries:
Research PI, Dr. Martin Cenek is requesting one month’s effort (173.33 hours) for scientific leadership of the project. Dr. Cenek will oversee the activities of the subaward. Dr. Cenek will also be responsible for supervision of graduate and undergraduate students and workforce development of those student. He will also be assisting with project evaluation and bringing research to capability process.

Other Personnel Salaries:
Researcher, Dr. Aaron Dotson is requesting two weeks’ (80 hours) effort to assist Dr. Cenek and continue development of the project, validation of data, and collaborate on publications as appropriate stemming from the ADAC project.

Total request for senior and other personnel salaries for year three is $17,247.

Fringe Benefits:
Benefits are applied according to the University of Alaska Anchorage’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $4,950.
Travel:
*Domestic:* Research PI and Researcher are requesting trips for project proof of concept and associated meetings with vendors, the U.S. Coast Guard, and subawardees. The request includes economy air travel, governmental subsistence allowance (GSA) rate lodging for two days, federal per diem for three days per trip, and miscellaneous expenses and ground transportation for each trip.

Total request for travel for year three is $5,310.

Materials and Supplies:
Computer supplies are being requested to assist with the development and testing of sensors. All supplies are disposable.

Total request for materials and supplies for year three is $936.

Participant Support:
Three undergraduate student fellows of $1,000 per month for 12 months is requested for student fellows to work specifically on the development of the sensor array. The funding for this request will be discussed in more detail in workforce development.

Total request for participant support for year three is $36,000.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska Fairbanks’ cognizant federal authority and on sponsored research are calculated at 50.5% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current approved F&A Rate Agreement.

Total request for indirect costs for year three is $14,563.

**PROJECT:** New class of propeller-driven Long-Range AUV for Under Ice Mapping of Oil Spills and Environmental Hazards.

**Project PI:** Dr. James Bellingham, Woods Hole Oceanographic Institute

**Total Project Budget Request:** $460,892
Project Budget Request by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$102,530.00</td>
<td>$0.00</td>
<td>$102,530.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$7,085.00</td>
<td>$0.00</td>
<td>$7,085.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$50,000.00</td>
<td>$0.00</td>
<td>$50,000.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$116,100.00</td>
<td>$0.00</td>
<td>$116,100.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$36,500.00</td>
<td>$0.00</td>
<td>$36,500.00</td>
</tr>
<tr>
<td>Other</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$148,667.00</td>
<td>$0.00</td>
<td>$148,667.00</td>
</tr>
<tr>
<td>Total</td>
<td>$460,882.00</td>
<td>$0.00</td>
<td>$460,882.00</td>
</tr>
</tbody>
</table>

Project Budget Allocated to Workforce Development: $0

Project Budget Justification:

Senior Personnel Salary:
Research, PI Dr. Jim Bellingham will be responsible for overall coordination of the project. Funding for his effort will be provided through the Center for Marine Robotics at WHOI.

Other Personnel Salary:
A. Kukulya will be responsible for operations and systems engineering, project development, management and coordination, R. Stokey, M. Jakuba will be responsible for software development and sensor simulation. C. Reddy will be responsible for scientific expertise and data analysis. MBARI, A. Kukulya and M. Jakuba will be responsible for vehicle development and testing. L. Freitag and K. Ball will assist with modem integration and data transmission for the demo. J. Kaeli will assist with data visualization and software. B. McCall and M. Basile will support procurement and budget reports.

Fringe Benefits:
Benefits are applied according to Woods Hole Oceanographic Institute’s approved federally negotiated fringe benefit rates.

Total request for salary and fringe benefits for personnel for year three is $102,530.

Equipment:
Funds have been requested to purchase a fluorometer to integrate into an AUV for a fall demo 2016 as well as peripheral hardware ($13,500). Funds are requested for a vehicle pressure housing, as well as materials for vehicle construction. Funds have been requested to purchase an extended endcap ($5208*), NBOSI CTD, Aanderra Oxygen Optode ($16,733*).

Travel:
Domestic Travel: Funds have been requested for two trips to Monterey, CA for vehicle development for one person. Funds are
requested for one trip to UAA for a meeting.

   Total request for travel for year three is $7,085.

Other Direct Costs:
Monies are requested for materials and supplies that include fabricated elements and small parts for the LRAUV. Funds are requested for peripheral cables and connectors for sensors and endcap. Funds are requested for L support equipment. Funds are requested for a WHOI modem 2.0 for vehicle to ship communications. Funds are requested for two half days for the OSL Zodiac for pre demo vehicle testing (half day=$450). Two full days of the R/V Tioga are requested for a fall demo exercise ($3300/day). $100 is requested for phone calls and faxing. 40 hours of shop ($60/hr) time are requested in order to machine an endcap for the fluorometer sensor.

   Total other direct costs for year three is $116,100.

