

**University of Alaska's Arctic Domain Awareness Center (and
in partnership with Sandia National Labs)
Spring 2019 Arctic Related Incidents National Significance
Workshop (Arctic-IoNS)
Workshop Report
16 July 2019**

**Arctic IoNS 2019
“Stressing the system...
Managing a Complex Arctic crisis.”**

**University of Alaska Anchorage
20-22 May 2019**



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Figure 1 Near Point Barrow, Alaska. Credit: ADAC

Introduction

The Arctic Domain Awareness Center (ADAC) is a U.S. Department of Homeland Security (DHS) Science and Technology (S&T) Center of Excellence in Maritime Research, hosted by the University of Alaska.

ADAC collaborated with Sandia National Laboratories in the planning and execution of the Anchorage IoNS workshop, 21-22 May 2019 at University of Alaska Anchorage. ADAC was also partnered with Sandia National Laboratories in the planning and execution of the Nome Insights workshop, 18-19 April 2019 at University of Alaska Fairbanks Northwest Campus. ADAC and Sandia were supported extensively by the following organizations, identified by their respective logos (and we respectfully wish to offer sincere thanks and appreciation). Further details in workshop planner and support appreciation is provided in the report conclusions.



Anchorage Arctic IoNS 2019 Workshop Planning Collaborators

The objective of Arctic IoNS 2019 workshop was to identify, understand, and analyze gaps in the capabilities needed to support effective crisis response operations during and after a series of incidents in which several significant challenges present themselves nearly simultaneously. As volunteer first responders from rural Alaska villages will most likely conduct immediate crisis response efforts, this workshop sought to highlight challenges and shortfalls in capabilities and interagency coordination required for effective rural emergency management. In addition, this workshop strove to identify potential technologies that can improve the safety and effectiveness of response operations and minimize the negative impacts of disasters upon rural Alaska Native cultures and traditional subsistence lifestyles.

This Anchorage Arctic IoNS Rapporteurs report, addresses the second of two Arctic IoNS workshops conducted by ADAC in 2019, provides insights and key information on shortfalls in response capability areas including:

- Arctic Communications - Limitations in voice and data communications;
- Arctic Maritime Domain Awareness and Understanding to Effect Decision-Making;
- Arctic Incident Response Logistics and Resourcing – including but not limited to latent detection challenges;
- Exercising the USCG-led Area Contingency Plan, principally focused in addressing crisis in Western Alaska.

Executive Summary

The preliminary workshop was an Alaskan Native/rural Alaskan “Insights” workshop in Nome, Alaska (18-19 April 2019), at University of Alaska Northwest Campus. The Nome Arctic IoNS workshop provided the cultural, geographic, and socio-economic foundational framework required for a grounded, reality-based examination of shortfalls in response capabilities, associated with responding to a complex crisis emanating from a significant and wide-spread weather event. Approximately 35 people participated in the workshop. The Nome workshop sought Alaskan Native and other rural Alaskans’ insights on Arctic crisis response to inform emergency response planners on flaws or inconsistencies in planning assumptions, to describe the key concerns or gaps that remote populations would experience during these types of incidents, and to discuss how their communities might act as force multipliers during an ongoing crisis. The concerns expressed at the Nome workshop demonstrate that Alaska Native and rural communities are troubled with both the short and long-term impacts of a host of emergency and disaster scenarios, with residents placing a priority on issues such as disaster and weather-related food shortages, supply and transportation system interruptions, and pandemics from virus and infectious disease. Participants noted the importance of solutions that work broadly, providing effective response capabilities for a wide range of potential emergencies. Participants related that many Alaska Native and rural communities are ready and willing to incorporate themselves into the incident response system as they strive for increased self-sufficiency through training and technological innovation.

Informed by prior planning and the advance “Insights” workshop in Nome, the second Arctic IoNS 2019 workshop was focused in understanding the science and technology shortfalls associated with the overall crisis response. Accordingly, the 2019 Anchorage Arctic IoNS workshop consisted of a set of expert keynote and plenary presentations, a table-top/computer-guided scenario exercise, and a set of breakout groups to identify shortfalls that will steer the development of emerging science and technology research applications. Approximately 90 people participated in this workshop.

The primary outcome of the Anchorage Arctic IoNS workshop is this Rapporteur's Report and an associated follow-on DHS S&T UP and USCG-approved Request for Proposal structured around the research questions that arose from the Arctic IoNS 2019 workshop process. Note, a complementary report from the Nome Arctic IoNS workshop was released by ADAC on 11 July 2019.

Arctic IoNS 2019 employed a hypothetical distress scenario created by a major storm incident in the Bering Sea, which first disabled a large container vessel, followed by a storm damage-related crisis along several coastlines of western Alaska, including damage and destruction of infrastructure along a wide path. Complicating matters as U.S. Coast Guard and other first responders swung into action was an earthquake centered near Anchorage, Alaska's most significant multi-modal port complex, restricting routine inter-theater logistics flow from outside of Alaska to intra-theater flow and then to crisis destinations in remote Western Alaska. In sum, these factors equated to a coastal/littoral disaster region-wide "stress to the system" and illustrated shortfalls in "managing a complex Arctic crisis response."

Participants noted the importance of solutions that are multi-functional, providing effective response capabilities for a wide range of potential emergencies. Experienced emergency managers and response coordinators expressed the need for multi-faceted domain awareness tools that include maritime and inland response capabilities and are flexible enough to address a wide range of incidents while being suitable for use by a wide variety of response organizations and government agencies. Participants expressed great interest in developing advanced, modern communications and energy solutions to augment existing infrastructure during disaster response operations and for continued use in the most remote Arctic areas. Participants also largely agreed upon the need for research into efficient environmental data reporting and collection to inform and validate existing models in today's dynamic and rapidly changing Arctic.

The combined workshops yielded 32 total research questions that achieved a Delphi prioritized voting of at least 2 votes associated with the workshop scenario. ADAC anticipates HQ U.S. Coast Guard will select a subset of these research questions to be included in an ADAC accompanying funded request for proposal planned for release in the summer of 2019.



Figure 2 Chukchi Sea Coast near Utqiagvik Alaska. Credit: ADAC

Summary of Arctic IoNS 2019 Research Questions

The following are the specific research questions developed from the Arctic IoNS “Stressing the System...managing a complex Arctic crisis” Workshop held at the University of Alaska Anchorage from 21-22 May 2019 (and informed by the preceding Arctic IoNS workshop accomplished at University of Alaska NW Campus on 18-19 April 2019).

The workshop breakout groups discerned 32¹ research questions regarding limitations and gaps in voice and data communications, maritime domain awareness, incident response logistics and resourcing, and latent detection technologies needed to effectively and efficiently respond to an Arctic crisis.

ADAC respectfully notes, DHS S&T UP and HQ USCG plans to select a subset of the below Arctic IoNS 2019 Research Questions to inform the corresponding ADAC Request for Proposal, planned for release during Summer 2019. ADAC also notes, as a result of post workshop staffing, minor adjustments to proposed questions have been made in several instances to improve focus and clarity.

Breakout Group 1: Communicating with Vessel Master, Responders, and Remote Communities in the Arctic Technologies.

Proposed Research Questions:

1. What would a Rescue 21 (R-21) like system look like for remote Alaska (and in particular, Alaskan Arctic) maritime environment? (Hypothesis is based on breakout group expert insight that Alaska needs to develop communication standards that exists elsewhere.)
2. What provided algorithms can suitably manage information overload for decision support in crisis response scenarios? Can research develop such algorithms?
3. What power systems can be developed for remote and austere regional communications that are affordable, sustainable and innovative?

¹ All proposed research questions were assessed using votes from the Delphi Prioritization method (discussed on page 74). Research questions that did not receive more than 1 vote were not included in the Executive Summary or the analysis. Research questions which received 1 vote or less are listed in the Appendix on page 80.

4. What autonomous and remotely operated systems can inspect and repair distant communications infrastructure? Can research design useful prototypes to support remote infrastructure inspection and repair?
5. How should the U.S. Coast Guard and the community of supporting research develop, optimize, and maintain user-defined operational visualization capabilities, and make these capabilities available to responders and communities?

Breakout Group 2: *Maritime Domain Awareness Technologies.*

Proposed Research Questions:

1. What are some practical and affordable methods which can maintain sustained monitoring of remote/distant objects/areas (associated with crisis response)?
2. How should U.S. Coast Guard and Federal On-Scene Coordination (FOSC) optimize the logistics footprint to most effectively respond to multiple complex/conflicting priorities across a remote and distant region (particularly oriented to the Arctic/polar regions)?
3. How should the U.S. Coast Guard and the community of supporting research develop and exercise prescription scenarios for complex crisis events?
4. How should the U.S. Coast Guard and the community of supporting research develop best practices for bulk fuel containers and predict risk from existing containers?
5. What are new, needed and useful knowledge management capabilities which would provide decision makers improved methods to afford best decision support in a crisis?

Breakout Group 3: *Latent Detection Challenge Technologies.*

Proposed Research Questions:

1. How should the U.S. Coast Guard and the community of supporting research suitably incorporate citizen scientist collected data into user-defined operational visualization capabilities?
2. How should U.S. Coast Guard and Federal On-Scene Coordination (FOSC) accomplish rapid/ad-hoc, large area information collection for a crisis event/response (particularly in remote/distant locations, such as the Arctic)?
3. What processes and protocols used to achieve situational understanding can be implemented for improved decision support? I.e. automated algorithms identifying the problem targets operationally (data fusion/database fusion)?
4. What improvements need to be made to convert current low SWOP (small size, weight, and power) to support crisis response in Arctic?
5. What are the cyber security vulnerabilities of detection and communication technologies that could impact crisis response operations? How do responders know their information is not compromised?
6. What cost-effective, satellite tracking mechanisms can be applied to marine debris (particularly in remote/distant locations, such as the Arctic)?

7. What sensors are capable of detecting chemicals (besides oil) and metals in the U.S. Arctic region, and how can that be used for response decision making?
8. What are some suitable research concepts that could leverage existing communications systems in unplanned ways to improve crisis information flow to remote and distant Arctic regions (e.g. research using University of Alaska's High-frequency Active Auroral Research Program (HAARP), considered as the world's largest high frequency radio, to disseminate information to all citizens). Further, how would individuals receive such information?

Breakout Group 4: Adverse Weather Response.

Proposed Research Questions:

1. What technologies and methods can be developed or exist to provide combined marine boundary layer observations for integration into coupled atmosphere-ocean models and support Arctic Concepts of Operations (CONOPS) and emergency management operations?
2. What technologies and methods can be developed or exist to evaluate the most effective observational data to increase operational and model efficiency for emergency management organizations during arctic operations. (What new observations - type and location - give suitably useful and affordable operational meteorological-ocean model improvement)?
3. What technologies and methods can be developed or exist to transition local observations and data, such as crowd sourcing into NOAA/NWS operational workflow and CONOPS and emergency management process as well as build a common framework to develop a statewide coordinated data collection network?
4. What standards can be set to simplify and incorporate disparate data into the incident command post?

Breakout Group 5: Predicting, Detecting, and Assessing Crisis Response Action Technologies.

Proposed Research Questions:

1. What community resilience standards exist and how do they apply to Alaska communities? Additionally, how should the U.S. Coast Guard and the community of supporting research assess and develop a resiliency criterion to apply to remote and distant locations across the U.S. Arctic region for communities to report?
2. What technologies exist to assist crowd source incident and domain awareness (particularly oriented to maritime and coastal regions)?
3. Do publicly available visualization tools exist to fuse data, including crowdsourcing data, from multiple sources?

4. Based on population centers, how does sea ice disposition affect village risk against coastal erosion and storm damage?
5. How can unmanned systems be suitably leveraged to better mitigate disabled vessels and oil/hazmat in water?
6. How can unmanned systems be suitably leveraged to better assist with facility inspections and leak detection?

Breakout Group 6: Technologies to Establish Communications with Remote Populations with Compromised Infrastructure.

Proposed Research Questions:

1. What technology advances would allow leveraging of various communication solutions, including social media, commonly in use in rural Arctic Alaska to affordably cross-communicate and create a unified system (including consideration of human factors, policies, Concept of Operations, etc.) to ensure an effective system?
2. Can technical and policy approaches and needs be addressed to allow leap-frogging past current limited communication technology in remote Arctic Alaskan locations to provide affordable, widespread, high-bandwidth capabilities with flexible and or decreased infrastructure needs?
3. What technologies could be developed to provide affordable, Arctic-capable power storage capability?
4. Can technology and transmission protocols be developed to deliver “Amber Alert” type messages, and text messages, with high priority and requiring low-bandwidth to deliver broadcast emergency messages over multiple communication platforms?



Figure 3. Melting sea ice. Source: Pixabay.com

Arctic IoNS 2019 Planning Overview

The Arctic IoNS workshop method planned for the 2019 workshop was an expert researcher, operator and government official structured seminar, tabletop exercise, breakout group discussion, with an advanced discussion with Alaska Native leaders in Arctic Alaska, oriented to provide key insights that can inform follow-on research to address capability shortfalls. This is the third ADAC conducted Arctic IoNS workshop over a 3-year period. Prior events conducted focused investigation into addressing fictitious scenarios for a disabled cruise ship in Arctic waters (June 2016) and a shipborne oil spill in U.S. Federal waters in the Beaufort Sea (October 2017). Prior ADAC Arctic IoNS workshops resulted in a total of 6 funded awards to conduct research addressing workshop identified shortfalls in applicable science and technology.

Arctic IoNS development begins with the Arctic operators specifying priority areas of concern to investigate. This is followed by comprehensive literature review regarding the current state of capability corresponding to the concerns; a structured and purpose-built workshop, guided by an array of operators, government officials and experts to validate and expand understanding of the baseline and required capabilities; followed by a Rapporteur's Report and funded solicitation to support the research and development needed to address those shortfalls discovered and discussed at the workshop.

Accordingly, for Arctic IoNS 2019, U.S. Coast Guard District 17 (USCG D17) asked ADAC to address research concerns associated with response logistics and the scientific knowledge and technological capabilities to enable physical response to a complex crisis in the Arctic region. The USCG D17 principal areas of focus areas of the workshop were as follows:

- Arctic communications - limitations in voice and data communications;
- Arctic maritime domain awareness and understanding to affect decision-making;
- Arctic incident response (e.g., logistics/resourcing) - not limited to, but including latent detection challenges;
- Exercising the USCG-led Contingency Plan.

Further, the USCG D17 identified the following as “key drivers” in the associated scenario.

- The scenario should prompt efforts to address latent detection capability (principally of chemicals and associated hazards located across isolated regions);
- Incorporate perspectives and potential resources of rural Alaska native communities,
- Address tracking and resolution of hazardous materials lost at sea (principally born by transshipment container);
- Conduct a participant exercise, to include incorporation of HQ USCG developed software simulation if possible;
- Place a strain on infrastructure system thus affecting logistics of response;
- Activate U.S. Federal, State of Alaska and Local government Incident response/Federal On- Scene Coordinated Response, and;
- Include suitable international participation.

As in prior years, Arctic IoNS uses fictitious (but intended as realistic) scenarios to orient participants within the environment and situation and to facilitate focused discussions that support the U.S. Coast Guard workshop goal to identify capability shortfalls that will inform science and technology research activities. Accordingly, the scenarios were designed to severely stress the system, allowing discovery of shortfalls to drive the areas of needed research to be compiled by ADAC and coordinated with USCG and DHS S&T.

Arctic IoNS 2019 Nome “Insights” Workshop Summary:

The Arctic IoNS Nome “Insights” workshop used the potential impacts of a major storm-driven Bering Sea maritime accident scenario, followed by widespread damage to Western Alaska coastal regions in order to “stress the



Figure 4. Local residents of Nome performing Alaska Native dances and songs during the Arctic IoNS: Nome Insights Workshop on April 19th, 2019.

system” and highlight shortfalls in “*managing a complex Arctic crisis response.*”

The Nome workshop sought Alaskan Native and other rural Alaskan’s insights on crisis response to inform emergency response planners on flaws or inconsistencies in their assumptions, to describe the key concerns or gaps that remote populations would experience during these types of incidents, and to discuss how their communities might act as force multipliers during an ongoing crisis.

Workshop participants described that overall, Alaska native and rural communities are concerned about an array of emergencies, with most residents placing a higher priority on issues such as disaster and weather related food shortages, supply and transportation system interruptions, and pandemics from virus and infectious disease. Participants noted it will likely be important for any new array of solutions to be capable to work broadly. Experienced local emergency managers expressed the need for multi-faceted domain awareness tools that include maritime and inland response solutions which are capable and flexible enough to address a wide range of incidents. Participants related that many Alaska native and rural communities are ready and willing to become more integral to the incident response system as they strive for increased self-sufficiency through training and technological innovation.

Participants placed emphasis on evidence that severe weather events are increasing in frequency, unpredictability, and severity. Due to a changing Arctic environment, the “once per 100 year storms” now occur on a much shorter time-cycle. While weather-related coastal region damage is increasing in frequency and severity in the U.S. Arctic, most infrastructure was designed to withstand much less challenging wave and flooding conditions. Workshop participants described unmet needs related to baselining of critical environmental conditions (including ocean currents, temperature, ice conditions, and wildlife movements) as they are vital for rural regional understanding and illustrating the true magnitude of future changes to the physical environment. Participants further noted that protecting sensitive information is a unique challenge in such an isolated region with limited specialized resources and the need for wide dissemination of information. Subsistence living is complicated by the loss of traditional hunting and fishing areas and the increased risks inherent in traveling the greater distances now necessary to successfully conduct those activities. Participants relayed a common desire for more cooperative research with Arctic Alaska natives and other rural residents and more rural outreach leading to local-community developed ideas and solutions. Participants highlighted a particular concern that strategically placed oil spill response equipment is key to reducing the environmental impacts of Arctic spills, which many noted, was a critical issue due to associated negative impact oil spills have to subsistence hunting and fishing. For further information/details, please refer to the full Nome Arctic IoNS Report, dated 11 July 2019, available at www.arcticdomainawarenesscenter.org

Anchorage Arctic IoNS 2019: Plenary Sessions

Following welcomes by the Workshop Co-hosts, ADAC Executive Director Church Kee and Sandia National Labs Dr Holly Dockery, the Arctic-focused IoNS 2019 Anchorage Workshop, 20-22 May 2019, UAA commenced with an introductory scenario overview by co-hosts Mr. Greg Stihel, Sandia, and Lieutenant Commander David Smith, HQ USCG Office of Emerging Policy (DCO-X).