Contractual and Outside services:
Mike Godin will be contracted to assist with vehicle software for $10,000. MBARI, non-profit which owns the licensing for the LRAUV, will be contracted to provide technical support and assist with building the LRAUV for $40,000.

   *quote has been taken from the Hydroid 2016 Price Sheet

   Total contractual and outside services for year three is $50,000.

Indirect Costs:
The Woods Hole Oceanographic Institution (WHOI) is a non-profit [501c (3)] research and education organization subject to the cost principles of 2 CFR 200. WHOI Principal Investigators are responsible for conceiving, funding and carrying out their research programs. Senior Personnel are expected to raise 12 months of support for themselves and their staff by writing proposals and obtaining sponsored research grants and contracts from a variety of sources. Some teach voluntarily in MIT/WHOI’s Joint Program, but support for this is limited.

The rates included in the proposal are negotiated with our cognizant government agency (Office of Naval Research).

For 2016 proposed costs, WHOI calculates overhead rates (both Laboratory Costs and General & Administrative Costs) as a percent of total direct salaries and benefits, as allowed by 2 CFR 200. Direct salaries exclude overtime-premium pay. A proposed labor month is equal to 152 hours or 1824 hours annually versus 2080 hours (40 hours/week for 52 weeks). The difference is for vacations, holidays, sick time, and other paid absences, which
are included in the Paid Absences calculation. WHOI cannot “waive” or reduce overhead rates on any sponsored research project due to the structure of our negotiated rates with our cognizant government agency. When a program sets limits on overhead, WHOI must use Institution unrestricted funds to pay the unfunded portion of the overhead costs.

In December 2015 WHOI received approval from our cognizant government agency to change the method of allocation of indirect costs to Modified Total Direct Costs (MTDC) effective 1/1/2017. Therefore, for 2017 and beyond, the MTDC allocation method is used to calculate indirect costs. The normal exclusions contained in 2 CFR 200.68 (MTDC) apply, as well as the following approved exclusions: ship use, submersible use, vessel charters and ship fuel.

Total indirect costs for year three is $148,667.

Project Budget Notes:
- No indirect costs will be reclaimed by the University of Alaska Anchorage for the subaward issued to Woods Hole Oceanographic Institute.
- All 2CFR200 regulations have been applied and fulfilled.
- Please note that pricing for the fall AUV demonstration is based on Woods Hole as the designated location. No travel is budgeted for an alternate location.

Theme 3: E2E

Project: E2E

Project PI: N/A

Total Project Budget Request: $0

Project Budget Request by Object Class: Project and theme are being defunded in year three; no breakdown of costs necessary as there are no costs.

Project Budget Allocated to Workforce Development: $0

Project Budget Justification: N/A

Project Budget Notes: N/A
Theme 4: Integrated Education

PROJECT: Arctic Education: Implementing the Arctic Strategy in Training

Project PI: Susan Hazelton, Coordinator Continuing Education, Maine Maritime Academy

Total Project Budget Request: $102,352

Project Budget Request by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$44,787.52</td>
<td>$0.00</td>
<td>$44,787.52</td>
</tr>
<tr>
<td>Travel</td>
<td>$9,000.00</td>
<td>$0.00</td>
<td>$9,000.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$1,800.00</td>
<td>$0.00</td>
<td>$1,800.00</td>
</tr>
<tr>
<td>Commodity</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other (Symposium)</td>
<td>$15,000.00</td>
<td>$0.00</td>
<td>$15,000.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$31,764.38</td>
<td>$0.00</td>
<td>$31,764.38</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$102,351.90</strong></td>
<td><strong>$0.00</strong></td>
<td><strong>$102,351.90</strong></td>
</tr>
</tbody>
</table>

Project Budget Allocated to Workforce Development: $0

Project Budget Justification:

Senior Personnel Salaries:
Research PI, Captain Ralph Pundt is requesting 400 hours’ effort for scientific leadership of the project. Captain Pundt will oversee the activities of accreditation and class development. He will also be assisting with project evaluation and bringing research to capability process.

Ms. Sue Hazelton is requesting 400 hours’ effort to assist Captain Pundt with the technical and administrative aspects of curriculum development and accreditation.

Total request for senior and other personnel salaries for year three is $32,932.

Fringe Benefits:
Benefits are applied according to the Maine Maritime Academy’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $11,856.

Travel:
Domestic: Senior Personnel are requesting trips for accreditation and associated meetings with ADAC team and the U.S. Coast Guard. The request includes economy air travel, governmental subsistence allowance (GSA) rate lodging for two days, federal per diem for three days per
trip, and miscellaneous expenses and ground transportation for each trip.

Total request for travel for year three is $9,000.

Contractual:
Funding is being requested to work with consultant STCW for appropriate formatting of accreditation paperwork and filing.

Total request for materials and supplies for year three is $1,800.

Other Direct Costs:
Symposium funding is being requested to showcase classes in a testing environment.

Total request for participant support for year three is $15,000.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the Marine Maritime Academy’s cognizant federal authority and on sponsored research are calculated at 45% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current approved F&A Rate Agreement.

Total request for indirect costs for year three is $31,764.

**Project Budget Notes:**
- No indirect costs will be reclaimed by the University of Alaska Anchorage for the subaward issued to Marine Maritime Academy.
- All 2CFR200 regulations have been applied and fulfilled.

**PROJECT: Minority Serving Institutions (MSI) outreach; and (combined projects)**

**PROJECT: Integrated Arctic Maritime Education (projects have been combined and will be managed by Education and Outreach Director to utilize resources effectively)**

**Project PI:** Clarice Conley, Education and Outreach Director, University of Alaska Anchorage

**Total Project Budget Request:** $129,493
Project Budget Request by Object Class:

<table>
<thead>
<tr>
<th>Object Class</th>
<th>Year Three Proposed</th>
<th>Carry Forward</th>
<th>Total Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary and Fringe Benefits</td>
<td>$69,916.00</td>
<td>$0.00</td>
<td>$69,916.00</td>
</tr>
<tr>
<td>Travel</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Contractual</td>
<td>$2,500.00</td>
<td>$0.00</td>
<td>$2,500.00</td>
</tr>
<tr>
<td>Commodities</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Equipment</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Other (Participant Support)</td>
<td>$20,000.00</td>
<td>$0.00</td>
<td>$20,000.00</td>
</tr>
<tr>
<td>Indirect</td>
<td>$37,076.99</td>
<td>$0.00</td>
<td>$37,076.99</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$129,492.99</strong></td>
<td><strong>$0.00</strong></td>
<td><strong>$129,492.99</strong></td>
</tr>
</tbody>
</table>

Project Budget Allocated to Workforce Development: 20,000

Project Budget Justification:

Senior Personnel Salaries:
Education and Outreach Director, TBN is requesting six month’s effort for leadership, development, and management of the ADAC and CDG Fellows program. The recruitment process for this candidate is underway. The successful candidate will oversee the activities of the students along with ADAC faculty mentors. The successful candidate will also be assisting with project evaluation and bringing recruitment efforts to workforce development capacity and opportunities for DHS and ADAC.

Total request for senior and other personnel salaries for year three is $47,757.

Fringe Benefits:
Benefits are applied according to the University of Alaska Anchorage’s approved federally negotiated fringe benefit rates.

Total request for fringe benefits for personnel for year three is $22,159.

Contractual:
Funding is requested to start and then expand the ADAC Fellow Research Network to include setup of email, website, monthly meetings.

Total request for contractual support for year three is $2,500.

Participant Support:
Five ADAC Summer Fellows at $2,000 per month for two summer months is requested. The funding for this request will be discussed in more detail in workforce development.

Total request for participant support for year three is $20,000.

Indirect Costs:
Facilities and Administrative (F&A) Costs are negotiated with the University of Alaska Anchorage’s cognizant federal authority and on
sponsored research are calculated at 51.2% of the modified total direct costs (MTDC). MTDC includes total direct costs (TDC) minus tuition, scholarships/fellowships, subaward amounts over $25,000, participant support costs, and equipment over $5,000. A copy of the rate agreement is available upon request. The indirect rate applied for this request is based on the current approved F&A Rate Agreement.

Total request for indirect costs for year three is $37,076.99.

**Budget and Justification – Institutional Support (Proposed)**

**Total Institutional Support Requested to the University of Alaska System:**
$597,520 (does not account for returned indirect back to the ADAC project directly)

<table>
<thead>
<tr>
<th>Institutional Support Budget Request by Object Class:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object Class</td>
</tr>
<tr>
<td>Salary and Fringe Benefits</td>
</tr>
<tr>
<td>Travel</td>
</tr>
<tr>
<td>Contractual</td>
</tr>
<tr>
<td>Commodities</td>
</tr>
<tr>
<td>Equipment</td>
</tr>
<tr>
<td>Other (Tuition Waivers)</td>
</tr>
<tr>
<td>Indirect</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

**Institutional Support Budget Allocated to Workforce Development:**
Approximately $92,000 in tuition waivers for graduate student

**Institutional Support Budget Justification:**

**Senior Personnel Salaries:**

PI, Dr. Douglas Causey is requesting ten percent effort (208 hours) for scientific leadership of the project as additional institutional support on the award. Per the University of Alaska Board of Regent’s Policy Manual, PIs must charge a minimum effort of five percent to sponsored research; all other costs are charged as institutional support. Dr. Causey is responsible for all associated PI duties of the award to include but not limited to: management of the ADAC team, obtaining institutional support, and reporting required to DHS as per the Terms and Conditions.

Executive Director, Randy A. Kee is requesting 12 months’ effort for leadership of the project. Executive Director Kee is responsible for the day to day management and operations of the Arctic Domain Awareness Center. He is also responsible as part of the executive team with project assessment and bringing research to capability.
Finance Director, Heather L. Paulsen is requesting 6 months’ effort for financial leadership of the project. Finance Director Paulsen will manage the day to day financial transactions and auditing requirements.