LCDR Smith explained that the encourages the United States Coast Guard to plan for the future by conducting tabletop planning sessions and scenario driven exercises to identify and illustrate potential gaps in capabilities, with a focus on communication, domain awareness, and incident response capabilities. The practice of identifying capability gaps through the use of alternative scenarios, frequently referred to as war gaming, is commonly used by the Department of Defense due to its effectiveness in preparing operators and leaders for future scenarios. As such, the 2019 Arctic IoNS workshop utilized this approach as a means to develop critical operator driven research questions.

Keynote Plenary– Results of the Arctic IoNS 2019 Nome “Insights” Workshop, 18-19 April 2019, UAF NW Campus.

Following introductory remarks, the opening Keynote Plenary panels sought to identify and discuss important perspectives, concerns, and needs derived from the Nome “Insights” Workshop. Of particular interest was the need to highlight Arctic Alaskan local and place-based knowledge as a means to assist emergency managers from outside of Western Alaska to better understand, integrate with, and coordinate with local incident responders. Senior leaders from the workshop presented summary results, and included:

- Dr. Gail Schubert, President & CEO Bering Straits Native Corporation.
- Ms. Mary David, Executive Vice President Kawerak Incorporated.

Both Dr. Schubert and Ms. David mentioned several serious concerns specifically regarding rural Western Alaska, including the geopolitical maneuvering of the United States, China, and Russia within the Arctic, particularly the Bering Strait, and climate change’s increasing hazards to coastal communities. The Bering Strait stands as a crucial geopolitical location, as it includes China’s self-declared Polar Silk Road and is potentially a gateway to billions of dollars in natural resources in the Arctic basin.

Patterns of diminishing sea ice, coupled with increases in maritime and sovereign activity within the Arctic are increasing the risks posed to local communities and requirements for correspondingly robust emergency response infrastructure. Expectations that the Arctic holds up to 25% of the world’s un-extracted natural resources are driving Russia to increase

both Arctic infrastructure and military activity. Increased Russian military activity includes plans to deploy nuclear submarines to patrol the region.

These presenters noted that China has established significant partnerships with Canada, Denmark, and Greenland. These connections stand as a major concern, as it allows China to access the Arctic with relative ease through means of seizing assets based on large debts.

As a response to the aggressive posturing of Russia and China, and as a means to ensure the United States' security in the region, increased efforts are being made to examine the development of infrastructure (e.g., roads, ports, airfields, etc.) which will strengthen already present, resilient, Arctic communities. The United States Army Corps of Engineers estimates the cost of proposed Port of Nome Modifications, which would transform the port into a deep-water port suitable for U.S. Navy warships, is approximately \$450 million. The U.S. Navy is currently planning to station resources on Adak Island, a less costly alternative. Proposed Naval Resources include an increased presence of aircraft carriers capable of deploying reconnaissance aircraft, among other warships. As it stands, Port Clarence, which is a natural deep-water port, is protected from storms and a viable alternative.

The combination of coastal erosion and diminishing shore-fast ice resulting from climate change is challenging animal populations, increasing the risks of hunting practices, and producing more frequent severe winter storm systems. Rural Alaskans are finding it necessary to harvest sea kelp and seal miles away from their villages in efforts to maintain an increasingly difficult and dangerous subsistence lifestyle. Elders within Arctic Alaska native communities report that this is the first year that their hunters could not locate sea kelp nearby. The loss of sea kelp, in addition to trends of increasing average water temperature, is resulting in the northward migration of important fish populations, further exacerbating change in an already rapidly changing ecosystem. These sudden changes force local communities to adapt their subsistence harvesting practices, further increasing the stressors placed upon villages. The speakers emphasized that no matter what future actions are taken in Arctic development and security, the "development must be done in a manner that protects subsistence resources."

Within the Bering Strait region, communities are primarily found along the coastlines, housing roughly 10,000 residents. Local representatives of this region have voiced major concerns regarding the lack of preparedness for oil spill incidents and resultant substantial impacts on local resources, coastal erosion, thawing permafrost, and the loss of both sea and shore-fast ice. Delays in disaster response, transportation of residents, acquiring needed resources, and maintaining assets are significant obstacles.

Coastal communities within the Bering Strait region endured a stunning and unexpected 16 major winter storms in the 2018-2019 season, with particularly severe events in the late fall

and early winter. While many communities are currently developing evacuation routes, it becomes difficult to identify the most effective routes with regard to environmental factors including elevation, tidal surges, and potential flood zones. Inadequate and failing communication systems (largely due to severe weather, to include extreme cold), and an overall lack of secure infrastructure to which people can safely evacuate are primary concerns.

Local government and tribal representatives in Western Alaska have requested the aid and presence of U.S. Coast Guard personnel during the late fall and early winter, when the most severe storm systems impact Western and North Slope Alaska. Tribal residents have also voiced the need for a more comprehensive tribal representation from regional communities in order to utilize indigenous knowledge in response decision-making processes. Due to the unique, isolated Arctic environment, tribal representatives have highlighted concerns surrounding a lack of properly trained first responders within those communities, while also proposing the need for a system that would provide early storm warnings.

A specific summary of each panelist's presentation is included below:

Dr. Gail Shubert, President & CEO Bering Strait's Native Corporation.

Dr. Shubert described climate change has made life more hazardous for coastal communities. Villagers must travel much further to harvest, hunt, and fish as populations begin to migrate north. Severe storms threaten coastlines as shorefast ice disappears. As development activities both onshore and offshore increase, subsistence resources must be protected. The U.S. Navy and U.S. Coast Guard are among the principal defense or security agencies in the Arctic, and a greater presence is needed as Russian military infrastructure within the Arctic region is increasing. Russia has an interest in oil and gas extraction in the Arctic and is developing resources and improving radar coverage of the area. In addition, China wants equal trade access to Arctic water and is seeking increased participation in the Arctic council. In response, the United States is beginning to rebuild its military infrastructure with a focus on strong and resilient Arctic communities (e.g., ports, airfields, roads). Improvements to Port of Nome are needed as the closest military bases to the Bering Strait are in Anchorage and Kodiak Island.

Ms. Mary David, Executive Vice President, Kawerak Incorporated.

Ms. David described within the Bering Strait region, all communities are located on the coast (~10,000 residents). The coast endured 16 storms in the last winter with the late fall/early winter storms being the most severe. Little Diomed Island (a geographically critical region due to proximity to Russian Federation territory) has experienced communication issues due to severe weather that threatens runways and helipads. Other concerns include coastal erosion, permafrost, loss of sea ice, delays in response, transportation in and out of

communities, transportation of resources and assets, closed runways and lack of evacuation routes.

During the Arctic IoNS 2019 Nome workshop, there was a focus on incident command as well as preparedness and response. Local communities appreciate USCG presence but would like increased response capabilities during late fall and early winter. Residents relay that better communication systems are needed that operate in severe weather as well as those that communicate between U.S. and Russia for the Bering Strait side. Ms. David remarked that each community is different and accordingly, has different needs. Kawerak Incorporated is well-suited to serve as a regional resource for understanding how actions will impact people across Western coastal Alaska who are reliant on subsistence resources.

Arctic IoNS Discussion Panel: Key Response Community Challenges (a government official's panel).

Panelists during this session were asked to describe their overall concerns related to the Anchorage Arctic IoNS 2019 scenario and priority focus areas. Perhaps most importantly, organization decision makers were asked to consider “what keeps you up at night” in context of the scenario.

- Key aspects in responding?
- Consequences if the response is not effective in this problem space?

Presenters were asked to describe expectations, capabilities, concerns, and priorities of partners of US Federal Agencies, State of Alaska, and International Government Officials. This panel consisted of the following members:

- David Kennedy, NOAA Senior Arctic Advisor;
- Don Moore, NWS Decision Support Specialist, Alaska;
- Amy Holman, NOAA Alaska Regional Coordinator;
- Geoff Merrell, State of Alaska Department of Environmental Conservation;
- Michael Duxbury, Deputy Commissioner State of Alaska Public Safety;
- Brigadier General Torrence Saxe, Commissioner State of Alaska Department of Military & Veterans Affairs, and State of Alaska Adjutant General;
- Lieutenant Colonel Ray Chiasson, Canada JTF-North, Yellowknife NWT, Canada;
- Captain Sean MacKenzie, USCG District 17 Sector Anchorage.



Figure 5. Participants of the Arctic IoNS 2019 Panel: Key Response Community Challenges.

Overall Panel Reflections.

Panelists from NOAA expressed concerns regarding coordination with all of the entities needed for a disaster response in the Arctic. Panelists placed emphasis on employing coastal mapping and marine mammal response capabilities in times of crisis. Furthermore, coordination amongst Federal, State and local communities needs to ensure timely and secure communication. Panelists further highlighted the need for around the clock public affairs resources that can feed information to the press in order to minimize damaging reports and media sensationalism.

NOAA's scope includes weather, ocean, navigation, and spill response. Ecosystem and protected species management, and satellite group and ocean and atmospheric research also fall under NOAA purview. With the challenge of modeling these large-scale and complex systems comes the uncertainties of losing small details in models due to satellite data errors that could reshape the entire playing field. In the event of a bomb cyclone (similar to a Category 3 Hurricane), the rapidly intensifying weather conditions can wreak havoc on computer models. These events need to be communicated to villages days in advance in order to give them the time to prepare, particularly in the darkness of winter.

Communications from vessels in distress to an operationally challenged Anchorage Port (in the event of something like an earthquake) could turn into one-way communications, or a perceived one-way communication. Contingencies to shift major operations (possibly to Fairbanks or Juneau) in the event of a large disaster should be included in plans.

Due to failed equipment and poor decision making by the crew, the M/V Selendang Ayu ran aground and was destroyed near Dutch Harbor Alaska in 2004, and in 2017 a 900 ft. container ship, located 2 miles off the Coast of Akutan Island in the Aleutians experienced incidents similar to the scenario proposed in this workshop.

In sum, panelists noted, the Arctic IoNS 2019 scenario is very plausible. Even with vessel quality increasing, panelists urged the need for a highly efficient and economic response model, and for the increased availability and efficiency of marine emergency towing in Alaska.

Additional concerns relayed by the panelists involve the overall high frequency of unknowns that occur due to the changing Arctic climate. For example, when measuring the risk of coastal communities to weather related disasters, it is important to understand the dynamics at play between water level, ice, and storm surges. However, the amount of shore-fast ice necessary to properly protect rural villages is unknown. Therefore, it is nearly impossible to assess the level of risk facing coastal communities based on measuring the current level of ice alone. Furthermore, panelists explained that effective prediction of safe water levels along coastlines is not yet thoroughly understood, particularly when accounting for the high level of variance caused by wind. Small changes in the vertical height of water can, and will, have a disproportionate effect on the horizontal change in water coverage. Without ample observational data to improve and validate models, confirming the accuracy of models is of concern and more research is necessary to identify locations to place water level sensors.

At the state level, including the Alaska State Troopers, many concerns are directly associated with communications challenges. The recent major earthquake in November, 2018 allowed the Alaska State Troopers to test internal emergency communication systems. Given the vastness of territory coverage in relation to miniscule population size, one major event would place the State Troopers over-capacity, particularly if a rural evacuation is taken into account. A limited capacity to respond to calls of service severely complicates matters, particularly in remote areas.

Similarly, there is a need for military assets to be able to provide their support to civilian response operations. In addition to mobilization, the methods and strategies of pre coordination that are utilized for to national defense can be implemented in a time of natural disaster. In the event of natural disaster, there is likely a great need for a dual status commander - someone responsible for coordinating both active and reserve military elements, including National Guard personnel, under state authority.

Canadian search and rescue (SAR) associated with Canada Joint Operations Command's (CJOC), Joint Task Force North (JTF-N), headquartered at Yellowknife Northwest Territories, coordinates and develops a community-based ranger program on Yellowknife, but that the program lacks resources, is spread thin, and in the event of a major crisis, would take 8 or more hours to get to Anchorage. Furthermore, military responses in the high North are complicated by extreme weather, distance, lack of infrastructure, sparse populations, minimal road systems, and low situational awareness of specific geographic areas.

Lastly, the U.S. Coast Guard stressed the need for a sturdy, yet economically feasible, ocean-going tug to be able to respond to a disabled vessel scenario. A stranded ship that is dead in the water during a severe weather event has a high potential to capsize. During the workshop, several participants noted there are a range of options to cope with container ship loss, radar reflectors to mini-AIS tags (similar to Radio Frequency tabs now in use for container shipment), all of which may assist with locating lost containers, reducing risk of tracking the container (particularly for those with hazardous materials (HAZMAT)).

A principal concern highlighted in panel was regarding, bulk fuel facilities located along the coastline in Western Alaska, coastal erosion, as well as aging infrastructure – all of which present a major risk of contamination to the marine environment. In a high wind and/or earthquake event, changing permafrost jeopardizes the storage of HAZMAT containers. Lastly, an earthquake/tsunamic scenario presents major concerns surrounding port access. Panelists noted, if an earthquake event occurs, will the port be able to accept any maritime traffic? If not, (which could be due to solely the earthquake or an associated tsunami), panelists related there should be a plan to address the maritime transportation system interruption caused by the loss of this vital port.

A specific summary of panel presentations is provided below:

Mr. David Kennedy, NOAA Senior Arctic Advisor.

Mr. Kennedy described that in a complex Arctic environmental derived crisis as outlined in the Arctic IoNS scenario, that essentially, all of NOAA would be involved or associated with the response. This includes fisheries, ecosystem and protected species, satellite groups, and ocean and atmospheric research. Identified and critical capability gaps include:

- The need for better remote instrumentation for analyzing the ice and atmosphere (e.g., advanced instruments, autonomous vehicles).
- Improved coordination across all entities involved (e.g., federal government, responsible party, state and local communities) for a large-scale crisis response. In sum, what may be suitable for smaller scale events, may prove very lacking for large-regional crisis, particularly in remote regions (such as Arctic Alaska).
- In light of the well-established 24/7 news cycle, the need to establish an effective 24-7 public affairs team to serve as point of contact for media during an event.

Ms. Amy Holman, NOAA Alaska Regional Coordinator.

Ms. Holman related there is a need for more Alaska-based solutions. NOAA is more than just a response agency; the agency has satellites that monitor and track ships and oil spills, map coastlines for damage assessment, and assist with marine response. Ms. Holman identified several important gaps to for the workshop consider, to include:

- In crisis response, it is critically important to advance knowledge and understanding regarding forming of the overall response team. When and where does everything come together (between agencies and other responding teams)? How does the collective group of federal, state, local, and tribal government responders along with supporting academic and industry member's work as integrating communities to bring together existing systems and comprehensive solutions?
- A compelling need to improve the integration between knowledge systems and products that support crisis response (e.g., coastal mapping linked to bathymetry, and crisis response assets).

Mr. Don Moore National Weather Service, Alaska.

Mr. Moore related that in Alaska, long-range weather predictions can change significantly in a 12 hour cycle and while NWS may have general weather information a week in advance, however precise, detailed forecasts will generally not be available until just before an event. The National Weather Service works with the State of Alaska to increase awareness and provide onsite support at operation centers. NOAA and NWS possesses and can other department satellite data associated with the Bering Strait region and operates useful models, but notes there is little observational data collection for model validation due to its remote location and accordingly, any information to refine forecast is very valuable. Real time reporting and local information are vital as rapid changes contribute to model errors and less accurate predictions.

Increased observing systems are needed to improve the performance of models, especially those for water level information along the west coast of Alaska, but it must first be decided where to place sensors and observation technology. The placement of new systems must be directly linked to improving models.

Mr. Geoff Merrell, State of Alaska Department of Environmental Conservation.

Mr. Merrell related there are many similar situations to the one discussed at Anchorage an Arctic IoNS 2019 which have occurred before, and the State of Alaska has been lucky so far that the situations or consequences from the crisis have not been more severe. Progress has been made over the last 20 years by working through scenarios, but important actions to reduce risk, have yet to be taken. The shipping industry has improved vessel safety and construction quality, but incidents still happen.

In supporting associated crisis response, Mr. Merrell related the State of Alaska has 11 emergency tow package systems (small and big) throughout coastal Alaska. The small system can be sling loaded by a USCG helicopter while the large system is generally ship deployed. These packages are limited to provide effective response to the area of concern,

(the East-Asia to West Coast of North America great circle route through the North Pacific) due to a lack of deep draft towing capability in the Aleutians.

Mr. Leon Morgan (Representing Deputy Commissioner Michael Duxbury), State of AK Public Safety.

Mr. Morgan noted that State of Alaska Public Safety has limited crisis response resources, and public safety works collaboratively with Federal and other State departments in coordinating crisis response. Representing both public safety and law enforcement communities within the State of Alaska, Mr. Morgan related that due to limited means, crisis response will invariably meet mission needs in one area via pulling assets from another part of the state.

Brig Gen (AK) Torrence Saxe, Commissioner, State of Alaska Department of Military and Veterans Affairs, and Adjutant General.

General Saxe related that military equipment and strategies are often successfully transitioned and effectively employed in disaster response operations. Alaska's National Guard forces are capable to support small-medium scale disasters, but would need augmentation from other states for a large-scale response. Current response plans are focused primarily on Anchorage and Fairbanks as the major population centers.

General Saxe noted the need to building more resilient communities, as time, distance and limited response capabilities challenge crisis actions teams. This resilience is particularly important because response is even more challenging in cold weather.

In terms of improving crisis response capability of the Alaska National Guard was a primary goal is to make sure pilots know where to fly and are familiar with every runway in Alaska. Lastly, the General queried the workshop participants in trying to determine what additional connections/networks can the community of willing responders and supporting response researchers along with industry participants continue to make ahead of time to improve the effectiveness of actual response operations?

LCol Ray Chiasson, Canada JTF-North, Yellowknife NWT, Canada.

Colonel Chiasson remarks that no one agency has everything they need to respond to an emergency, and we all must develop pre-crisis relationships. Canada divides response into 3 regions to address challenges such as extreme weather, isolated populations, distance/time, lack of infrastructure and situational awareness.

JTF-N developed a "Coms-plan" for use in major air disasters (also applicable to maritime). This includes a crisis response capability kit run by 12 people that is deployable in 24 hours at -35 F weather. Challenges for the Coms-plan include time and space, location of the kit,

remote infrastructure and airfields, domestic stakeholder capabilities, lack of resources, and integration of international response.

Sean MacKenzie, CAPT, USCG D17 Sector Anchorage.

CAPT MacKenzie described the greatest threat to the Arctic from the U.S. Coast Guard's perspective is in the high volume of deep-draft marine traffic utilizing the Western Coast of North America to East Asian markets via the North Pacific Great Circle Route. Due to vulnerabilities in safe navigation in the vicinity of the Aleutian Islands, CAPT MacKenzie noted there may potentially an effective economic model to support a rescue ocean-going tug stationed in an Aleutian port, such as Dutch Harbor. If/until such an ocean tug may be available, Good Samaritan ships and air response must be utilized.