Education and Outreach Director, TBN is requesting six month’s effort for leadership, development, and management of the ADAC and CDG Fellows program. The recruitment process for this candidate is underway. The successful candidate will oversee the activities of the students along with ADAC faculty mentors. The successful candidate will also be assisting with project evaluation and bringing recruitment efforts to workforce development capacity and opportunities for DHS and ADAC.

Associate Director of Operations, Elyce Hackley is requesting six months’ effort for day to day performance of administration duties associated with the Center.

    Total request for senior and other personnel salaries for year three is $323,250.

Fringe Benefits:
Benefits are applied according to the University of Alaska Anchorage’s approved federally negotiated fringe benefit rates.

    Total request for fringe benefits for personnel for year three is $129,710.

Contractual:
Request for $32,400 is made to support continued web contracts for website, Department of Defense certification requirements, and information technology work that cannot be completed by the University of Alaska Anchorage IT team due to migration of platforms. These services are requested of Dubay who has worked on the project since year two.

Additional funding is requested in the amount of $10,000 for various expenditures that might be needed during year three to include preparation of the bi-annual review, additional required meetings, etc.

    Total request for contractual for year three is $42,400.

Materials and Services:
Additional funding is requested in the amount of $10,000 for various expenditures that might be needed during year three to include preparation of the bi-annual review, additional required meetings, etc.

    Total request for material and services for year three is $10,000.
Participant Support:
Request for funding is made for 10 in-state tuition waivers for the full year. As written in the original proposal, tuition waivers for graduate students were committed by the Institution.

Total request for participant support for year three is $92,160.

Project Budget Notes:
- Institution agreed to contribute greater returned indirect back to the project to help support internal needs of ADAC. $153,147 is the anticipated indirect to be returned to the Center in year three to help defray costs.
- Other Institutional Support requests are pending with the System for final approval and determination.

The section showing Institutional Support no way binds the institution until final approval has been received by ADAC.
Appendix B. Arctic Information Fusion Capability Team specific tasks.

The following describes the particular focus and project work for the AIFC development team envisioned in the coming project year:

Alaska Ocean Observation System/Axiom Data Sciences: Will provide data engineering and access to authoritative data sources to advance applied research in direct support of Co-PIs and hosting of UAA student research interns.

For the purpose of AIFC, Axiom Data Sciences has proposed a framework for managing a variety of ocean data types (in-situ and remotely sensed data streams, multidimensional grids, GIS and other structured formats).

The following represents Axiom’s planned structural engineering for AIFC.

This framework exposes managed data through interoperability systems and uses several user interface tools that allow the data to be discovered and explored by the broader community. Utilizing this framework to power the AIFC will enable the ADAC data team to rapidly ingest or connect to data sources relevant to ADAC and develop advanced user tools efficiently. The framework below illustrates the flow of data through logical technology tiers, enabling discovery and understanding the ocean and coastal environments.

Figure 16 AIFC Structural Overview (Axiom Data Sciences)
At the base (Tier 1) of the pyramid lie source data produced by numerical modeling centers, GIS analysts, instruments, CSW catalogs, models and remote sensing platforms.

Many data sources can be ingested autonomously into the back-end data system through a series of harvesting mechanisms written in Java, Scala and Python that make use of lower-level interfaces (e.g., FTP, HTML and ad hoc service APIs). Data files are processed during the ingestion process and loaded into a clustered file storage and database system (GlusterFS and Postgres).

A suite of interoperable systems (Tier 2) connect to the data storage, including 52 North SOS, GeoServer, THREDDS, ErDDAP, ncWMS and ncSOS, and they expose data feeds through SOS, WFS, WCS, WMS and OPeNDAP protocols.

The asset catalog (Tier 3) is a database containing ontological information describing the dimensional characteristics (space, time, unit, measured parameter and taxonomy) of each known data resource and how these characteristics relate to each other across data sets. References to both internally- and externally-hosted data feeds are stored in the ontological database and provide the user with a harmonized set of interfaces for consistent access to data and visualizations.

Sensors, numerical model output and remotely sensed observation grids are mapped to common characteristics (space, time, and climate forecast parameter) for comparison across sources. Data sets are further mapped across keywords and, if applicable, Integrated Taxonomic Information System (ITIS) records.

The asset catalog also exposes web services providing external access to metadata in the database and provides a method for indexing metadata across multiple formats and types using ElasticSearch, a scalable, Apache Lucene based, clustered search engine.

The top level (Tier 4) is composed of the web-based applications and tools that provide users with access to data and products, which are developed in HTML5 and various web programming user interface frameworks. Users sit at the top of the pyramid with all underlying systems working together to create a powerful and intuitive way to rapidly discover, access and use data. This framework has enabled Axiom to support three other IOOS Regional Associations, several non-governmental research funders, and many state and federally funded research and data integration centers.