As regards to spill response, Captain MacKenzie noted that a USCG D17 Sector Anchorage team is planned for this summer (2019) to visit 20-30% of the aging storage tanks along Alaska coastlines that pose risk for latent oil spills.

Lastly, the Captain related the recently released U.S. Coast Guard Arctic Strategy document (the April 2019 USCG Arctic Strategic Outlook) will drive the USCG to increase focused to advance comprehensive domain awareness and regional crisis response.

Arctic IoNS Research Panel 1: Communication Technologies - Voice and Data.

Panel 1 discussed the current baselines for communications with the distressed vessel, among responders and with affected communities. The panel further addressed vulnerabilities due to infrastructure damage and possible solutions to current gaps.

This panel consisted of the following members:

- Mr. Bruce Hellenga, ARCTICOM (a BNSC subsidiary);
- Dr. Bob McCoy, Alaska Geophysical Institute, University of Alaska Fairbanks;
- Mr. Leon Morgan, Director, Alaska Information Analysis Center (AKIAC), State of Alaska Department of Public Safety.

Overall Panel Reflections:

The first Arctic IoNS 2019 research panel discussed the gap in satellite coverage in the northern regions of Alaska. Currently, there is a need to update support communications within rural Alaska with the use of satellites, as the terrestrial communications network has more incomplete coverage than the current satellites. While there are various ways for satellites to orbit Earth, the low Earth orbit has proven to provide the best satellite coverage for Alaska. CubeSats satellites are small, cost-effective, and easily deployable. However,

they are unable to orbit at high altitudes. Nonetheless, when a satellite is closer to the ground, there is no need for the antenna to be pointed in order for it to acquire a signal.

Airborne communications in the Arctic could be augmented by the use of Unmanned Aircraft Systems (UAS), providing the region with platforms that are capable of operating at high altitudes. UAS are equipped with a low power, high intensity Radio Frequency (RF) link, are rapidly deployable, and are easier to service than low atmosphere satellites.

ARCTICOM (a Bering Straits Native Corporation subsidiary) is in partnership with Iridium, and works to support a variety of communications that include, but are not limited to, the Alaska Land Mobile Radio Network (ALMR), and communications with China and Puerto Rico. ALMR supports voice and low-speed data operations across the state. A transportable version of this technology is utilized by the Department of Defense as a means to provide a mobile communications network that is capable of pairing with other technologies. A control panel is located in both Anchorage and Fairbanks, and has the ability to bring sites back online in the case of an emergency.

Currently, researchers are working to develop new technologies, including Iridium push-to-talk technology that will be fast and easy to use for remote regional response. These technologies are named Push to Talk (PTT) and WAVE, and will be coupled with an upgrade (7.19) that is estimated to cost \$27 million.

A specific summary of panel presentations is provided below:

Mr. Bruce Hellenga, ARCTICOM (a BNSC subsidiary).

Mr Hellenga described a current project focus of ARCTICOM is to update support communications within rural Alaska via the use of satellites. As the terrestrial network coverage is incomplete, satellites already cover most of rural Alaska (via polar orbiting low earth orbit satellites, which currently do not provide around the clock coverage). Through partnering with Iridium ARCTICOM works to support a variety of communications that include Alaska Land Mobile Radio Network (ALMR) and maintaining communications with countries like China and Puerto Rico. Currently, Iridium is working to develop a push-to-talk communication system that will be fast and user friendly. This communication system is not limited to Alaska, and will be used to reach emergency first responders.

Dr. Bob McCoy, Alaska Geophysical Institute, UAF.

Dr McCoy related there is a gap in the satellite coverage in Northern Alaska. While there are various ways for satellites to orbit the Earth, the low Earth orbit has proven to provide the most complete coverage for Alaska. CubeSats are small satellites that are cost-effective and easily deployable, but are unable of orbiting outside of the lower atmosphere, and due

to size and associated limited power, these platforms are not suitable for geo-stationary orbit.

Airborne communications within the Arctic can be provided by Unmanned Aircraft Systems (UAS) and include several platforms that are capable of functioning at high altitudes, thus providing communication coverage to a larger surface area of rural Alaska. These platforms function with a low-power, high-intensity RF link, are rapidly deployable, and are easier to service than low-atmosphere satellites.

Mr. Leon Morgan, Director, Alaska Information Analysis Center (AKIAC).

ALMR supports voice and low-speed data operations across the state of Alaska. The Department of Defense owns a transportable version of the ALMR technology that is capable of providing the region with a mobile communications system. Control panels for the DoD technology are located in Anchorage and Fairbanks. The control panels have the ability to bring sites back online in the aftermath of an emergency. Currently, there is a project in place to integrate new technologies such as Iridium PTT and WAVE into the communications network, as well as an upgrade (7.19) that is estimated to cost \$27 million.

Arctic IoNS Research Panel 2: Arctic-Capable Maritime General and Domain Awareness and Management Technologies.

Panel 2 provided the current baselines for dark target tracking, predicting drift, and advancing Arctic Domain Awareness and corresponding Domain Management in support of crisis decision makers. Participants for Panel 2 included:

- Dr. Peter Webley, University of Alaska Fairbanks (UAF) Alaska Center of Unmanned Aerial Systems Integration (ACUASI);
- Mr. Jon Salton, Sandia National Laboratories;
- Mr. George Knizewski, Knight Sky Limited Liability Corporation (LLC);
- CAPT (Ret.) Ed Page, USCG, Marine Exchange of Alaska;
- Mr. Eric Velte, Arctic Slope Regional Corporation (ASRC) Federal Mission Solutions;
- Mr. Matt Cox, Senior Manager, Space and Airborne Systems, Raytheon Corporations;
- Mr. Martin Thompson, Sandia National Laboratories;
- Dr. Shari Matzner, Pacific Northwest National Laboratories.

Overall Panel Reflections:

The ongoing development and enhancement of UAS equipped with Synthetic Aperture Radar (SAR) is being undertaken by several facilities, each focusing on slightly different applications. SAR will be utilized to provide emergency to first responders with real-time

surveillance information, as well as identifying a variety of problems including ice jams, flooding, fires, earthquakes, oil spills, and ship detection.

The panel determined that access to centralized, reliable data is fundamental to effective disaster response planning. The development of an integrated database, which is being referred to as an Analytical Tool for Interdiction, would be equipped with the ability to make an assessment on the geographical location and environmental state of a disaster, thus giving an operational picture and assisting emergency first responders during real-time operations.

The utilization of both traditional and non-traditional intelligence sources is crucial to determining a new baseline of information, whose need was created by a rapidly changing geographical and geopolitical landscape in the Arctic region.

A specific summary of panel presentations is provided below:

Dr. Peter Webley, UAF ACUASI.

The working goal for ACUASI is to enable 24 hour, 7 days a week, 365 days a year awareness beyond the visual line of sight operations in Alaska. There are various UAS with varying capabilities available to accomplish this goal, including the ING Response and Griffon Sea Hunter. These UAS are capable of supporting visual, long-wave, and mid-wave infrared wavelengths, as well as supporting SAR. In order to function, the SAR system requires an antenna to be built on the aircraft. Functional uses for the UAS include: gas detection, change detection seen during flooding and fires, and surveillance of moving targets such as rivers. UAS have the ability to fly long distances from the launch point before needing to land. Finally, UAS may vary in size and are available in sizes that would fit within a backpack of an emergency first responder.

Mr. Jon Salton, Sandia National Laboratories.

Gaining reliable access to communities is a critical element to the disaster response plan. Attempts are being made to create an Analytical Tool for Interdiction, which would tie together surveillance and interdictions information, compute, analyze, and provide emergency first responders with target information using a one tool and grab database. The overall assessment of geographical location and environmental state will provide a focused operational picture and assist real-time operations.

Mr. George Knizewski, Knight Sky LLC.

Knight Sky specializes in government contracts of satellite communications. They provide service and equipment integrator functionality and offer complete connectivity of associated systems. For example, the SATCOM project is defined by a mobile system that is fully

equipped with communications equipment designed to be utilized by emergency management sites. A major challenge to the project and common hazard across the region is the extreme temperatures at high latitudes. A possible solution for the Arctic would be to increase the number of polar oriented low earth-orbit communications satellites, and new terminal designs that include tracking antennas.

CAPT USCG (Ret.) Ed Page, USCG, Marine Exchange of Alaska.

CAPT (Ret) Page informed workshop participants that currently Alaska Marine Exchange AIS transponder coverage from their facility monitors includes an area of 1.5 million square miles. Every six seconds, a transmission is received from connected ships, containing information including the ship's name and position. An automatic detection system is able to sound an alarm based on abnormal changes within the ship's plan, including unplanned reduction in speed, changing trajectory, etc. A major hazard while transiting in the Arctic is found when transitioning between the Arctic Ocean and the waters surrounding the Aleutian Islands, as the water in the Arctic is relatively shallow in comparison, meaning increased caution must be employed. A possible solution to track vessel traffic is an "app" (software application) that would be available to communities and provide them with increased maritime domain awareness within the Bering Sea.

Mr. Eric Velte, ASRC Federal Mission Solutions.

Mr. Velte related the nature of digital systems and analytic-based systems which are available as a means to track ships and enhance maritime awareness. AIS tracking facilitates responders to predict the drift of a ship, even when that ship may have their onboard AIS offline, by using real-time weather and ocean current patterns. Integrated buoy systems are used to calibrate drift models. Additionally, ADAC's Arctic Information Fusion Capability (AIFC) has evolved through the fusion of multiple displays as a means to reduce inefficiency and implement a simple AI, thus allowing situational awareness to become situational understanding. Risk management includes the possible creation of classification levels that will be activated when the system is used during joint-operations with other countries.

Mr. Matt Cox, Senior Manager, Space and Airborne Systems, Raytheon Corporations.

Mr Cox described Raytheon services the United States military and its allies, and as such, is equipped with a variety of sensors that range across all platforms, including both undersea and air platforms. They also have systems that can predict drift, determine water depth, and track dark targets that are otherwise avoiding detection. Raytheon is underway in fielding additional assets to include next generation satellites for weather prediction, and advanced satellite sensor systems which increase resolution and ability to access geographical

interests through cloud cover, while seeking comprehensive 24/7 worldwide surveillance coverage.

Mr. Martin Thompson, Sandia National Laboratories.

Mr. Thompson related a major issue facing emergency first responders and decision makers is accessing data. Once data is accessed, it can be used to monitor a variety of situations including climate change, environmental conditions, accessible resources, sustainable development, megacities, mobility, hazards, and crises. The utilization of SAR can enhance the rapid identification and response to situations including ice jams, flooding, fires, earthquakes, oil spills, and ship detection.

Dr. Shari Matzner, Pacific Northwest National Laboratories.

Dr. Matzner highlighted there is a great need to maximize the use of existing traditional and non-traditional sources for crisis response. Additionally, there is a need to determine the new baseline for Arctic crisis response and emergency management by analyzing data in order to determine which factors are fluctuating with time. There are a variety of ways to assist predictions, such as machine learning from past storms and analyzing specific, beneficial operational locations. Likewise, focus must be placed on the analysis of the geopolitical climate within the Arctic and surrounding area as those related factors would influence crisis response operations within the region. Finally, crisis response information and logistics response requires further automation and optimization, which will serve to improve efficiency while also functioning to disperse critical information in a timely manner.

Arctic IoNS Research Panel 3: Current Technologies Associated with Detection of Latent/Small Leaks in Remote Locations.

The situation presented to the panel was designed to 1) Feed research problem development related to latent or low-level leak detection; damage assessment, communication, and supply chain challenges; and 2) Modeling and Simulation of the loss of Anchorage as a key hub for distribution could help inform how and when to create an alternate logistics hub, or to develop contingencies if the supply chain is completely disrupted. Panel addressed current solutions for remotely piloted aircraft and integrated sensor technology research and industry. Concurrently, they addressed currently solutions in affordable satellite options for latent detection in remote northern regions. Participants for this panel included:

- Dr. Peter Webley, UAF ACUASI;
- Mr. Jon Salton, Sandia National Laboratories;
- Dr. Kelly Brumley, Fugro Corporation;
- Dr. Amoret Bunn, Pacific Northwest National Laboratories.

Overall Panel Reflections:

Data processing and consequential situational understanding stem from effective sensors and accurate charts. Sensors deployed on UAS include both active and passive variants, which depend on which measuring and detection equipment is required, such as single and double lasers, and long-wave infrared sensors. UAS have the capability to evaluate damage done to infrastructure, and also have the capacity to be utilized to monitor leaks, fires, flooding, and landslide susceptibility, as well as aid in evacuation efforts. Next, updating charts of both the seafloor, and coastal and remote regions will provide emergency first responders with accurate geographical information that will allow effective disaster response planning. Additional research in the area of latent detection is needed to combat challenges defined by oil and hazardous material spills, climate change, interface change, and signal collection.

Data processing via Artificial Intelligence holds the potential for valuable implementation, however it will take further development before the core elements of mobility, control, and perception are mastered. This technology has the capability to provide information in a more holistic manner, assist the processing of large, complex data sets, and ultimately simplify UAS missions.

A specific summary of panel presentations is provided below:

Dr. Peter Webley, UAF ACUASI.

Dr. Webley described Unmanned Aircraft Systems (UAS) considerations for aircraft supporting crisis response include payload limit, flight time, runway length and surface type, and the appropriate altitude for data collection. Sensors available for UAS are comprised of passive and active. Passive sensors are defined by long-wave infrared, which is affected by the sun and reflected surfaces, while active sensors are defined by either a single or dual laser. These systems are capable of evaluating damage done to infrastructure in remote distant regions. UAS when paired with the right kinds of sensors can structurally assess and ascertain facilities which are unsafe for emergency responders to enter. By monitoring leaks, fires, flooding, and landslide susceptibility, new UAS integrated with cutting edge sensors will enhance effective evacuation of dangerous geographic regions and/or suspect infrastructure. By coupling the UAS sensors with atmospheric modeling, the detection of hazardous gasses may also be included as a possible application in remote locations.

Mr. Jon Salton, Sandia National Laboratories.

Mr. Salton described advances in Artificial Intelligence (AI) and how it is processed and presented is located at the core of the Autonomy Revolution. Robotics is the integration and balance of three key technologies, including asset mobility, control, and perception. AI has the capability to provide information in a more holistic manner, while helping to process

large, complex data sets (e.g., marine harbors) and presenting the information as a color-coded system that demonstrates anomalies. This will eventually lead to the overall simplification of unmanned systems via reduction in the number of sensors required, while still providing improved awareness of known and unknown objects. System validation is the most important step in the development of new technologies, but is proving difficult with AI due to the human tendency not to trust autonomous information, as the concept introduces autonomy into a level of heightened complexity.

Dr. Kelly Brumley, Fugro Corporation.

Successful disaster response begins with an accurate chart. However, current charts are out of date, prompting the need for modern-day sea floor mapping. While mapping the seafloor is a large investment, the resulting charts may be used many times over. Multi-beam Echo Sounders (MBES) are a useful tool for detecting hydrocarbon seeps through data detailing a water column. This form of mapping can be done through the use of unmanned surface vehicles and bathymetry. Combining MBES with other sampling devices allows for the collection of additional data (e.g., sub-bottom profiling, core sampling, gas chromatography, fluorescence, etc.).

Dr. Amoret Bunn, Pacific Northwest National Laboratories.

An important step forward is the transition between situational awareness to situational understanding. Partnerships between organizations working to improve analytics can both upgrade baseline and new information, as well as effectively inform decision makers. The areas of latent detection are met by a myriad of obstacles including:

- Oil and hazardous substance spills, whose challenges include baseline data for vector change analysis and the accurate translation of lab results,
- Climate, whose challenges include visibility and seasonal changes,
- Interfaces of physical and chemical changes, whose challenges include terrestrial-aquatic interface and the transition between fresh and saltwater, and
- 4) Signal collection, whose challenges are defined by the availability of information for remote locations and the resolution of information. Finally, varying platforms allow for a spectrum of resolutions, which may be utilized individually based on situational needs.

Arctic IoNS Discussion Panel 4: Current Technologies Associated with Predicting, Detecting and Assessing Crisis Response Actions to Support Remote Coastal and other Response Entities, when Established Infrastructure is compromised

This panel sought solutions for remote region communications in support of connectivity while addressing cyber security concerns directly following a crisis. Participants on this panel include:

- Mr. Eric Velte, ASRC Federal Mission Solutions;
- Ms. Lori Parrot, Sandia National Laboratories;
- Mr. Andres Morales, Alyeska Pipeline Corporation;
- Mr. Scott Blough, Tiffin University Ohio;
- Mr. Richard Garrett, Sandia National Laboratories.

Overall panel reflections

Some overarching themes of the panel include infrastructure, communications with community and government, cyber security, and decision support tools all in a changing arctic environment. The resultant infrastructure needs to be designed and utilized in a way that benefits both decision makers and communities. Future planning for infrastructure development should be targeted at what is our best guess of what the arctic will look like in the future. Communications between communities, government, and industries must be improved. There should be a go-to for crisis response with a contingency in case of failure of that system. That being said, everyone needs to be on the same page so that collaboration can take place. Cyber security is a risk that needs to be kept constantly in the planning process. The world we live in is an ever-changing theatre on multiple different issues and information dissemination can be compromised fairly easily if a plan for validation is not put in place. Decision support tools are imperative to mission success and need to be implemented as well as communicated in the best ways possible. Better research must be planned and used to strengthen those decision support tools.

Mr. Eric Velte, ASRC Federal Mission Solutions.

Mr. Velte related there needs to be a focus on local communication to support remote and rural communities. North Slope current infrastructure is traditional including wired internet, broadband capability, commercial satellite options, and eventually connection up to a route through the Aleutian chain or Japan. The overlying issue is how to leverage all existing communication technologies with the compatibility for communication and coordination between first responders, multiple layers of government, and local communities all while maintaining security and reliability of information. All ASRC communication centers have trained personnel and basic operating equipment including internet, phone, fax, VHF radio,

and AIS. They have demonstrated success, primarily in the facilitation of conflict prevention and resolution.

Ms. Lori Parrot, Sandia National Laboratories.

Ms. Parrot described that collaboration can help us understand complex system interactions between people, infrastructure, and natural system. There are too many uncertainties, but computation environment can help us address and manage those uncertainties. As infrastructure continues to develop in the Arctic, changing permafrost should be a major concern. It is important to look into the future when developing infrastructure; “future infrastructure should be planned against future risks.” Incorporate the scientific knowledge to understand risks and create resilient and effective infrastructure.

Mr. Andres Morales, Alyeska Pipeline Corporation.

Mr. Morales related that crisis response in remote areas without infrastructure is currently conducted by Alyeska Pipeline Corporation Predicting, but then over predicting turns into preparedness. There are a range of response options, but over-responding can lead to a greater human footprint – a consequence that must be acknowledged and mitigated where possible. Satellites can be overloaded which then impacts communications. In-scenario testing on equipment is important to improve interagency and inter-industry communications, keeping VHF in mind as the industry preferred communications platform.

Mr. Scott Blough, Tiffin University Ohio.

Cybersecurity should be considered during communications planning and decision-making. Depending on the target, ransomware is a threat to security at all levels. GPS based technologies can be interfered with, especially by Russia who currently jams U.S. military GPS and acts in close proximity to Alaska. Terrorists could exploit the frantic nature of physical disaster response in cyberspace. Cyber security is also related to any sensors that use automation or autonomy, and the differences in these terms must be understood and used accordingly. Validation of information can be difficult and must be improved. Organizations like the cartels and other organized crime outlets should also be taken into considered when planning communications.

Mr. Richard Garrett, Sandia National Laboratories.

Three critical steps were presented in increase arctic outlook: address infrastructure research and data needs, implementation of decision support tools, and develop pathways to implement research. Unique arctic data needs must be understood and used to better implement research into practical applications. A need for a high arctic research center was brought up. Decision support tools are proven to have a major impact and should be upgraded to include analysis.

Arctic IoNS Discussion Panel 5: Review of Salient Points in USCG led area Contingency Plan (ACP)

The goal of this panel was to provide an operator's point of view on the most important elements of the response plan and key gaps. This panel was presented by:

Lieutenant Commander Jereme Altendorf, USCG District 17 (D17), Sector Anchorage.

LCDR Altendorf explained that the USCG D17 covers the entirety of the state of Alaska, and maintains more facilities than all other sectors in the western hemisphere. As a result, it receives extra funding for the Arctic in the form of “Arctic Shield.”

USCG D17 has identified 394 regulated facilities containing bulk oil storage. Of these 394, only 36 are accessible via the road system. Furthermore, due to personnel constraints, only 6 inspectors are assigned to the USCG D17 Sector Anchorage facilities inspection office, shop, of which, only 3 are fully qualified

Travel and inspection costs associated with accessing these facilities costs USCG D17 approximately \$1M per year. As these facilities age, there has been an increase in spills due to the harsh conditions of the Arctic and remote region Alaska marine environment.

However, despite the challenges with maintenance, it is far more cost effective to keep the facilities from degrading, as Alaska has the most expensive per gallon oil spill cleanup cost in the country.

USCG D17 Sector Anchorage invests proactive measures to seek and train qualified USCG personnel for the right communities at the right time. Hub communities selected based on their accessibility via commercial airlines. The primary mission of USCG D17's remote and rural inspection program is to establish a baseline of maritime domain awareness, and to better understand the operations of rural communities.

Achieving this mission begins by directly meeting with regulators (state and federal), to discuss oil spill preparedness, vessel response plans, oil spill platform response plans, and all industries that move and manage oil.



Figure 6. LCDR Altendorf giving panel presentation regarding salient points in the USCG led Area Contingency Plan at the Arctic IoNS 2019.

Each of these plans must further reference a contingency plan managed by on-scene coordinators.

Arctic IoNS 2019: Tabletop Exercise Sessions

Tabletop Exercise and Participant Group Selection

Following the plenary session, workshop participants addressed crisis response in a tabletop exercise. The tabletop consisted of two distinct moves, or scenarios, to address a disabled vessel with lost cargo containers (Move 1), followed by an earthquake response (Move 2).

The tabletop consisted of six pre-selected participant groups. Workshop planners selected the composition of each group based on the qualifications and expertise of each participant. This method allowed for dynamic discussions as participants leveraged their own backgrounds and experiences to iterate as a group.

In order to evaluate the two scenarios, participant groups first discussed the existing resources that could be leveraged to address each move. Next, participants exercised a “Hot Wash” capture, in which all group members transcribed their thoughts, potential needs, and further questions prompted by each scenario.

Overview of Anchorage Arctic IoNS 2019 Tabletop Scenarios

Arctic IoNS uses fictitious (intended as realistic) scenarios to orient participants within the environment and situation, and to facilitate focused discussions that support the U.S. Coast Guard workshop goal to identify capability shortfalls that will inform science and technology research activities. Accordingly, the scenarios are designed to severely stress the system, allowing discovery of shortfalls to drive the areas of needed research to be compiled by ADAC and coordinated with USCG and DHS S&T UP.

While both Moves #1 and #2 were briefly discussed previously, the following sections contain a more detailed illustration of each scenario, which was used to guide the discussions of each tabletop group exercise:



Figure 7. Bering Sea bomb cyclone. Source: Washington Post.

Workshop Tabletop Exercise Move 1.

A large container ship carrying a number of containers, some holding hazardous materials, encounters extreme weather in the form of a “bomb cyclone” steaming from a western North America port while transiting the Aleutian Islands (along great circle route) to East Asian markets. During the storm, a large wave generated from the storm unexpectedly strikes the vessel resulting in loss of a number of containers overboard and failure of the vessel power plant, steerage, and communications systems. Due to the loss of power, the storm is driving the vessel northward into the Bering Sea. The crew elects to stay aboard the vessel but is unable to communicate due to the damaged and/or lost equipment. Many of the containers remain afloat, due to watertight seals. Due to number of lost containers with hazardous materials, the need to gaining maritime domain awareness of both the vessel and the lost and drifting containers, drives a USCG led response.

Associated Move 1 Modules.

In order to guide the discussions, groups were asked to address “Move 1” in three distinct topic modules, with each module categorized as a separate component of a disaster response:

- Module A: Incident Initiation.
- Module B: Response.
- Module C: Maritime Domain Awareness.



Figure 8. Capsized container ship. Source: core77.com

Workshop Tabletop Exercise Move 2.

While the USCG led response seeks to safely secure the vessel and containers, the violent Bering Sea storm wreaks havoc on western and southwestern Alaska. Once the USCG response results in safely and sufficiently addressed the vessel and the lost containers, the workshop enters into the second move: The aftermath of the storm results in flooding and a number of damaged/destroyed buildings.

A number of locations along shorelines in southwestern and western Alaska show signs of environmental trauma following fuel, oil and potentially other chemical leaks. Initial reports indicated many of the leaks were potentially caused by collapsing facilities that led to ruptured bladders and other containers with chemicals. Due to the remote and rural nature of many of the damaged facilities, latent detection of spills becomes a problem of growing concern.

Coincidentally, the greater Anchorage area receives a 7.5 earthquake, damaging the Port of Alaska and facilities in the Anchorage area. Damage to Ted Stevens and Joint Base Elmendorf-Richardson airports and the Port of Alaska, (near downtown Anchorage) was classified as damaged but serviceable. Roadways across southcentral Alaska (particularly bridges) experience damage. A number of strong aftershocks escalate further damage to facilities and infrastructure. U.S. Coast Guard and other emergency response personnel, address damage to port and coastal region infrastructure. Operationally supporting the response and logistically supporting response forces across rural portions of southwest and western Alaska becomes problematic.

Associated Move 2 Modules.

Similar to “Move 1,” when addressing “Move 2,” groups were asked to discuss the scenario using three distinct topic modules, with each module categorized as a separate component of a disaster response:

- Module A: Preparation.
- Module B: Coastal Response.
- Module C: Latent Detection.

Anchorage Arctic IoNS 2019 Tabletop Exercise - Summary of Discussions by Specific Breakout Group.

The following is a summary of the tabletop exercise by the 6 participating breakout groups corresponding to the two moves described in the preceding paragraphs.

Anchorage Arctic IoNS 2019 Breakout Group 1 Exercise Summary.

Moderator: Dr. Nancy Kinner, University of New Hampshire (UNH), ADAC researcher.

Recorder(s): Megan Verfaillie (UNH ADAC Fellow), Raul Reutov (UAA ADAC Fellow).

Table 1. Breakout Group 1 participants and their respective affiliations.

Participant	Affiliation
Shannon Jenkins	HQ USCG 5PW
Samuel Shea	US National Weather Service
LCDR David Smith	HQ USCG DCO-X
Scott Socolofsky	Texas A&M University
OSC David Bergman	USCG District 17, Sector Anchorage
Brian Dolph	USCG Research & Development Center
Bruce Hellenga	ARCTICOM
LT Emily Motz, USN	U.S. National Ice Center
Gregory Stihel	Sandia National Laboratories
LCol Ray Chiasson, Canadian Armed Forces	JTF-North, Canada Joint Ops Command

Sarah Allan	NOAA Office of Response and Restoration
Chris Hall	Alaska Clean Seas

Group 1 - Tabletop Exercise - Addressing “Move #1.”

Module A: Incident Initiation.

Group 1 began with a discussion of the unknowns inherent to the scenario. The primary concern was the lack of communication between the vessel and the responders. Assuming communication could be established, and the system was not damaged, the USCG would normally instruct the vessel to drop a hook once the water was shallow enough (~1 mile from land). Without communication, it will be challenging to predict what actions the crew has already taken (e.g., abandon ship, drop hook) since there is no information on the state of the vessel. Commercial vessels should have primary and secondary communication, but if communication cannot be established, a C130 would have to be deployed to establish short range communication. Another option would be to request commercial traffic in the area to respond to the event.

The group was also very concerned with the location and temporal aspects of this response. The exact location of the vessel is unknown and must be estimated based on environmental conditions, last known coordinates, and reported direction. Based on the information provided, the team only has about 10-12 hours to respond and stabilize the ship. In addition, the storm is not likely to move away until the following day. Not all assets may be able to respond in these conditions or within this time frame.



Figure 9. Dr. Nancy Kinner from the University of New Hampshire facilitating the Tabletop Exercise at the Arctic IoNS Workshop 2019.

Exercise Question 1: What resources are available to acquire the manifest and details on potential hazardous materials?

The group determined that the shipping company would be the best point of contact to get a record of what materials were on the ship. USCG command center and Marine Exchange

may also have this information available. In addition, a record of crew members on board could be requested to help with medical response. Since these containers are non-transmitting, they will be difficult to track and locate. Specific systems may be available to address this (e.g., Navy, USCG).

Exercise Question 2: How does the information in the initial distress call change the response?

Normal response time for this scenario would typically take nearly a week due to the length of travel and lack of resources. The response time frame should be used to prioritize what information is needed to inform decision makers.

Module B: Response.

Exercise Question 3: What are the hazards associated with the containers lost overboard? How would the priorities change if the containers contained hazardous materials?

After receiving the actual manifest, the group discovered that the initial manifest did not accurately report what was being carried. Polyamide, potassium hydroxide, organic peroxide, sulfuric acid, tetrafluoromethane (compressed), potassium hydroxide, and NN were all lost overboard. The first step would be to determine the impact of the chemicals spilled, and what their interactions may be in the cold seawater. The UN codes listed on the manifest will tell what type of storage containers they are in, and the environmental concerns upon release. The team also noted that the containers would be inaccessible during the storm event and may not even be floating depending on their density, or if they have been punctured.

The Group decided that the best way to address these containers in the short term would be to restrict transportation and fishing in the area by contacting the correct agencies. Aside from local traffic, these chemicals spilled may also affect response and rescue operations if they have been spilled on deck or if hazardous gases have been released. In order to protect responders, a hazardous waste disposal team may have to be deployed first. It is unknown if this team has the capacity to travel in adverse weather conditions.

Module C: Maritime Domain Awareness.

The group spent time discussing what predictions are needed to respond to the situation. The first was a hydrodynamic model (likely from NOAA) to search for floating objects such as the unpowered vessel and the lost containers. The bomb cyclone will increase the uncertainty in these models and decrease the accuracy of the predictions. Models for the containers can be verified more accurately by aerial reconnaissance than by dropping tracking buoys in the same location. One solution suggested was “SciMap,” a search and rescue model used by NOAA. Visual observations should also include colors and numbers

which will identify contents and ensure that the containers from this event are the ones located. In addition to visual reconnaissance, infrared may also help locate containers in good weather conditions.

Group 1 - “Hot Wash:” Capturing Key Outcomes from Move #1.

The consensus from Group 1 was that the first step in this response should be focused on increasing domain awareness. The satellites available do not have enough resolution, however, using tracking such as EPIRB may narrow the scope. In addition, international cooperation may create new sources of information, such as Canadian radarSAT imagery of the general area.

Another major concern for this response revolved around challenges with restoring communication with the vessel. Participants agreed that there would be a 4-hour gap between the lost communication and when a plane could reach the vessel. Other communication avenues, such as personal SAT phones or locator beacons should be explored. There is a potential to improve communication infrastructure in future events by discussing challenges from this response with the shipping companies that operate in this region.

Finally, the group was very concerned with the status and location of the containers. They proposed further research on container tracking methods and techniques. One mitigation technique would be to require container tracking for ships traveling nearshore in high sensitivity areas, although this may not be a perfect solution as moving further offshore still has inherent risks. Finally, the dissemination of public information about these containers is important in the event that they wash up onshore. Reducing civilian contact with hazardous substances should be a primary concern.

Group 1 - Tabletop Exercise - Addressing “Move #2.”

Module A: Preparation.

In rural Alaska, there are a lot of unknown oil and chemical risks. One solution discussed by Group 1 was how to improve understanding and communication between responders and the local impacted community for a more effective response. For example, by implementing community education before a disaster occurs, responders will not have to spend time explaining the risks and challenges. An interdisciplinary team may be able to convey a well-crafted message. Education is especially important due to climate change. Melting permafrost has not happened in the cultural history of many of these communities, and this creates new risks. Traditional knowledge is valuable, and near-term knowledge needs to be updated.

One communication challenge stems from the regulator role played by the responding agencies. It is important that regulators do not “tell” (or direct) what actions the communities should or must accomplish. Communication should be addressed as a partnership based on a trusted relationship built in advance. This way, responders can inform the community of the risk, allowing community members to decide for themselves how to make an informed decision. However, Group 1 participants expressed that building this relationship can be a challenge for the USCG due to a low level of available manpower. For example, many villages only have one civilian liaison. The Group proposed utilizing a village point of contact, or a safety officer, who may carry more influence than an outside source of information. In addition, it may be possible to collaborate with a non-regulatory agency outside of USCG to facilitate communication. Understanding and collaborating with existing structures will improve mitigation of hazards.

Module B: Coastal Response.

Question Posed by Moderator: What would you need from the unified command (from your perspective) that would be helpful? What would you need at your disposal (whether it is an existing resource or not)?

The USCG develops their overall response profile using SAR FAC (search and rescue facility list), which is a master list updated by someone in the command center. One major ongoing project is the assessment of storage tanks in rural communities. This method can be problematic, as maintaining up-to-date information of these resources is difficult.

The Group also agreed that a storm surge inundation map would be helpful. NOAA has a model for this, but it lacks accuracy and is based on outdated maps. It was uncertain how much the model is able to address impacts of ice. In addition, erosion is occurring so fast that models are becoming outdated quickly. Flooding is primarily based on bathymetry, so adding this to existing models will provide better estimates. Despite this, storm surge models on the Arctic are exceptionally difficult to accurately create due to “fast ice,” which is not yet included in models due to a lack of data.

Module C: Latent Detection.

In regard to latent detection, Group 1 determined that the first step should be prioritizing and detecting which tanks need to be addressed first, and which can wait until later in the response. Solutions include an integrated technology to alert a monitoring agency, or implementation of a kit that can be used by local community members prior to the arrival of emergency responders. However, these solutions are challenged by a lack of available resources. In particular, participants expressed concern regarding local trained personnel, as it was noted that these individuals often leave communities after they have been educated in order to seek higher paying jobs elsewhere. Another consideration for latent

releases is the risk to drinking water resources. Berms or source water protection may not be sufficient if secondary containment does not exist, or is broken. Despite recurrent training of local response teams, competing priorities make maintaining these programs challenging.

In addition to drinking water, critical infrastructure varies for each community (e.g., heating tanks for schools, grocery stores) and is not well defined by USCG or DEC. Alternatives to diesel and fuel oil energy sources have been considered, but still require further research.

Involving communities in reporting spills was also proposed as a solution, but reporting does not always happen quickly. Education may help encourage self-reporting due to better understanding of the risks. One proposed reporting technique was to encourage local students to take photos with GPS location and observations. According to participants, this has worked in the past for shipping, and the Local Environmental Observer (LEO) network does this as well, but not for oil. In addition, communities may be equipped with small, easy to use drones as part of an Arctic Sustainment Package for assessing conditions. This may, however, pose challenges for response operations without proper training of local drone operators.

Finally, the group emphasized the need to involve community representatives in this conversation to assist with both generating the solution, while also “ground truthing” it.

Table Top Exercise Group 1 - “Hot Wash:” Capturing Key Outcomes from Move #2.

In order to capture the key outcomes of Group 1’s discussions of “Move 2,” the group developed a list of key goals and research questions:

1. How do we get this baseline knowledge?
2. Defining critical infrastructure and building community inventories.
3. Identify risks to critical infrastructure in the communities.
4. Help communities identify issues to their resiliency, goes with the education piece.
5. Tools that are out there need to be identified and evaluated. What pre-existing tools are in the community (apps, programs, etc.) that we can leverage and springboard?
6. How to retain locally trained community members?
7. Correlate traditional knowledge and climate change.
8. Updating/improving coastal shoreline data needed for accurate model.
9. Focusing on prevention/preparedness and community resilience, not only on response.



Figure 10. Group 1 discussing the scenario during the Tabletop Session

Anchorage Arctic IoNS 2019 Breakout Group 2 Exercise Summary.

Moderator: Dr. Shawn Butler, UAA

Recorder(s): Jessica Manning (UNH ADAC Fellow), Tristan Goers (UAA ADAC Fellow)

Table 2. Breakout Group 2 participants and their associated affiliations.

Participant	Affiliation
Hank Blaney	HQ USCG
Phil Brown	USNORTHCOM J7
CAPT Sean Mackenzie	USCG D17
Mark Everett	USCG D17
Leon Morgan	State of Alaska, Dir. AK Analysis Center
Ryan Metzger	National Weather Service
Patrick Lottinville	ALCOM HQ
Geoff Merrell	State of Alaska, Dept. of Environmental Conservation
Andreas Morales	Director of Emergency Preparedness and Response
Robert McCoy	University of Alaska Fairbanks, Geophysical Institute

Group 2 - Tabletop Exercise - Addressing “Move #1.”

Module A: Incident Initiation.