In order to create the AIFC structure, the below are the recommended specific tasks:

1. Ingest, integrate and fuse data sources - Axiom software engineers and data scientists will work to ingest and integrate
sources of relevant data which will include numerical models describing ocean/atmosphere conditions (Tom Ravens, University of Washington and others), satellite imagery (UAF Geophysical Institute, NASA and NOAA) and other sources of GIS and scientific time series. These datasets, once processed, will be enabled to be visually integrated onto a web based map and common timeline. Inter comparison across disparate data types will be possible enabling data fusion. Furthermore, users will be able to review and assess these resources through a data catalog interface which can be searched and filtered across several dimensions including space, time and data type.

2. Coordinate with ADAC partners to interchange data feeds - Axiom will work with team members at UAF Geophysical Institute, ER, SAROPS and FIST to coordinate the interchange of data feeds. This will include standing up Open Geospatial Consortium (OGC) compliant data feeds to serve out to partners in addition to ingesting and integrating feeds made available from partner groups.

3. Improve user interface tools to better support protocols of the emergency response community and Coast Guard - The AIFC platform will be to better support the operating procedures of emergency responders and Coast Guard. This will include developing software interfaces which provide users with advanced data integration and analytics.

Marine Exchange of Alaska: Will provide latent data feeds of maritime traffic information.

NOVA Dine and Kestrel Corporations: Provides applied research to enable a field deployable aspect of AIFC, to the benefit of USCG on-scene coordinators and community-based observers. NOVA Corporation has previously developed a Field Information Support Tool (FIST) in support of USG field operations. Applied research application of FIST may prove useful to support field operations for both USCG on-scene coordinators and community-based observers. As a Phase One effort, an interaction of USCG on-scene coordinators and/or a community-based observer network CBONS and Arctic Fusion Ops will demonstrate:

- Strategic Plan for collection and reporting for HADR pre-incident preparation for USCG on-scene coordinators and community-based observers a community environment.
- Aggregation and Fusion of multi-source data across a Region
- Assessment and Analysis and Decision Support Knowledge
- Decision Application and Incident Management

In summary knowledge creation will be applied to support HADR field operations in a unified cycle as per below:
The value achieved by the effort will be increasing regional understanding that can be readily applied in complex, high tempo HA DR response in austere communication environments.

In order to demonstrate in the above concept within the project resource envelope, a detailed data collection exercise spaced over time can replicate a real deployment.

Additional data inputs will be harvested or simulated from additional virtual data collections to enable fusion based analytics. Command center information will then guide the local community team in a follow-on data-driven response exercise.

For planning purposes, in project year, supporting deployable AIFC team will appropriately coordinate a fictitious scenario of a ship foundering in Arctic coastal waters to exercise deployable AIFC to create a data collection exercise.

The exercise will simulate recovery surveys - incident preparation for activities such as qualifying boat landings, identifying hazards to navigation and transport, location of air transport sites and emergency triage locations with resource support (water, shelter, aid supplies).

For further planning purposes, in project year, supporting deployable AIFC team will appropriately coordinate with CBONS-SA for Community Surveys, in order to identify and socialize and initiate “high fidelity” community members for civic support of environmental management and response.

Additionally, deployable AIFC team will work communications aspects of fusion. This will be an exercise of SATCOM in both handheld and portable modes that could directly benefit USCG on-scene coordinators and other government responders.

Deployable AIFC team support in applied research for Multi-source Fusion. Access to authoritative data from the below myriad of sources, historical, near real time (between a few seconds and up to 30 minutes) and/as designated via user defined needs can greatly aide as appropriate, on-scene coordinators and community observers.

Further field deployable AIFC capabilities (as a result of investigating current and tailorable aspects of NOVA Corporation capabilities) to be investigated in the applied research in the coming project year:
• Historical data in any format that could be ingested, visualized, examined, and analyzed. This includes historical data on vessels, environmental statistics, AIS feeds.
• Available field reports (from shore, vessel, or high-fidelity reporters), alarms, and multi-media are visualized in near real-time for rapid situational awareness.
• A cell phone centric data system, combined with a wide variety of distributed sensors leave to informed decisions and making deployed AIFC an effective communication protocol.
• Data collected is possible be quickly and easily exported into Social Network Analysis tools to identify and display networks. This includes potentially describing CBONS communities of interest.
• Data can be utilized to identify specific areas of interest according through the FIST region mapping capability.
• Incident response: Aid to a cruise or passenger ship incident.
• Creation, distribution of basic response plans
• Leverage Regional, Area and Environmental Knowledge to guide responders
• Assess resources and local environment
• Coordinate responders to plan of action in a local area
• High fidelity or other operators support detailed landing taking into account sea-state, terrain, and winds
• Mobile assessment of local area
• Distressed ship landing monitoring
• Terrestrial triage and evacuation preparations.
• Post event lessons learned

In sum, the deployable AIFC team of NOVA Dine and Kestrel Corporations will work in close collaboration with the remainder of the AIFC team to ensure that developed capability for between “main” and deployable” remain fully synchronized.
University of Alaska Anchorage: UAA principally serves as a co-developer of AIFC, with specific focus in the computer engineering to integrate multiple sources of authoritative data and information, to then fuse for agile decision support.