When assessing “Move 1,” Group 2 determined that the vessel in distress will be quickly detected from 24/7 monitors at JBER’s command center, and from communication transmission. To respond to this situation, the responders will need to determine the location of large assets, as small helicopters and ships will not be sufficient. Additional useful information is wave height, wind speed, and the identification of, and communication with, additional involved agencies. The responsible party (RP) should respond first, but if for some reason they are unable, the Coast Guard will hire contractors to clean-up the hazardous materials, and will bill the RP and their insurance.

Module B: Response.

The Group decided that, in an ideal scenario, they would launch two tugs. One tug would be sent as fast as possible to physically push the container vessel away from shore, while additional responders would load the other tug with the emergency towing package. However, since there is only one tug available, they will load the emergency towing package on that tug. If the tug was travelling slower than expected, they would need to find a local ship that is capable of assisting, and lower the emergency towing package onto that ship via helicopter. A helicopter can also deliver equipment to slow the rate of drift of the distressed vessel (an anchor cannot be used in deep water, or if the vessel is travelling above one knot).

Module C: Latent Detection.

With regard to the two injured people in the scenario, the responders would first need to understand the urgency for required help. A helicopter can then be sent to gather the individuals from the scene. Next, St. George needs to be notified that the vessel ship is arriving via a telephone call to emergency POCs from St. George or St. Paul. In addition, nearby ships should be notified of the vessel in order to avoid a larger problem. C-130’s can further be used to provide site observations about the vessel, and to confirm the safety of individuals. Should containers wash ashore, local communities need to be notified to stay clear of the hazardous materials, and allow crew members to clean the debris once the storm has passed.

Table Top Exercise Group 2 - “Hot Wash:” Capturing Key Outcomes from Move #1.

Group 2 categorized the key outcomes of their discussions from “Move 1” into two sections: final plan, and identified gaps.

Final Plan:

In order to address the scenario in “Move 1,” Group 2 would execute the following tasks:

- Task a tug from Dutch Harbor with an emergency tow package.
- Task a Good Samaritan ship towards the container ship.
- If needed, task a helicopter to drop the small emergency tow package to the Good Samaritan ship.
- Task a C-130 plane towards the vessel so the flight surgeon can communicate with shipboard medical personnel and so they can communicate with the ships engineer.

Identified Gaps:

Group 2 identified a number of gaps for “Move 1” listed below:

- Need to track containers that may have gone overboard.
- Alaska seems to have a lack of tow cables.
- There is a lack of large USCG vessels in the area.
- How can contact be made with St. George Island to warn of impending ship and containers that are inbound?

Group 2 - Tabletop Exercise - Addressing “Move #2.”

Module A: Preparation.

When addressing “Move 2,” Group 2 determined that the first step would be to prepare the management team in order to determine the best approach the response. Next, a damage assessment can be obtained via unmanned instruments. For example, if runways are not functional, experts need to determine what is required to be able to repair the runways (e.g., engineers), so that supplies can be transported. Furthermore, a map of all possible unconventional areas that can be used for helicopters and/or airplanes would be beneficial.

Additional information needed for a response includes the boundaries of the storm, if there are hazardous materials involved, and if so, their details. In the case of the oil spills, additional information regarding the oil also must be collected, such as the location of the spill, how much oil has spilled, and will oil continue spilling, what type of oil is it, and a rank of importance to determine the urgency.

Module B: Coastal Response.

Once the above tasks have been completed, responders, must work with partners and resources to execute the plan. Some catastrophes already contain geographic pre-planned responses in order to account for sensitive environments. However, these preplans need to

be upgraded, and the uncertainties should be defined. In addition, it would be beneficial to have a scale to evaluate different issues and determine a priority list.

Module C: Latent Detection.

Communication throughout the whole incident is crucial. There should be a way to share information quickly and broadly, and there should be several different means of communication (e.g., outdoor speakers) in the event that communication lines go down. Furthermore, the Coast Guard needs to seek input from local individuals in order to prioritize response tasks. Additionally, in the case of “Move 2,” the governor should declare a state of emergency (this can increase the capabilities of the Coast Guard response, depending on the situation).

Table Top Exercise Group 2 - “Hot Wash:” Capturing Key Outcomes from Move #2.

After discussing “Move 2,” Group 2’s key outcomes were formed as a series of questions needing solutions in order to appropriately respond to the scenario:

- How can resources be consolidated onto a single map from all involved organizations?
- How can we effectively get equipment to a remote site?
- How can we easily assess, report, and ensure the quality of the report when it comes to assessing damage?
- Are there satellite phones or other alternatives that can assure communications across the state?
- Is there a need for an expanded logistical footprint to backup Anchorage in the case that Anchorage is unable to help other locations in the state?
- How can we get and maintain visuals on oil spill?

Anchorage Arctic IoNS 2019 Breakout Group 3 Exercise Summary.

Moderator: Jessica Garron, UAF

Recorder(s): Sarah Gering (UAA ADAC Fellow)

Table 3. Breakout Group 3 participants and their associated affiliations.

Participant	Affiliation
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MSTCS John Rice	USCG D17, Sector Anchorage
Brenda Dunkle	ADAC Affiliated Researcher
MST1 Barnum	USCG PACAREA, IMD
Jonathan Salton	Sandia National Laboratories
Craig Ziolkowski	Alaska Department of Environmental Conservation
Douglas Causey	UAA ADAC
Scott Blough	Tiffin University
Amoret Bunn	Pacific Northwest National Laboratory
Lori Parrott	Sandia National Laboratories
Heather Seemann	North Slope Borough, Office of Emergency Management

Group 3 - Tabletop Exercise: Addressing “Move #1.”

Module A: Incident Initiation.

Group 3 determined that the initial approach to the scenario presented in “Move 1” would be to encourage deployment of SAR Teams. However, this decision would be based on the prevalence of injuries. If so, in this case, the local Emergency Manager would contact RCC.

Module B: Response.

Next, the Coast Guard would initiate the QRC based on the distress call. They would need, or would likely already have, access to the ship's manifest. The information in the manifest would greatly tailor their response. For example, manifests often contain details regarding the contents of the ship's containers, the ship's layout, personnel information, etc.

Furthermore, the group considered whether the lost containers would likely sink to the bottom of the ocean, which would depend on the ocean depth and current. However, sinking containers are considered a low priority when compared to containers that wash ashore. Land bound containers can potentially leak hazardous materials, and/or attract people to the hazard.

Module C: Maritime Domain Awareness.

The Group further discussed the incorporation of oceanographic data in order to track the movement of the vehicle, as well as the need to contact the scientific coordinator. In this scenario, the Group suggested to contact NOAA for oceanographic and current data (located at JBER), and would request particular information about chemical hazard modeling.

Group 3 - “Hot Wash:” Capturing Key Outcomes from Move #1.

In order to capture the key outcomes of “Move 1,” Group 3 listed the response gaps, limitations, and concerns that emerged from their discussion of the scenario:

- The need to track lost containers.
- The use of a helicopter not possible during a bomb cyclone.
- Rough seas minimize the ability to see chemical spills from ships.
- Satellite quality and return (minimum 24 days) of imagery is too long for disaster response.
- The only satellite data available in an extreme weather event is radar.
- There is no local entity in rural villages that could have boots on the ground based on a local coastal receive of the mayday call.
- No coordinated state/local asset lab.
- The ETA for fixed air to track vessel is approximately 4 hours.

Group 3 - Tabletop Exercise: Addressing “Move #2.”

Module A: Preparation.

In regard to the second scenario, Group 3 determined that the first step would be to prep their gear, which can take three to five days. From this discussion, a number of gaps in the process were highlighted by group participants, such as the need to optimize the process, and to develop a one-time checklist for gear preparation (both of these factors can greatly affect the efficiency of mobilization).

Additional concerns regarding gear included where and how to preemptively stage gear near the incident site, while taking into account a wet, soggy, unstable landscape, as well as food, water, and waste management. Solutions to these concerns could begin to develop by consulting local points of contact, as well as those in the area contingency plan.

Module B: Coastal Response.

Module 2 included a slight update to the scenario, in which Cook Inlet now has a large percentage of leaked oil and gas, and is facing the threats of an oncoming storm. In order to address the change in scenario, Group 3 determined that first, residents and visitors would require safety information, particularly when communication is limited due to the potential lack of access to electricity caused by the oncoming storm. To complicate matters, Western and Northern Alaska do not have immediate emergency broadcasting systems (such as the Nixle application used in Southcentral Alaska). While residents may not have the ability to receive emergency broadcasts, the Coast Guard would send broadcast notifications to mariners prior to the landfall of the storm.

Module C: Latent Detection.

In the wake of the earthquake scenario, Group 3 addressed the concerns regarding the loss of port access in Anchorage. In this case, Fairbanks would become the main point of contact for rural and remote Alaskan communities. Local communities would likely have to rely on their own infrastructure to sustain themselves while their traditional source of assistance recovers from the major earthquake (Anchorage).

In this scenario, participants discussed the need to send information to the EOC, however, there would likely be a lack of manpower and responders due to the impacts of the earthquake. In either case, Group members noted that JBER would maintain the ability to initiate the EOC immediately.

Table Top Exercise Group 3 - “Hot Wash:” Capturing Key Outcomes from Move #2

The above discussions highlighted a number of gaps and potential changes in emergency response needed to address “Move 2.” In order to capture the key outcomes developed from the analysis of Move 2, Group 3 listed numerous questions and gaps below:

- There is a need for a more interactive way to disseminate real time decisions, particularly when communication information from Anchorage if their communication systems are compromised due to a disaster scenario.
- Social media would be an effective method to disseminate emergency information.
- There is a need to invest in immediate notification technology, particularly when individuals are in heavily insulated buildings with little cell reception during the event of an emergency warning.
- What resources outside of Alaska are available to help with providing data or analyzing imagery?
- Need to determine where to send assets to address latent detection.

- Currently, limitations exist in local communities due to a lack of trained personnel when it comes to assessing damage. Efforts need to be focused on training local community members in order to increase available and efficient disaster response when additional resources (such as those from Anchorage) are unavailable.
- Would it be possible to develop an app, such as Nixle or a drone, to disseminate information regarding emergencies to remote communities?

Anchorage Arctic IoNS 2019 Breakout Group 4 Exercise Summary.

Moderator: Amy Holman, NOAA

Recorder(s): Rachel Lewis (UAA ADAC Fellow)

Table 4. Breakout Group 4 participants and their associated affiliations.

Participant	Affiliation
Phil McGillivray	USCG PACAREA
LCDR Jerome Altendorf	USCG D17 Sector Anchorage
John Pearce	USGS Alaska Science Center
Michael Bonadonna	DOC-NOAA
Alan Hickford	National Weather Service
Tom Ainsworth	NOAA NWS
Renee Tatusko	NOAA National Weather Service
Mary David	Kawerak Incorporated, Executive Vice President
Matthew Cox	Raytheon Space & Airborne Systems

Group 4 - Arctic IoNS 2019 Tabletop Exercise: Addressing “Move #1.”

Module A: Incident Initiation.

Group 4 begin their discussions of “Move 1” by addressing communications, and the two tracks it would follow in the given scenario. On one side, most people would focus on the weather advisory in the area, either by receiving a Nixle alerts, watching the NWS/NOAA coverage, or listening to the radio for updates. On the other side, as the storm progresses, the NWS would be alerting those who need the updated conditions. However, once the ship

reported its transmission issue, a third communications track would be initiated by alerting the Coast Guard to begin their response. If it were an immediate need, some assets would be grouped together and a request for an aircraft would be sent. If more information was needed, they would call the command center.

In the case of the overboard containers, NOAA would be alerted first. Next, due to the size of the vessel, information would then be sent to the White House for a potential disaster declaration, particularly in the case of contents overboard near international territories. As knowledge disseminates, additional steps would be taken to contact the shipping company, and/or the marine exchange in order to determine pitch and roll data for the Coast Guard.

Module B: Response.

In the case of the response, multiple agencies would be observing different aspects of the same region in order to assist with the Coast Guard response. For example, the weather service would continue to forecast alerts, warnings, specific requests, or anything out of the ordinary. The islands affected by the storm would additionally receive information directly via phone. NOAA would continue to execute satellite scans for higher resolution images (particularly in this case as AIS and communications are down). If the vessel is visible from the coast, local community members could further provide observations based on first-hand observations. Last but not least, the lost cargo would need to be consistently tracked.

Module C: Maritime Domain Awareness.

First, the lost cargo needs to be tracked. Unmanned aircraft could be used to find the lost cargo and monitor its path. This solution is useful as some cargo will be submerged, while others will float. Inexpensive vests could also be placed on the cargo to provide a location when the cargo is submerged in the water. The group also discussed existing websites containing locational data for distressed objects drifting towards shore.

Once potential and currently affected communities have been identified, the Coast Guard would send an alert. Currently, there are various ways for the communities to alert those responsible for cleanup of debris, including via debris apps, cell phones, and email.

Arctic IoNS 2019 Table Top Exercise Group 4 - “Hot Wash:” Capturing Key Outcomes from Move #1.

After discussing “Move 1,” Group 4’s key outcomes were formed as a series of further questions prompted by the scenario:

- Can tracking of containers be simplified, even when submerged?

- Do devices for hazardous materials exist that could be used for tracking?
- Can unmanned aircraft be designed to locate containers?

Group 4 - Arctic IoNS 2019 Tabletop Exercise: Addressing “Move #2”

Module A: Preparation.

In order to discuss the “preparation” phase of responding to the scenario of “Move 2,” Group 4 was assigned two specific communities to consider when addressing disaster response, Adak and St. Paul. Aside from the topological differences, Group 4 chose to treat the communities with similar response mechanisms.

First, the U.S. Department of Homeland Security would identify critical infrastructure, including drinking water, power plants, and alternative power sources. Additionally, they would determine who would need to be rescued first, with injured individuals and children prioritized first. In this case, the flood maps created by DGGs would be crucial for response teams.

Furthermore, each community would have their own response plan in place. The local health clinics should be notified to begin preparations for the storm. Once the alert is initiated, communities would be capable of identifying missing individuals. Emergency response personnel would then be called in for the crisis response. It was noted that it is unsure if the specific villages contain siren systems, so it was decided that radio would be the best method for communicating updates and evacuation notifications. Furthermore, the local school is the primary location for evacuations, storage of extra supplies, and a general rallying point.

Module B: Coastal Response.

The Rural Community Perspective: In the event of an earthquake in Anchorage, while news would spread quickly, the information would not be disseminated immediately to rural communities. If there is significant damage, both NWS and NOAA would have to forecast from locations beyond Anchorage, most likely resulting in a delay. As a consequence, this would likely also delay Coast Guard aid efforts.

Communications would arrive after the storm detailing what was needed by those in the affected areas. Available funds would be used to purchase the needed supplies and sent to those affected by the storm. Water could be a major issue, as with contamination in the lagoon and lack of snow and ice in the region due to the timing, the communities would be relying on water tanks in their communities unless they have stored their own water. Any additional supplies held by the communities would be in the school.

The U.S. Coast Guard Perspective: In contrast to the rural community perspective, workshop participants reflected the U.S. Coast Guard is normally focused “post-storm”. As a result, most rural communities act as the technical “first responders.” However, communities contain their own emergency plans, so it is assumed that the plans will be performed accordingly. After 2-4 days of the storm have passed, the Coast Guard will need to bring supplies to rural communities. For the long term, the Coast Guard relies on the state local emergency and contingency plans to execute these efforts. If a community has gone dark for more than 3-5 days, meaning they have not signaled for help, the Coast Guard knows they need assistance.

Module C: Latent Detection.

In regard to latent detection, the Group discussed that there mechanisms to measure if fuel has leaked. If there is a leak, local communities can do simple assessments, but there are no hazmat personnel on the island of St. Paul to truly handle it. When the crisis is over, the community would thus be required to call outside emergency personnel in order for the leak to initiate the spill clean-up.

Arctic IoNS 2019 Table Top Exercise Group 4 - “Hot Wash:” Capturing Key Outcomes from Move #2.

After discussing “Move 2,” Group 4’s key outcomes developed into a series of questions needing solutions to properly respond to the scenario:

- How can weather-services related continuity of operations plans be coordinated to minimize the cascading delays caused by forecasting interruptions?
- How can we most effectively deploy response equipment to a remote area?
- How can ensure the quality of the reporting when it comes to disaster damage?

Anchorage Arctic IoNS 2019 Breakout Group 5 Exercise Summary.

Moderator: Maj Gen (Ret) Sandy Finan, PNNL

Recorder(s): Stacey Hanson (UAA ADAC Fellow), Jack McCaslin (UAA ADAC Fellow)

Table 5. Breakout Group 5 participants and their associated affiliations.

Participant	Affiliation
LCDR Latarsha McQueen	USCG D17, Sector Anchorage
Ed Page	Marine Exchange of Alaska
LT James Nunez	USCG D17
Karin Messenger	HQ USCG
Quinn Wilkins	University of New Hampshire
Richard Garrett	Sandia National Laboratories
Zach Schulman	HQ USCG
Michael Duxbury	State of AK Office of Public Safety
CAPT Shannon Greene	USCG D17
Robert Page	HQ USCG

Group 5 - Arctic IoNS 2019 Tabletop Exercise: Addressing “Move #1.”

Module A: Incident Initiation.

In order to initiate the incident response, Group 5 determined that the first step would be to identify the Coast Guard’s closest assets. For example, the Group discussed the possibility of flying a C-130 from Kodiak in order to provide communication ability, and/or sending a Coast Guard cutter. Furthermore, the Group determined that identifying any nearby vessels would be crucial, as they can more quickly assist those on board the distressed vessel. In addition, they may have a working VHF radio on board. Lastly, a notice to all nearby mariners would need to be provided in order to prevent collisions with the lost containers.

Module B: Response.

To begin the response, Group 5 agreed that they would first need to contact the vessel using VHF radio, if possible. Secondly, the residents of St. George would need to be notified of the situation. Group 5 further agreed that the response itself would require both a tug from Dutch Harbor, as well as a C-130 from Kodiak. The tug can assist the ship, while the aircraft can utilize radar to search for the adrift containers.

Module C: Maritime Domain Awareness.

In order to obtain domain awareness of the impacted area, a spot report from NOAA regarding the immediate area would need to be obtained. Furthermore, the spill and drift from the lost containers would need to be modeled, however, this is very timely. Additional modeling would be required to predict which containers would sink, and which have the potential to float ashore.

The Group also discussed the use of a geofence in order to track both the distressed vessel and its missing containers. A geofence can also assist coastal communities with tracking containers that may enter their vicinity.

Arctic IoNS 2019 Table Top Exercise Group 5 - “Hot Wash:” Capturing Key Outcomes from Move #1.

After discussing “Move 1,” Group 5’s key outcomes were formed as a series of further questions prompted by the scenario:

- Container detection is needed; the technology exists, but not where it is needed.
- Can we track individual containers in a cost-effective way?
- Can an app be used to track the spilled containers?

Group 5 - Arctic IoNS 2019 Tabletop Exercise: Addressing “Move #2.”

Module A: Preparation.

In order to prepare for the response needed to address “Move 2,” Group 5 decided that coastal resident’s first need to be evacuated. However, in order to do so, an evacuation plan needs to be in place, along with shelters and a prioritized emergency contact list. Local communities should also have battery based communication established as backup, as well as rudimentary containment equipment for hazardous chemical spills. Wind direction and the location of spilled containers needs to be known.

Module B: Coastal Response.

In order to initiate a coastal response, Group 5 agreed that neighboring communities may need to step in and assist while the Coast Guard and additional resources prepare. The Group agreed that in this case, both Bethel and/or Nome may be good hubs for preemptively storing extra emergency equipment for communities in the region. However, a plan needs to be made regarding what, and how, extra resources can be stored in these locations. The Group agreed that at the very least, basic oil spill clean-up supplies should be in place, and residents should be trained on how to use them.

Module C: Latent Detection.

Group 5 agreed that latent detection should be addressed using remote sensing. However, this begged the question of whether user-friendly remote sensing technology even exists for

oil spill detection. Furthermore, the Group discussed the need for cost-friendly, and durable technology, as this is often a major limiting factor when supplying communities with resources and technology.

Arctic IoNS 2019 Table Top Exercise Group 5 - “Hot Wash:” Capturing Key Outcomes from Move #2.

After discussing “Move 1,” Group 5’s key outcomes were formed as a series of requests for more information, as well as resources, that group participants feel are needed locally in order to address scenarios such as this:

- There is a need for emergency training in rural and remote Alaskan communities.
- There is a need for repair technologies intended slower leaks.
- Rural and remote Alaskan communities need resources to sustain themselves, such as oil spill clean-up technologies.

Anchorage Arctic IoNS 2019 Breakout Group 6 Exercise Summary.

Moderator: Cara Condit, USCGA Center of Arctic Study & Policy

Recorder(s): Kelly Ireland (UAA ADAC Fellow)

Table 6. Breakout Group 6 participants and their associated affiliations.

Participant	Affiliation
Holly Dockery	Sandia National Laboratories
Philip Thorne	USCG D17
CDR Mark Kuperman	USCG D17, Sector Anchorage
Michael Abe	University of Alaska, Anchorage
Dylan Conduzzi	Aleut Community of St. Paul Island Tribal Government
Gail Schubert	Bering Straits Native Corporation
Jifeng Peng	University of Alaska, Anchorage
Catherine Berg	NOAA OR&R
Joy Baker	City of Nome
David Norvell	Conoco Phillips Alaska

Group 6 - Arctic IoNS 2019 Tabletop Exercise: Addressing “Move #1.”***Module A: Incident Initiation.***

In order to discuss and evaluate the initial incident response of “Move 1,” Group 6 was assigned the community of St. George. As such, Group 6 determined that during this time of year (September storm season) the Coast Guard would likely have a presence in St. George due to the crab fishing season, and could be utilized for response efforts. To initiate a response, the Coast Guard would first have to consider safety of human life, communication challenges with no radios aboard the ship, getting C130s in the region, inclement weather challenges, and tracking locational gaps of the vessel and of the responders.

Module B: Response.

Furthermore, triaging is necessary for response. Who’s injured? Are they key crew members? What’s been impacted on the island? With a natural disaster, assume that community cannot provide assistance to the vessel. Therefore, the Coast Guard would likely focus on setting up a remote command center on the nearby island of St. Paul. In that case, a C130 could establish communications with the vessel by flying over it, but it could have an ETA of four hours or more.

Module C: Maritime Domain Awareness.

If hazardous materials in the containers have leaked, there is a need to establish a moving safety zone that will be broadcasted to nearby navigating vessels in order to prevent them from colliding with the containers.

In order to retrieve drifting containers, the Coast Guard can utilize the drift modeling software (SAROPS). To do so, identification of spilled contents needs to be made in order to prioritize their retrieval. From this notion emerged several questions regarding the ability to track the distressed containers:

Arctic IoNS 2019 Table Top Exercise Group 6 - “Hot Wash:” Capturing Key Outcomes from Move #1.

After discussing “Move 1,” Group 6’s key outcomes were formed as a series of further questions prompted by the scenario:

- Can Remote Frequency Identification (RFID) tracking of containers still work once submerged?

- Do ping devices for hazardous materials containers exist that could be used for tracking mechanisms?
- Is there potential for an emergency float on containers with a hydrostatic release?

Group 6 - Arctic IoNS 2019 Tabletop Exercise: Addressing “Move #2.”

Module A: Preparation.

When addressing the preparation phase required to respond to “Move 2,” Group 6 highlighted that establishing lines of communication with the community was of utmost priority. Next, preparations for the impending storm would begin, and prepositioning of equipment for oil containment of the above ground storage tanks. Oil tanks would further require protection, such as through the use of berms, and/or booms surrounding the facility.

Oil spills can pose risk to water, sanitation, and food supply. Therefore, oil containment should be initiated as soon as possible. The needs and vulnerabilities of local life (human and wildlife) should also be assessed and prioritized. In order to do so, supply chain disruptions should be considered, in addition to the identification of critical structures needing protection in the community. Local assets (physical/material and human resources) that are currently available for response should also be identified, and assistance for crucial missing assets should be requested from an outside community.

After the storm hits and the community floods, the community would likely be more concerned with establishing power and addressing the flood, than with dealing with the oil spill.

Module B: Coastal Response.

After the earthquake hits, supplies stemming from Anchorage will likely be delayed. In this case, USCG would prioritize finding oil spills, assessing port and waterway damage, and search and rescue, but would likely be overworked and overstressed. A hotline for reporting oil spills would be created, oil spill modeling would begin via flyovers. Unmanned aircraft could also be launched to detect oil spills, as well as to relieve the USCG’s burden.

Module C: Latent detection.

In addition, if the USCG’s resources are spread too thin, they will begin asking communities to prioritize their needs, and would further rely on EOC as an intermediary. Furthermore, task orders would likely be issued to private companies to assist and relieve stressed agencies. Oil response teams in the Lower 48 would also likely need to be activated.

Arctic IoNS 2019 Table Top Exercise Group 6 - “Hot Wash:” Capturing Key Outcomes from Move #2.

After discussing “Move 1,” Group 6’s key outcomes were formed as a series of further questions prompted by the scenario:

- Is there potential for another nearby community not as hard hit to provide assistance as the community waits for the state or feds to respond?
- Communities often have to survive 72 hours before reinforcements generally arrive. How do community members begin coordination, and how do they coordinate outside help?
 - A list of resources in the region would be beneficial to communities so they know what support they can ask of one another after a disaster. It’s important to identify and create redundancies/resources within the region so multiple communities can access them. Alaskan communities are very connected, and that connectedness should be leveraged following disasters.
 - There is a need to identify and classify the specific vulnerabilities of each community. For example, how much food and shelter are generally available?

Anchorage Arctic IoNS 2019: Breakout Group Session

Breakout Group Participant Selection and Focus Areas

Following the tabletop session, participants moved to the breakout group session, in which participants were asked to discuss predetermined topics of concern in order to identify shortfalls and gaps of current and emerging capabilities that would warrant further investigation.

As mentioned in the previous section, workshop planners selected the composition of breakout group participants based on qualifications and expertise. The participants within each group remained the same across both the Tabletop Exercise session, and the Breakout Group Session. However, as opposed to the Tabletop Session, each breakout group was further given a predetermined technological focus area in order to guide their discussions and analysis of key U.S. Coast Guard determined topics of specific concern. This method allowed for dynamic discussions as participants leveraged their own expertise, plenary group presentations, tabletop experiences, and the provided Literature Review to iterate as a group. The technological focus areas for each group were:

- **Breakout Group 1:** *Communicating with Vessel Master, Responders, and Remote Communities in the Arctic Technologies*
- **Breakout Group 2:** *Maritime Domain Awareness Technologies*
- **Breakout Group 3:** *Latent Detection Challenge Technologies*
- **Breakout Group 4:** *Adverse Weather Response*
- **Breakout Group 5:** *Predicting, Detecting, and Assessing Crisis Response Action Technologies*
- **Breakout Group 6:** *Technologies to Establish Communications with Remote Populations with Compromised Infrastructure*

Identifying Issues, Shortfalls, and Solutions in Existing Technology



Figure 11. Photograph of the butcher block notepads used for workshop participants to list their identified issues, shortfalls, and solutions regarding disaster response in the Arctic.

Throughout the plenary and tabletop sessions of the workshop, participants were asked to continuously keep note of any issues, shortfalls, and solutions that emerged from discussions of existing disaster response technology in the Arctic. Participants were then asked to record these thoughts on sticky notes, and place them on butcher block notepads categorized by each of the 6 technological focus areas listed above (see Figure 7). The butcher block notepad pertaining to the specific group focus area was then utilized to prompt further discussions during the breakout sessions. Tables containing each group's technological focus area, with the identified issues, shortfalls, and solutions, are included at the end of each breakout group summary discussed in below.

Breakout Group Topic Areas

As mentioned previously, the breakout groups were further aligned to address U.S. Coast Guard determined topics of concern regarding disaster response in the Arctic. To investigate and dissect these topics, each group discussed the *current* capabilities, *desired* capabilities, and understood shortfalls that emerge when addressing the following seven topic areas as they relate to each group's assigned technological focus area:

- Identifying maritime domain awareness challenges, shortfalls, and needed solutions for tracking the vessel and containers.

- Identifying voice and data communications challenges, shortfalls, and needed solutions for tracking the vessel and containers.
- Addressing crisis response decision context needs and priorities in wake of a disaster
- Identifying latent detection challenges, shortfalls and needed solutions associated with rural and remote spills into the marine environment.
- Addressing logistical support for both responses and logistics support for the Responders.
- Identifying shortfalls in USCG led Area Contingency Plans (ACP).
- Rural Alaska views and recommendations in addressing the response.

Desired Outcomes of Breakout Groups

The desired outcome from each group was to determine research needs (and associated research questions) to address shortfalls, and to determine desired capabilities to sufficiently improve the ability to respond for each topic. Determining research questions were the key desired outcome of the workshop.

The following sections will discuss the major themes that emerged from each individual breakout group, as well as their associated issues, shortfalls, and solutions.

Anchorage Arctic IoNS 2019 Group 1 Breakout Summaries: Communicating with Vessel Master, Responders, and Remote Communities in the Arctic Technologies.

Moderator: Dr. Nancy Kinner, UNH

Recorder(s): Megan Verfaillie (UNH ADAC Fellow), Raul Reutov (UAA ADAC Fellow)

Major Themes of Discussion in Breakout

Group 1

Discussions in Breakout Group #1 were devoted to identifying the existing technology, as well as the gaps and shortfalls in communication amongst vessel masters, emergency responders, and remote Arctic communities. Several major themes emerged throughout the activity, which included the topics of national technology differences and communication centralization and uniformity.

National Technology Differences

“Lower 48 based solutions don’t meet northern realities.”

-Breakout Group 1 Participant

The discussions of Breakout Group 1 heavily revolved around the notion that standard communication technology used throughout the country is frequently unfeasible, or

inapplicable, to the needs of many Arctic communities. For example, the group discussed the Rescue 21 system, which only covers a small percentage of the Arctic. This inconsistency is largely due to the weather, size, distance, population, infrastructure, extreme weather, and day/night cycles. In addition to the communication challenges, everyday activities in Arctic communities (e.g., fishing, hunting, travel) are considered “high risk.” As a result, there is a need to develop a communication structure that can broadcast messages to all targets, can function between EOC and communities, between EOC and nearby vessels, as well as within the communities themselves. Existing systems such as landline, SATdata, and radio also require further development to be reliable in the Arctic.

Communication Centralization and Uniformity.

Breakout Group 1 further discussed the need for increased centralization and uniformity of communication. Participants explained the desire for a system that would allow both community members and the U.S. Coast Guard to easily communicate via a shared channel, as well as a broadcast system. This concept emerged from the concern that a lack of uniformity often deters community members from contacting the U.S. Coast Guard for help first. Rather, they frequently react as the “first responders,” often increasing a great deal of risk factors.

In addition to a uniformed system, Group 1 participants expressed the need to streamline their current communications by developing “best practices for communication.” With this, community members and the U.S. Coast Guard can streamline their communication in the event of an emergency, potentially resulting in a faster response time.

Group 1 participants further expressed that the lack of uniform communication in remote locations often leading to delays response times. For example, many communities have multiple forms of communication, much of which is outdated. Local community members feel that they either need the funding to upgrade their systems, or a method of uniform compatibility needs to be developed

Breakout Group 1 - Identified Issues, Shortfalls, and Solutions

Table 7. Workshop participants' identified issues, shortfalls, and solutions regarding communicating with vessel master, responders, and remote communities in the Arctic technologies.

Issues	Shortfalls	Solutions
Amateur radio: What are the HAM radio capabilities in the state and could they be better leveraged?	What is needed to upgrade cell communications in rural Alaska to allow warning deliveries, such as tsunami warnings?	- COP: ERMA - Deployable communications package.

• How to equip small communities with common communications? Who is in charge, who dictates funding, who keeps up with maintenance? Etc. • Why did the ship lose sat phone and EPIRB capabilities? • How to establish communications as soon as possible (preferably within the first four hours before the arrival of the C-130)?	• Reliable power for incidence response in remote areas. • Infrastructure not hearty and will very likely go down under high winds, flooding, etc.	• Ad-hoc network/communications. ○ Rapid stand up ○ Autonomous ○ Tethered UAS (drone, balloon, etc.) • Notification/education program to coastal communities about the dangers of shipping containers.
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Breakout Group 1 - Research Question Development

For the purpose of this breakout exercise, it was assumed that commercial SOLAS Class vessels have more redundant systems and ability to respond to disasters, and that local/smaller non-SOLAS vessels are the maritime priority. Within communities, there is no standard way to send or receive messages across Alaska due to lack of systems/infrastructure. This is largely due to nearby communities that utilize completely different communication schemes (e.g., CBs vs cellphones). Finally, it was assumed that communication needs and limitations are variable based on response time frame. Timeframe describes the shift from prevention/preparedness to emergency response and to recovery. In this context, recovery includes both short term and long-term recovery (e.g., returning home safely and going back to normal life).

Anchorage Arctic IoNS 2019 Group 2 Breakout Summaries: Maritime Domain Awareness Technologies.

Moderator: Dr. Shawn Butler, UAA

Recorder(s): Jessica Manning (UNH ADAC Fellow), Tristan Goers (UAA ADAC Fellow)

Major Themes of Discussion in Breakout Group 2.

Discussions in Breakout Group #2 were devoted to identifying the existing technology, as well as the gaps and shortfalls in current maritime domain awareness technologies. Several major themes emerged throughout the activity, which included knowledge management and

decision support tools, as well as the centralization of such tools, the optimization of local emergency management equipment, sustained monitoring of distressed objects, and pre-scripted scenario modeling.

Knowledge Management and Decision Support Tools

Similar to Breakout Group #1, Breakout Group #2 emphasized the need for the centralization of information, particularly as it relates to decision support tools. More specifically, the group discussed the creation of a shared knowledge system to include a repository of data elements such as weather, damage assessment, ship tracking, GIS, and technical and locational data. The data would include information from multiple agencies (particularly government/military), while providing each agency with the ability to filter the data as it is relevant to their needs. This knowledge system database would further allow a “one-stop-shop” location for individuals/communities/agencies to access crucial data in the case of a disaster, minimizing the loss of valuable time and information that can occur when seeking information from multiple sources.

Breakout Group #2 referenced ADAC’s current “All Hazards GIS” as an example of a tool with centralized information. The All Hazards GIS is underway with designing a virtual tool that allows individuals, communities, and/or organizations to access the same information in a time of need. The working plan is to design a system that allows the filtering of information in order to quickly assess only pertinent information.

Optimizing Local Emergency Management Tools.

Particularly in reference to emergency management tools in rural Alaska, Breakout Group #2 discussed the need to optimize emergency response equipment to respond effectively to crisis scenarios. More specifically, participants expressed concern that rural communities may be too reliant on urban resources (such as those from Anchorage and Fairbanks). As a solution, the group discussed the development of decision support tool that would allow the pre-deployment of cache materials to numerous supply hubs prior to crises. This mechanism would require preemptive logistical planning to determine the supplies needed, the amount, and the potential lifespan of such materials based on the modeling of current local community characteristics, demographics, and assets.

Sustained Monitoring.

In reference to the workshop scenario, “Move 1,” the group further discussed how to increase situational awareness of distressed objects in the ocean (e.g. containers or distressed ships). However, due to the many uncertainties of shipping containers, their tracking cannot be easily modeled. The group discussed the potential use of mathematical models, GPS trackers, as well autonomous vehicles as tools to track containers with hazardous contents.

Scenario Modeling.

Disaster scenarios can be extremely difficult to model, with emergency responses even more difficult to practice, as they primarily occur when weather conditions are particularly dangerous. Due to this, remote communities particularly feel that there is both a lack of communication as well as appropriate response in the case of extreme and complex events. With this, the breakout group discussed the need to model these “worse case scenarios” in order to increase disaster mitigation in remote locations with limited resources, particularly as climate change continues to decrease the predictability of such extreme weather events.

Breakout Group 2 - Identified Issues, Shortfalls, and Solutions.

Table 8. Workshop participants' identified issues, shortfalls, and solutions regarding maritime domain awareness technologies.

Issues	Shortfalls	Solutions
● Access to tracking data on containers. ● 24-48 hours for NOAA assessment of water interaction with materials. ● High resolution satellite data availability. ● Real-time planet observations. ● Domain awareness besides C-130. ● UAS video as GIS overlay. ○ Arctic ERMA. ● Lack of staged resources (airborne observations) to support MDA or SAR. ● Access non-routine citizen data to provide eyes on scene. ● Need for updated bathymetry for storm surge modeling.	● Currently can't model where containers will go, float, or sink. ● Container tracking. ● Improved drift model for containers. ● Money limitations with A15 - need to fill gaps. ● Difficulties associated with getting hazmat capable resources to Western Alaska. ○ Small compared to oil spill. ● Funding to cover vast marine domain.	● Build sensors into containers to enhance real-time tracking. ● Satellite tracked EPIRB. ● Leverage RFIP or create something similar. ● Create asset map of state/local commercial emergency response equipment/capabilities/trained personnel. ● Attach 'corner reflectors' to lose containers to provide a point source for airborne and satellite synthetic aperture radar. ● USCG search and rescue (SAROPS) model can drift a container as a search object. ○ This technology could be useful in predicting where to find lost containers. ● Database of community capacity to provide hub for local SAR.