University of Alaska Fairbanks: UAF principally serves as co-developer of AIFC with specific focus towards information system engineering, connecting with authoritative data sources. These include existing information, satellite feeds (in particular commercially available near real-time Electro-optical and Synthetic Aperture Radar imagery) and mapping networks across Alaska and the Arctic. Accordingly, leveraging access through UAF’s Geophysical Institute, Geographic Information Network of Alaska, Alaska Satellite Facility and other aspects as available, provides the project co-developer team in Fairbanks an array of useful material to aid USCG decision support.

University of New Mexico: UNM’s Data Observation Network for Earth (DataONE) provides AIFC project team access to authoritative Arctic data and expertise in data management. DataONE is comprised of a distributed network of data centers, science networks or organizations. DataONE is leading national and international efforts to federate data holdings from a wide variety of institutions.
associated with the biological, environmental and Earth sciences to facilitate data discovery and new knowledge creation.

DataONE will support AIFC through its existing programs to support science by: (1) engaging the relevant science, library, data, and policy communities; (2) facilitating easy, secure, and persistent storage of data; and (3) disseminating integrated and user-friendly tools for data discovery, analysis, visualization, and decision-making.

DataONE contributes to AIFC through data management, particularly through interoperability of data collections, even in the face of heterogeneous metadata. DataONE has developed standard interfaces for providing access to community collections. By providing a standard interface, the multiple independent collections can be federated into a community resource.

In addition, DataONE has added a new provenance tracking system that will work with existing analytical software and enable researchers to easily replicate complex analyses as well as understand how results were derived.

ADAC will be able to leverage core services provided by the DataONE infrastructure in support of AIFC development. Such services include: globally unique identifiers for all data and metadata objects; preservation by replication of content across participating Member Nodes; extensible search and discovery services; and federated identity and access control.

Specific areas of collaboration between DataONE and ADAC for the AIFC project include: Help identifying existing datasets from Member Nodes that would be made available to the project.

There are four existing Member Nodes (MN) with data of interest to this project: the Alaska Ocean Observing System Gulf of Alaska Data Portal, the International Arctic Research Center (IARC) Data Archive, the NOAA National Centers for Environmental Information (NCEI) Oceanographic Data Archive, and our newest MN, the NSF Arctic Data Center.

Upcoming project year will investigate and research a suitable AIFC Develop a data management plan to ensure that data created by this project will be well-described, easily discoverable, and have long-term availability. Additionally, applied research will be conducted to ensure datasets from AIFC are on a pathway to be incorporated into an existing or new Member Node of DataONE.
University of Texas El Paso. UTEP will directly collaborate with Co-PIs in the overall engineering and integration of models and sensors to AIFC. Through an extension of established working collaborations and discussions with ADAC investigators, UTEP will leverage multiple past and current research efforts and their related infrastructures to AIFC.

UTEP component of AIFC network will focus on data and information sources integration, for sensor model advancement and inclusion. Such work will enable development and integration into AIFC – particularly those focused on Arctic sea ice and storm surge modeling and low-cost sensors for arctic monitoring.

Accordingly, UTEP’s focus will promote access to historic data sets and transmission of near real time data (between a few seconds and up to 30 minutes) from a 5-node wireless meteorological and environmental sensor network spanning the Barrow Peninsula. Data will be documented using standards promoting open access, interoperability, and discoverability and span 2013-2017.

Synthesize recent erosion estimates from survey-grade Differential GPS surveys of 120km shoreline in the Barrow area including waterline, bluff edge, engineered structures, and beach profiles along the Chukchi Sea and Elson Lagoon coastlines. This data will also include detailed characterization of land-sea topobathy adjacent to camera stations described below.

Replace ageing fixed camera traps that have captured time lapse images of coastal erosion and beach, ice, and wave dynamics at 7 locations along the Chukchi Sea and Elson Lagoon coastlines since 2012. Replacement cameras that will be serviced multiple times during the award period will include a new and highly customized digital camera system that was recently provisionally patented by Tweedie and students, which is coupled to digital image analysis software.

Develop algorithms from the analysis of time lapse coastal digital photography as a baseline for the automated detection of different sea ice conditions, landscape phenology, sea state from fixed camera stations.

Document data using established open source standards that maximize data integration and fusion, and discoverability.

Contribute to the education of three minority Hispanic students spanning three degree programs at one of the nation’s largest minority-majority serving institutions with a proven research record in the Arctic.
Enhance collaboration and communication with other ADAC project personnel to synergize, share, and communicate findings in a manner that maintains a creative and productive research and education environment. Risk to conclude project goals for the coming year is rated medium to medium-high.
## Appendix C: Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACNFS</td>
<td>Arctic Cap Nowcast/Forecast System</td>
</tr>
<tr>
<td>ADAC</td>
<td>Arctic Domain Awareness Center</td>
</tr>
<tr>
<td>ADCIRC</td>
<td>Advanced Circulation Model</td>
</tr>
<tr>
<td>AESC</td>
<td>Arctic Executive Steering Committee</td>
</tr>
<tr>
<td>ADAC Fellows Program</td>
<td>ADAC Fellows Program</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AIA</td>
<td>Aleut International Association</td>
</tr>
<tr>
<td>AIFC</td>
<td>Arctic Information Fusion Capability</td>
</tr>
<tr>
<td>AIS</td>
<td>Arctic Information System</td>
</tr>
<tr>
<td>AOOS</td>
<td>Alaska Ocean and Observation System</td>
</tr>
<tr>
<td>AOS</td>
<td>Arctic Oil Spill Calculator</td>
</tr>
<tr>
<td>ARN</td>
<td>ADAC Research Network</td>
</tr>
<tr>
<td>ASRC FS</td>
<td>Arctic Slope Regional Corporation Federal Systems</td>
</tr>
<tr>
<td>BOEM</td>
<td>Bureau of Ocean Energy Management</td>
</tr>
<tr>
<td>BSSN</td>
<td>Bering Sea Sub-Network</td>
</tr>
<tr>
<td>CAFF</td>
<td>Conservation of Arctic Flora and Fauna</td>
</tr>
<tr>
<td>CDG</td>
<td>Career Development Grant</td>
</tr>
<tr>
<td>CBP</td>
<td>Customs and Border Protection</td>
</tr>
<tr>
<td>CBO</td>
<td>Community Based Observers</td>
</tr>
<tr>
<td>CBONS-SA</td>
<td>Community Based Observing Networks for Situational Awareness</td>
</tr>
<tr>
<td>C&amp;ES AD</td>
<td>Communications and Educational Support Associate Director</td>
</tr>
<tr>
<td>CIMES</td>
<td>Center for Island Maritime and Extreme Environment</td>
</tr>
<tr>
<td>CIS</td>
<td>Critical Indicators System</td>
</tr>
<tr>
<td>CPS</td>
<td>Climate Forecast System</td>
</tr>
<tr>
<td>CMR</td>
<td>Center for Maritime Research</td>
</tr>
<tr>
<td>COE</td>
<td>Centers of Excellence</td>
</tr>
<tr>
<td>CONAS</td>
<td>Community Observing Network for Adaptation and Security</td>
</tr>
<tr>
<td>COTS</td>
<td>Commercial Off-the-Shelf</td>
</tr>
<tr>
<td>CPS</td>
<td>Climate Forecast System</td>
</tr>
<tr>
<td>DA-E</td>
<td>DHS Data Analytics Engine</td>
</tr>
<tr>
<td>DGPS</td>
<td>Differential Global Positioning System</td>
</tr>
<tr>
<td>DHS</td>
<td>Department of Homeland Security</td>
</tr>
<tr>
<td>DHSEM</td>
<td>Division of Homeland Security and Emergency Management (State of Alaska)</td>
</tr>
<tr>
<td>DHS S&amp;T OUP</td>
<td>Department of Homeland Security Science &amp; Technology’s Office of University Programs</td>
</tr>
<tr>
<td>DIPP</td>
<td>Data Information Protection Plan</td>
</tr>
<tr>
<td>DR</td>
<td>Disaster Response</td>
</tr>
<tr>
<td>E2E</td>
<td>End to End</td>
</tr>
<tr>
<td>ED</td>
<td>Executive Director</td>
</tr>
<tr>
<td>EO&amp;WFD</td>
<td>Education Outreach and Workforce Development Director</td>
</tr>
<tr>
<td>ERAU</td>
<td>Embry Riddle Aeronautical University (ERAU)</td>
</tr>
<tr>
<td>EO&amp;WFD</td>
<td>Education Outreach and Workforce Development Director</td>
</tr>
<tr>
<td>ERMA</td>
<td>Environmental Response Management Application</td>
</tr>
<tr>
<td>ET</td>
<td>Extra Tropical Storm Surge</td>
</tr>
<tr>
<td>FEMA</td>
<td>Federal Emergency Management Agency</td>
</tr>
<tr>
<td>FMI</td>
<td>Finnish Meteorological Institute</td>
</tr>
<tr>
<td>FIST</td>
<td>Field Information Support Tool</td>
</tr>
<tr>
<td>FTD</td>
<td>Federal Tribal Designation</td>
</tr>
<tr>
<td>FTIR</td>
<td>Fourier Transform Infrared Spectroscopy</td>
</tr>
<tr>
<td>GoMRI</td>
<td>Gulf of Mexico Research Initiative</td>
</tr>
<tr>
<td>GNOME</td>
<td>General NOAA Operational Modeling Environment</td>
</tr>
<tr>
<td>HA</td>
<td>Humanitarian Assistance</td>
</tr>
</tbody>
</table>
HFO
High Fidelity Observer