		● Remote SUAS (re-charge) system for communities that can be locally maintained. ● Arctic (polar) SUAS. ○ Built in Alaska, for Alaska ● Increase number of Part 107 pilots in rural Alaska ● Regional Strategic UAS hubs to operate in the Bering Sea (not just the Strait)
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Anchorage Arctic IoNS 2019 Group 3 Breakout Summaries: Latent Detection Challenge Technologies.

Moderator: Jessica Garron, UAF.

Recorder(s): Sarah Gering (UAA ADAC Fellow).

Major Themes of Discussion in Breakout Group 3:

Discussions in Breakout Group #3 were devoted to identifying the existing technology, as well as the gaps and shortfalls in current latent detection technologies. Several major themes emerged throughout the activity, which included remote sensing technology, voice and data communications, knowledge management, rural and remote spills in marine environments, and shortfalls in USCG Led ACP.

Remote Sensing Technology.

Breakout Group #3 began by discussing the current capabilities of remote sensing technology. In particular, how can remote sensing be leveraged during a disaster response, and is there a database to utilizes such tools? The group determined that the existing information regarding such capabilities must first be combined and condensed in order to assess the feasibility of using remote sensing technology for latent detection. Similar to Breakout Groups 1-2, Breakout Group 4 discussed the desire to manage knowledge through a centralized database.

Voice and Data Communications.

Stemming from the above conversation on knowledge management, Group #3 further addressed concerns regarding the challenges associated with access to information,

particularly as it relates to the limitations of manpower and resources. The Group discussed the need to streamline data accessibility for citizens, researchers, and agencies, in order to increase the accessibility of information in event of an emergency.

Furthermore, participants expressed concerns regarding the potential lack of critical knowledge dissemination at the community level. This led to conversations about the public release of information both in the form of a centralized database, as well as through public trainings.

Group #3 further discussed the ability to utilize existing technology, such as unmanned aerial devices, as a means for knowledge dissemination. For example, coastal community members expressed concerns that in the case of an emergency, knowledge dissemination amongst both local residents, as well as neighboring villages, is extremely difficult. The group thus proposed the idea of using tethered drones to launch and carry information in the case of a natural disaster.

Latent Detection in Rural and Remote Oil Spills.

In the case of an oil spill into the marine environment in rural and/or remote Alaska, Breakout Group #3 emphasized the need to utilize both new and existing technology in order to detect and communicate the status of the impacted area. For example, the Group discussed the integration of smart technology into existing infrastructure, with the ability to detect spills within chemical containers, or even on roads and bridges. The Group further expanded on this notion to discuss the need to develop self-health assessment technology for oil infrastructure.

Lastly, the Group evaluated the idea of utilizing existing sensor technology in order to detect spills beyond oil, such as those of metals and additional hazardous chemicals.

Shortfalls in USCG Led ACP.

When discussing the shortfalls in USCG Led ACP, Group #3 identified a gap in accomplishing rapid ad-hoc large area-information collection for an event/response. In particular, the Group expressed concerns regarding the inability to rapidly collect event information, particularly from satellite technology. However, the identification of this gap further led to concerns regarding the vulnerabilities of such technological solutions, such as cyber security threats that would damage or hinder command response.

Breakout Group 3 - Identified Issues, Shortfalls, and Solutions.

Table 9. Workshop participants' identified issues, shortfalls, and solutions regarding latent detection challenge technologies.

Issues	Shortfalls	Solutions
• What is a cost effective, logistically capable system to track lost containers (EPIRB)? • Has CG identified and mapped location of tanks throughout the region? ◦ GIS overlays? • What tech can be used to increase inspections of tanks before an incident? • Auto-charging systems for communities to use for detection. • Little capacity in communities (trained) but everyone will want to help.	• Remote locations and lack of variety of platforms to choose from for deployment to detect/monitor. • Formalized technical advisory board to vet purchasing, training, etc. decisions before they are made. • Funds to purchase high-tech hardware. ◦ Trained personnel to use/maintain technical tools. • Small hyperspectral sensors for small UAS to store in communities to detect fuel on water.	• Operation automated detection algorithms. • Inventory of technology deployed. ◦ Vulnerability (cyber) assessment. ◦ Recommend hardening mitigation. • Cost effective tracking mechanisms (EPIRB for Hazmat). ◦ On all Hazmat containers; or ◦ On those that are bobbing around. • Tracking of containers with something that is tossed overboard when containers are lost. ◦ Floats with/tracks containers. • Experiments with multispectral sensors to detect metals. • Effectively utilize local observers/human sensing/data collectors. ◦ Find long term programs for data connection. • Infrastructure self-state of, self-health assessment, and broadcasting. • Tools inventory: ◦ Evaluate pre-existing programs/tools (e.g. LEO) ◦ NSF Reconnaissance app

		○ Arctic sustainment package (add on communication tools) ● Deploy critical infrastructure and building community inventories. ○ Identify risk profile of them for communities.
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Anchorage Arctic IoNS 2019 Group 4 Breakout Summaries: Adverse Weather Response Technologies.

Moderator: Amy Holman, NOAA.

Recorder(s): Rachel Lewis (UAA ADAC Fellow).

Major Themes of Discussion in Breakout Group 4:

Discussions in Breakout Group #4 were devoted to identifying the existing technology, as well as the gaps and shortfalls in current adverse weather response technologies. This Group strictly discussed the pre-identified topics determined by the U.S. Coast Guard as specific areas of concern in addressing an Arctic persistent disaster response. These topics are listed below as major themes:

Identifying maritime domain awareness challenges, shortfalls, and needed solutions for tracking the vessel and containers.

In regard to improving maritime domain awareness through tracking vessels and containers, Group #4 discussed the need to develop a device containing cargo attachment capabilities. The tracker would allow agencies and personnel to receive real-time status updates on the lost and distressed object, while also providing a notification if once/if the object has reached land. However, this concept is complicated by the difficulties in predicting whether lost cargo will remain afloat, or sink once it is adrift.

Identifying voice and data communications challenges, shortfall and needed solutions for tracking the vessel and containers.

In addition to the potential need for creating a tracking device in order to track lost vessels and containers, Group #4 discussed the use of crowdsource data. This would require frequent and sustained communication with identified communities regarding storm reporting as well as data accuracy. Consistent communication, however, would require the development of a two-way communication system.

In addition to establishing a two-way communication system, the Group discussed disseminating inexpensive weather equipment to communities, in which weather and storm data could be transmitted to headquarters for the analysis.

Alternatively, a crowdsourcing app could potentially provide a platform for communities to share photos of the flooding and damage to provide updates and validate models. This technology would reduce the demand for constant two-way communication via phone or radio in an emergency, freeing resources for emergency responders. This information would also be useful for the DGGs flood map development. However, this concept requires research on how to best crowdsource information from local community members and ways that data can best be promulgated for use by emergency personnel.

Addressing sensor and platform technology needs for crisis response surveys in remote Arctic regions.

It was noted that during a disaster, landslides, debris flows, and ice jams are reported as greater concerns than valley flooding. In order to address potential platform technology needs in the case of these scenarios, the Group discussed utilizing unmanned aerial systems to monitor the status of the event impacts. Some progress has already been made in this realm, and by utilizing potentially comparable data sets for similar scenarios, previously established scientific data may be transferrable. For example, disaster mitigation procedures for avalanches have been well established, and are highly practiced. The data sets produced by these studies may be transferable, or at least used as a model, in the case of landslides, debris flows, and ice jams.

- Could avalanche data be used to determine safety zones for infrastructure in Alaska?

Observation points are key. However, Group #4 expressed the need to determine which observation points provide the most data, as well as the best method(s) for their collection. The following list contains potential solutions to these problems as discussed by the group:

- Simulations could be used to monitor the changes in models to determine the best location to place observations points to monitor storms, damage, and regular weather events.
- Utilize local knowledge, particularly in rural Alaska.
- Transportable array stations or NOAA sail drones/sail gliders could be used.
- Experiments for storm prediction would also help improve where to place these observations in the ocean. This allows for improved modeling of storms and coastal inundation.

Addressing crisis response decision context needs and priorities in wake of a disaster.

In regard to priorities in the wake of a disaster, Group #4 discussed the issues of runway and port conditions. In the case of adverse weather conditions, runway and port inspections must first take place in order to determine the safety of their use. During a storm surge, drift creates issues for incoming and docking ships. As a potential solution, an unmanned aircraft survey could be used to preemptively survey the runways and ports to determine their safety. Altogether, the ability for the Coast Guard to assist is based on their ability to operate out of Anchorage. If they are unable to leave Anchorage, or to safely approach a destination, disaster response is severely hindered.

The utilization of the maritime boundary layer was further discussed as a potentially helpful resource for taking off, landing, and for tracking oil spills. This boundary layer is described as 100 feet above and below the surface of water. When traveling above 100 feet, the salt spray drops, altering the composition of the lower 100 foot atmospheric layer above the water. Therefore, the Group discussed the creation of an unmanned platform that could be used to collect atmospheric data for this region.

In addition to the above discussions regarding crisis response decision needs, the Group expressed needs for annual surveys, real-time data collection, how to improve certainty and predictability in the case of adverse weather events. Currently, data from the pilots determines if it is safe.

Addressing logistical support for both responses and logistics support for the Responders.

In terms of logistical support, group members discussed the issue of managing technology. When focusing on the common operational picture, all details need to be brought to a node. This avoids the consistent need to manage data for the given situation, allowing for more manpower and resources to be dedicated directly to the response. In particular, the Group expressed the need to utilize all personnel possible, and the inconvenience of utilizing an entire team to consistently manage technology.

The Group further expressed a lack of data standardization. For example, NOAA records their data in a particular format, such as in kilometers, whereas the Coast Guard typically utilizes increments of feet, Yards or Nautical Miles. These format differences can prove to be dangerous in the event of an emergency when a rapid response is required. What methods exist to translate this data into this format?

Group 4 - Identified Issues, Shortfalls, and Solutions.

Table 10. Workshop participants’ identified issues, shortfalls, and solutions regarding adverse weather response technologies.

Issues	Shortfalls	Solutions
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• How to get ad-hoc observations into NWS models. • Work with community members (environmental coordinators). • UAS have an endurance/range issue, but help with runway issues. ◦ ScanEagle advertised capability not true. • What is the true threat of tsunamis in Anchorage from earthquakes? • How communication would occur between different groups monitoring the situation. • Water supply/filtration will be an issue in disaster scenarios. • What are best practices of collaboration between communities, corporations, and government regarding I.C.S.? • Risk of saltwater contamination of drinking water from coastal flooding.	• Besides in person observations, there is a lack of observations that limit our abilities to do forecasts. • We need better drift modeling at different depths. • Need for improved info to feed water level modeling for Alaska. • DNR/DGGS ability to develop coastal inundation maps for all western Alaskan coastal communities. • Airborne UAS observations. ◦ Sensors are needed. • Blue force tracking unreliable in storms - now carry SPOT (self-provided).	• Increase weather observation points along coastline of Alaska. ◦ Improving preparedness as well as response and follow up. • Improve water drift modeling at different depths. • Analyze the ability to deploy/utilize a 'hurricane hunter' capability for enhanced situational awareness and observations for Bering Sea storms, i.e. Sea Hunter. • Identify best place to set up observations. ◦ Ask communities and knowledge holders. • ADAC run exercises to bring new technologies/techniques to operators so that they may become familiar with them before they are needed to be deployed. • Mobile water purification systems to respond to contamination events faster. • Verification studies of ground observations, like transportable areas. ◦ Which observations provide greatest model improvement?
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Anchorage Arctic IoNS 2019 Group 5 Breakout Summaries: Predicting, Detecting, and Assessing Crisis Response Action Technologies.

Moderator: Maj Gen (Ret) Sandy Finan, PNNL

Recorder(s): Stacey Hanson (UAA ADAC Fellow), Jack McCaslin (UAA ADAC Fellow)

Major Themes of Discussion in Breakout Group 5:

Discussions in Breakout Group #5 were devoted to identifying the existing technology, as well as the gaps and shortfalls in technology used to predict, detect, and assess crisis response action. Several major themes emerged throughout the activity, which included technology for modeling oil spills, involvement of Alaska Native communities, and technology to track lost containers.

Technology for Oil Spill Modeling.

Group 5’s discussions heavily revolved around existing technology for oil spill modeling, as well as potential improvements to such technology. For example, the Group discussed the program Arctic ERMA, which is a web-based GIS visualization tool, and it’s potential ability to crowdsource data for existing and upcoming oil spill models. Furthermore, the Group discussed the need to develop a repository of existing modeling data in order to improve current technology.

Involvement of Alaska Native Communities.

The Group further discussed the need to continuously involve Alaska Native communities in all aspects of the decision-making process. In addition, participants expressed the desire to increase emergency management training for residents of rural communities, as they are often the technical “first responders” until outside assistance has arrived. From this notion emerged the proposal to develop community disaster resilience assessments. Such assessments would evaluate existing infrastructure and resources, which could identify gaps in disaster preparedness.

Tracking Technology.

Lastly, Group 5 discussed the need for tracking technology for containers lost at sea, particularly those containing hazardous materials. Such tracking devices would require the ability to monitor both submerged containers, as well as those bound for land. That said, tracking technology is likely expensive, decreasing its feasibility.

Group 5 - Identified Issues, Shortfalls, and Solutions.

Table 11. Workshop participants’ identified issues, shortfalls, and solutions regarding predicting, detecting, and assessing crisis response action technologies.

Issues	Shortfalls	Solutions
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• Can biodegradable materials be used for “see it and forget it” unmanned systems? • What are the materials science needs to improve equipment and facilities survivability and decrease maintenance requirements? • What technologies are required for coastal communities after fast ice no longer forms? • How does thawing permafrost impact response efforts?	Group 5 did not identify any shortfalls.	Group 5 did not identify any solutions.
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Anchorage Arctic IoNS 2019 Group 6 Breakout Summaries: Technologies to Establish Communications with Remote Populations with Compromised Infrastructure.

Moderator: Cara Condit, USCGA Center of Arctic Study & Policy.

Recorder(s): Kelly Ireland (UAA ADAC Fellow).

Major Themes of Discussion in Breakout Group 6:

Discussions in Breakout Group #6 were devoted to identifying the existing technology, as well as the gaps and shortfalls in technologies to establish communications with remote populations with compromised infrastructure. Several major themes emerged throughout the activity, which included discussions of existing technology, bridging communication systems, and power outage scenarios.

Better Leveraging Existing Technology.

In regard to existing technology that could be utilized to assist remote communities with compromised infrastructure, Group #6 discussed the use of solar and generator powered transportable communication systems (ARCTICOM has this available). This system has a range of 3-5 miles, and can be flown-in or prepositioned. A UAS cell repeater could also be used given the likelihood of available cell-phone use, as well as little need for prepositioning or training. This system would allow for about 50 phone connections, or 250 calls. A UAS would have the ability to fly above communities, with minimal need to land for fuel.

The Group also discussed the use of FirstNet as a means to establish communications with communities. FirstNet is a cell service primarily used by first responders. However, it is not available in some remote areas, and requires 4.5-5G networks.

Satellite phones were also discussed, as a satellite would not be affected by the storm (though there may be issues with clarity). However, satellite phones require an expensive monthly fee.

Web-based messaging was also explored as an option. It was identified that audio capabilities typically fail before internet connection and data. Therefore, if latter two features are still intact, web-based messaging, such as WhatsApp which requires low bandwidth, could be used. Furthermore, web-based messaging is likely the most cost-friendly form of data in terms of satellite.

Bridging Communication Systems.

Group #6 further discussed whether there is an ability to transmit radio frequencies to satellite communication, as well as cell to satellite (i.e., an ALMR to satellite nexus). According to participants, 83% of first responders have access to ALMR, and almost everyone has a cell phone. Therefore, a potential mechanism to bridge these communication systems could be highly beneficial. Interoperability and redundancy could reduce inability to communicate as well.

Power Outage Scenarios.

Several group members highlighted important considerations regarding communications in remote locations during storm scenarios - if and when communications fail, many remote communities must revert to “cash only,” as power outages are likely. Power outages could further hinder the ability to use communication equipment. Therefore, the Group discussed the need to create power redundancies, as well as “Arctic-proof” batteries in order to augment power.

Local radios can also be used to disseminate information to community members. However, it is always important to note that there may be marginalized community members who do not have access to the resources that may provide them with disaster warnings following an incident.

Lastly, the Group discussed the need to prioritize communication systems to use so that first responders can refer to list of potential communication options when one (or multiple) fail.

Breakout Group 6 - Identified Issues, Shortfalls, and Solutions.

Table 12. Workshop participants' identified issues, shortfalls, and solutions regarding technologies to establish communications with remote populations with compromised infrastructure.

Issues	Shortfalls	Solutions
● Power production. ○ Need mobile, enduring power system. ○ Consider small, mobile nuclear power plants. ○ Department of Defense has started some efforts with a request for solutions. ● When communications are out, we need to communicate with villagers. ● Lack of capacity and timeline. ● Need for general cross-agency knowledge of what communities have a communication plan, infrastructure, and equipment, and what communities are lacking. ● Community response ○ What actions will communities take in the first 12-24 hours before outside resources arrive? ○ We need to know: ■ What we could accomplish if we trained residents or worked with them.	● May have to deal with more severe injuries in places without hospitals and doctors. ● The need to coordinate with fishing fleets and use other partners is in the plan, but how you recover the containers is not.	● Notify St. George and surrounding nearby communities and ensure that they are aware of possible hazmat washing up on their shorelines, and the impacts of exposure. ● Ensuring people in the communities know who will be contacted and how (VHF, sat phones, text, email, etc.). ● Renewable energy backup systems to provide communications. ● Hotline for reporting any gaps and needs (C130s create network). ● Fly in generators in order to get the power back on.

Arctic IoNS 2019: Analysis of the Research Questions and Delphi Prioritization

Following the Breakout Group Session, workshop participants utilized the Delphi Prioritization method in order to rank the research questions developed by each group. The Delphi Prioritization method allows each participant to vote on a total of 5 research questions, using colored stickers as their “votes.” If desired, participants were able to place more than one sticker by a research question.