HTOMAS
High-resolution Ice-Ocean Modeling and Assimilation System

HIPPA
Health Insurance Portability and Accountability Act

HSARPA
Homeland Security Advanced Research Projects Agency

HYCOM
Hybrid Coordinate Ocean Model

IANA
Indian and Northern Affairs

IARPC
Interagency Arctic Research Policy Committee

ICECON
Ice Conditions Index

IICWG
International Ice Charting Working Group

IMO
International Maritime Organization

InSAR
Interferometric Synthetic Aperture Radar

IONS
Incidents of National Significance

JTFN
Joint Task Force North (Canada)

KTG
Kestrel Technology Group

LIDAR
Light Detection and Ranging

LPBK
Local Placed Based Knowledge

LRAUUV
Long Range Autonomous Underwater Vehicle

LWIR
Longwave Infrared

MBARI
Monterey Bay Aquarium Research Institute

MIZMAS
Marginal Ice Zone Modeling and Assimilation System

MMA
Maine Maritime Academy

MDA
Maritime Domain Awareness

MN
Member Node

MOTR
Maritime Operational Threat Response

MSI
Minority Serving Institutions

MXAK
Marine Exchange of Alaska

NAIS
North American Ice Service

NASA
National Aeronautics and Space Administration

NCAR
National Center for Atmospheric Research

NCEI
National Centers for Environmental Information

NCEP
National Center for Environmental Prediction

ND
Nova Dine

NIC
National Ice Center

NOAA
National Oceanic and Atmospheric Administration

NSC
National Security Cutter

NSF
National Science Foundation

NWS
National Weather Service

OODA
Observe, Orient, Decide and Act

OGCWS
Open Geospatial Consortium Web Service

OSA
Open Systems Architecture

OUP
Office of University Programs

ORR
Office of Response and Restoration

ONR
Office of Naval Research

PI
Principal Investigator

PII
Personally Identifiable Information

PIOMAS
Pan-arctic Ice-Ocean Modeling and Assimilation System

PM
Program Manager

PMD
Project Management Director

POA
Port of Anchorage

PolSAR
Polarimetric Synthetic Aperture Radar

RD
Research Director

RPA
Remotely Piloted Aircraft

SAR
Search and Rescue

S&T
Science and Technology

SETS
Social-Ecological-Technological Systems

SDI
Spatial Data Infrastructure
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>SME</td>
<td>Significant Minority Enrollment</td>
</tr>
<tr>
<td>STCW</td>
<td>Standards of Training, Certification, and Watchkeeping</td>
</tr>
<tr>
<td>SWAN</td>
<td>Simulating Waves Near Shore</td>
</tr>
<tr>
<td>TAMOC</td>
<td>Texas A&amp;M Oil Spill Calculator</td>
</tr>
<tr>
<td>TAMU</td>
<td>Texas A&amp;M University</td>
</tr>
<tr>
<td>TRL</td>
<td>Technology Readiness Level</td>
</tr>
<tr>
<td>UAA</td>
<td>University of Alaska Anchorage</td>
</tr>
<tr>
<td>UAF</td>
<td>University of Alaska Fairbanks</td>
</tr>
<tr>
<td>UAV</td>
<td>Unmanned Aircraft Vehicle</td>
</tr>
<tr>
<td>UDOP</td>
<td>User-defined Operating Picture</td>
</tr>
<tr>
<td>UoI</td>
<td>University of Idaho</td>
</tr>
<tr>
<td>UNM</td>
<td>University of New Mexico</td>
</tr>
<tr>
<td>UGV</td>
<td>Unmanned Ground Vehicle</td>
</tr>
<tr>
<td>USCG</td>
<td>United States Coast Guard</td>
</tr>
<tr>
<td>USCG RDC</td>
<td>United States Coast Guard Research and Development Center</td>
</tr>
<tr>
<td>USGCRP</td>
<td>US Global Change Research Program</td>
</tr>
<tr>
<td>US MDA</td>
<td>United States Maritime Domain Awareness</td>
</tr>
<tr>
<td>USN</td>
<td>United States Navy</td>
</tr>
<tr>
<td>USNORTHCOM</td>
<td>United States Northern Command</td>
</tr>
<tr>
<td>USV</td>
<td>Unmanned Surface Vehicle</td>
</tr>
<tr>
<td>UTEP</td>
<td>University of Texas El Paso</td>
</tr>
<tr>
<td>UUV</td>
<td>Unmanned Underwater Vehicle</td>
</tr>
<tr>
<td>UW</td>
<td>University of Washington</td>
</tr>
<tr>
<td>WHOI</td>
<td>Woods Hole Oceanographic Institution</td>
</tr>
</tbody>
</table>