Each group received a different colored sticker, allowing workshop planners to further evaluate how each group voted. The colors belonging to each group are listed below:

- **Breakout Group 1:** *Communicating with Vessel Master, Responders, and Remote Communities in the Arctic Technologies*
 - Vote (sticker) color – yellow 
- **Breakout Group 2:** *Maritime Domain Awareness Technologies*
 - Vote (sticker) color – blue 
- **Breakout Group 3:** *Latent Detection Challenge Technologies*
 - Vote (sticker) color – dark green 
- **Breakout Group 4:** *Adverse Weather Response*
 - Vote (sticker) color – pink 
- **Breakout Group 5:** *Predicting, Detecting, and Assessing Crisis Response Action Technologies*
 - Vote (sticker) color – lime green 
- **Breakout Group 6:** *Technologies to Establish Communications with Remote Populations with Compromised Infrastructure*
 - Vote (sticker) color – orange 

Delphi Prioritization of Research Questions by Group.

Each group’s proposed research questions, along with their received number of votes, is listed below². In addition, a table has been included for each group to illustrate the number of votes received per question by different groups (illustrated via “group color”).

² As mentioned previously, questions that received 1 vote or less are only listed in the Appendix

Breakout Group 1:

1. What would a Rescue 21 (R-21) like system look like for remote Alaska (and in particular, Alaskan Arctic) maritime environment? (Hypothesis is based on breakout group expert insight that Alaska needs to develop communication standards that exists elsewhere.) **(21 votes)**
2. What provided algorithms can suitably manage information overload for decision support in crisis response scenarios? Can research develop such algorithms? **(4 votes)**
3. What power systems can be developed for remote and austere regional communications that are affordable, sustainable and innovative? **(13 votes)**
4. What autonomous and remotely operated systems can inspect and repair distant communications infrastructure? Can research design useful prototypes to support remote infrastructure inspection and repair? **(9 votes)**

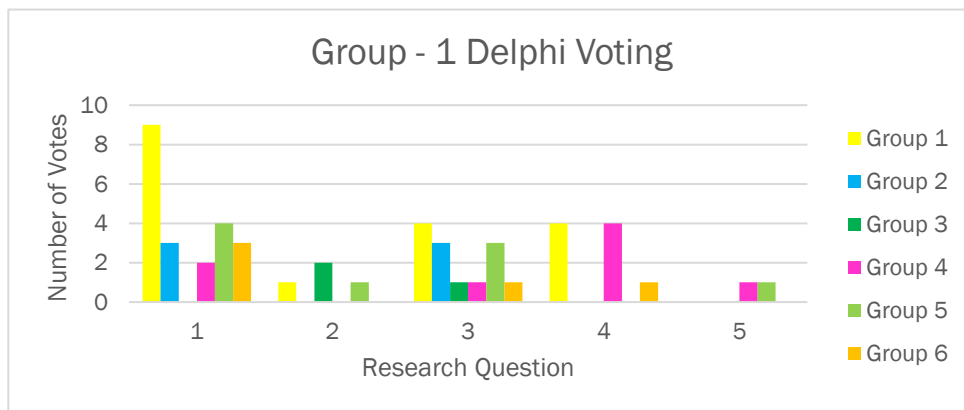


Figure 12 Color-coded plot of all workshop participant votes on research questions identified by Group 1.

Breakout Group 2:

1. What are some practical and affordable methods which can maintain sustained monitoring of remote/distant objects/areas (associated with crisis response)? **(2 votes)**
2. How should U.S. Coast Guard and Federal On-Scene Coordination (FOSC) optimize the logistics footprint to most effectively respond to multiple complex/conflicting priorities across a remote and distant region (particularly oriented to the Arctic/polar regions)? **(12 votes).**
3. How should the U.S. Coast Guard and the community of supporting research develop and exercise prescription scenarios for complex crisis events? **(4 votes)**
4. How should the U.S. Coast Guard and the community of supporting research develop best practices for bulk fuel containers and predict risk from existing containers? **(4 votes)**

- What are new, needed and useful knowledge management capabilities which would provide decision makers improved methods to afford best decision support in a crisis? **(15 votes)**

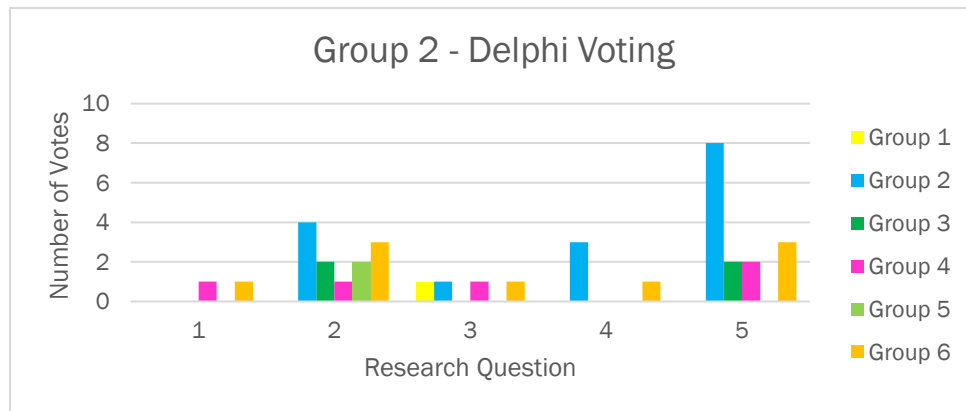


Figure 13. Color-coded plot of all workshop participant votes on research questions identified by Group 2.

Breakout Group 3:

- How should the U.S. Coast Guard and the community of supporting research suitably incorporate citizen scientist collected data into user-defined operational visualization capabilities **(2 votes)**
- How should U.S. Coast Guard and Federal On-Scene Coordination (FOSC) accomplish rapid/ad-hoc, large area information collection for a crisis event/response (particularly in remote/distant locations, such as the Arctic)? **(8 votes)**
- What processes and protocols used to achieve situational understanding can be implemented for improved decision support? I.e. automated algorithms identifying the problem targets operationally (data fusion/database fusion)? **(3 votes)**
- What improvements need to be made to convert current low SWOP (small size, weight, and power) to support crisis response in Arctic? **(3 votes)**
- What are the cyber security vulnerabilities of detection and communication technologies that could impact crisis response operations? How do responders know their information is not compromised? **(11 votes)**
- What cost-effective, satellite tracking mechanisms can be applied to marine debris (particularly in remote/distant locations, such as the Arctic)? **(3 votes)**
- What sensors are capable of detecting chemicals (besides oil) and metals in the U.S. Arctic region, and how can that be used for response decision making? **(9 votes)**
- What are some suitable research concepts that could leverage existing communications systems in unplanned ways to improve crisis information flow to remote and distant Arctic regions (e.g. research using University of Alaska's High-frequency Active Auroral Research Program (HAARP), considered as the world's largest high frequency radio, to

disseminate information to all citizens). Further, how would individuals receive such information? **(3 votes)**

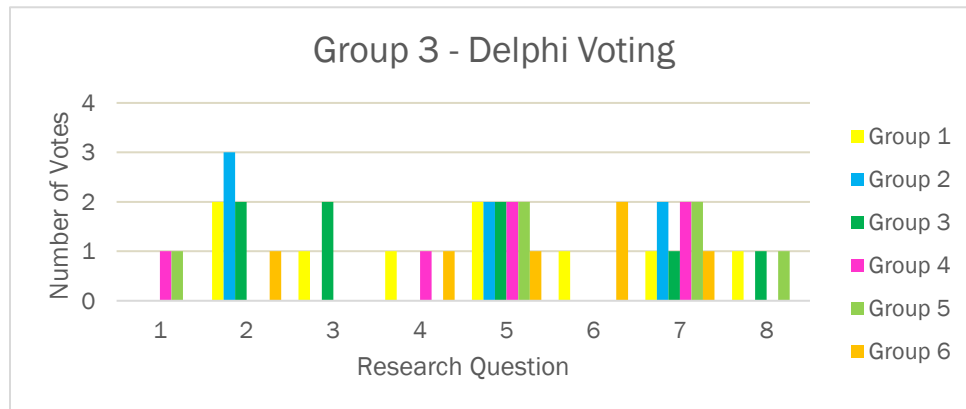


Figure 14. Color-coded plot of all workshop participant votes on research questions identified by Group 3.

Breakout Group 4:

1. What technologies and methods can be developed or exist to provide combined marine boundary layer observations for integration into coupled atmosphere-ocean models and support Arctic Concepts of Operations (CONOPS) and emergency management operations? **(13 votes)**
2. What technologies and methods can be developed or exist to evaluate the most effective observational data to increase operational and model efficiency for emergency management organizations during arctic operations. (What new observations - type and location - give suitably useful and affordable operational meteorological-ocean model improvement)? **(2 votes)**
3. What technologies and methods can be developed or exist to transition local observations and data, such as crowd sourcing into NOAA/NWS operational workflow and CONOPS and emergency management process as well as build a common framework to develop a statewide coordinated data collection network? **(20 votes)**
4. What standards can be set to simplify and incorporate disparate data into the incident command post? **(5 votes)**

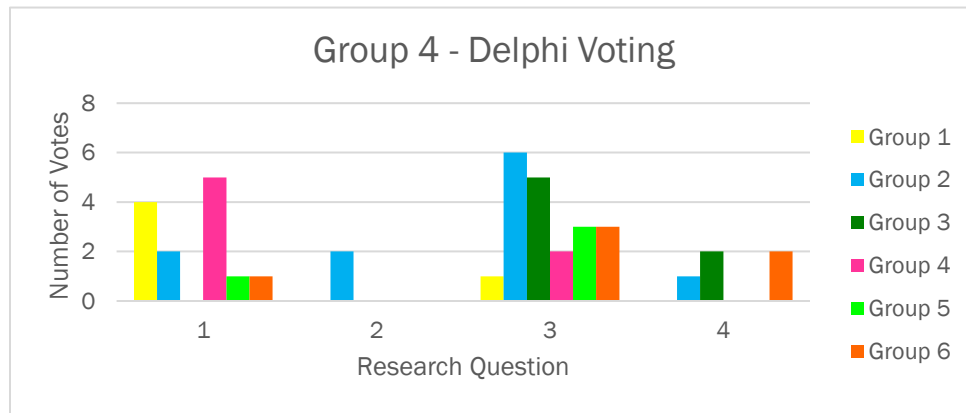


Figure 15. Color-coded plot of all workshop participant votes on research questions identified by Group 4.

Breakout Group 5:

1. What community resilience standards exist and how do they apply to Alaska communities? Additionally, how should the U.S. Coast Guard and the community of supporting research assess and develop a resiliency criterion to apply to remote and distant locations across the U.S. Arctic region for communities to report? **(5 votes)**
2. What technologies exist to assist crowd source incident and domain awareness (particularly oriented to maritime and coastal regions)? **(4 votes)**
3. Do publicly available visualization tools exist to fuse data, including crowdsourcing data, from multiple sources? **(10 votes)**
4. Based on population centers, how does sea ice disposition affect village risk against coastal erosion and storm damage? **(17 votes)**
5. How can unmanned systems be suitably leveraged to better mitigate disabled vessels and oil/hazmat in water? **(7 votes)**
6. How can unmanned systems be suitably leveraged to better assist with facility inspections and leak detection? **(7 votes)**

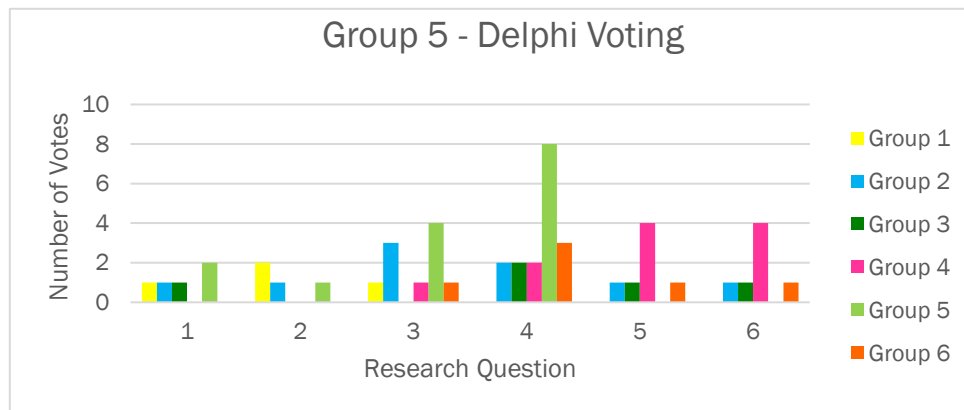


Figure 16. Color-coded plot of all workshop participant votes on research questions identified by Group 5.

Breakout Group 6:

1. What technology advances would allow leveraging of various communication solutions, including social media, commonly in use in rural Arctic Alaska to affordably cross-communicate and create a unified system (including consideration of human factors, policies, Concept of Operations, etc.) to ensure an effective system? **(11 votes)**
2. Can technical and policy approaches and needs be addressed to allow leap-frogging past current limited communication technology in remote Arctic Alaskan locations to provide affordable, widespread, high-bandwidth capabilities with flexible and or decreased infrastructure needs? **(5 votes)**
3. What technologies could be developed to provide affordable, Arctic-capable power storage capability? **(27 votes)**
4. Can technology and transmission protocols be developed to deliver “Amber Alert” type messages, and text messages, with high priority and requiring low-bandwidth to deliver broadcast emergency messages over multiple communication platforms? **(7 votes)**

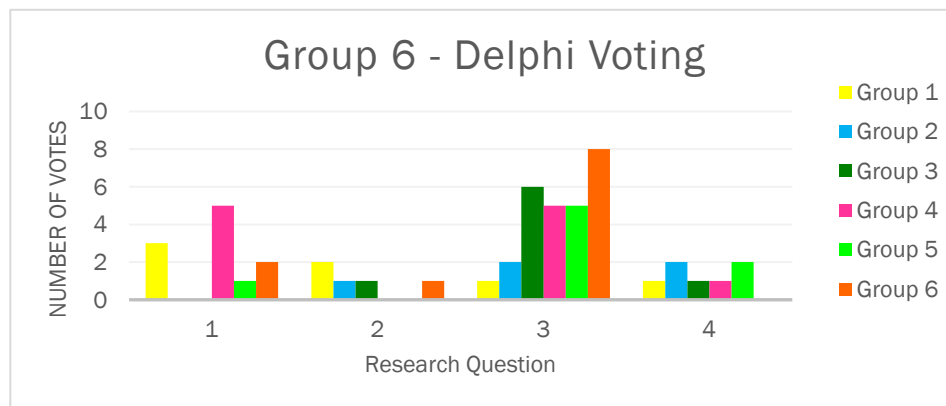


Figure 17. Color-coded plot of all workshop participant votes on research questions identified by Group 6.

Conclusions and acknowledgment

Arctic IoNS 2019 brought together a talented group of professionals with a vested interest in the health, safety, and prosperity of Arctic Communities, Maritime Operations, and the pristine Arctic Environment. Their combined experience, vision, and keen understanding of Arctic operations guided spirited discussions closely aligned with tabletop exercise topics. No Industry, Community, or Government agency operating in the Arctic should shoulder the enormous risks associated with going-it-alone in such a remote and harsh environment. Strength through partnership and an all hands, stakeholder-driven approach in effectively leveraging technologies and infrastructure is vital to good stewardship of Arctic interests and protection of precious environmental resources.

Workshop planners and participants noted that singular research pathways with the potential to resolve multiple capability gaps can minimize costs and foster interagency coordination, and are highly valued due to their multi-use potential. One such research pathway includes Arctic Drone/UAV/AUV use for remote area facility inspections, environmental monitoring, and emergency communications. Another popular multi-faceted research pathway involves inter-agency development of portable emergency communications, environmental monitoring, and power production platforms capable of sustained and autonomous operation in extreme cold and darkness. Effective development of Arctic communications pathways requires end-user consideration and support throughout the research and development process, particularly in remote areas where whole-of-community familiarization with concepts and functionality are vital.

Research in transitioning more of the coverage and functionality of the US Coast Guard VHF “Rescue 21” system to Alaska was of surprising great interest in the Anchorage Arctic IoNS workshop. One key to this interest stems from the fact the continental United States enjoys advanced direction finding and position fixing capabilities not presently available anywhere in Alaska. Research into processes for enhanced VHF direction finding in mountainous areas or rugged terrain, may significantly reduce operational risks to responders.

Many participants stated a desire an Arctic-Focused, interagency Common Operating Picture (or better described as a “user defined operational visualization”) in the attempt to standardize graphic information displays and provide Arctic-focused tactical or regional response information to local partners.

ADAC and our fellow workshop planners note the number of research questions derived from the breakout groups highlight the fact, regional crisis response to Western and North Slope Alaska, is not as capable as perhaps is needed. The fact that experts declare the Arctic IoNS scenario as plausible, should give pause to the community of operators and researchers, the time is now, to move purposely to develop solutions to address the challenges described in this report, before a dramatic crisis occurs.

While the purpose of ADAC’s Arctic IoNS is to identify and then sponsor research to address shortfalls discovered via the workshop process, effective response requires not only science and technology solutions, but an increase in exercises and training, involving the community of responders. In full certainty when viewing Nome and Anchorage Arctic IoNS 2019 workshop discussions, there is an unmet need across Arctic Alaska to conduct crisis response education, training and exercises between and within, the communities of response. There are many assumptions that are dated or factually inaccurate and there are many lessons to learn or refresh in addressing a wide-spread regional crisis in this strategically important region of the United States.

In conclusion, this report will not only serve to inform researchers responding to the Arctic IoNS 2019 Shortfall Request for Proposal, it actually is well positioned to serve as a stand-alone knowledge product.

Accordingly, ADAC and the University of Alaska extends our sincerest appreciation and most profound “thank you” to a remarkable team of professionals who supported this workshop...starting with workshop partner’s Sandia National Laboratories (SNL). Their individual and collective investment in this workshop has provided an immense amount of insight concerning the improvements needed to aid the USCG and community in responding to a complex crisis in the Arctic region. ADAC particularly offers our highest compliments to SNL’s Dr Holly Dockery and Mr. Greg Stihel for their unwavering commitment to this project, we are truly grateful. ADAC also wishes to offer sincerest thanks and appreciation to the

U.S. Arctic Research Commission, which provided financial support to both the Anchorage Arctic IoNS and the preceding Nome Arctic IoNS Workshops. This support proved critical as the original workshop for Anchorage was planned for the lower cost, non-tourist season, but was forced to move to May as a result of the partial U.S. government closure in December 2018 and January 2019.

As this Arctic IoNS workshop was a “whole of community planning effort,” ADAC and Sandia National Laboratories are very appreciative of the efforts of the following workshop planners, organizers, supporters and collaborators:

- Headquarters U.S. Coast Guard Arctic Advisor to the Commandant;
- Headquarters U.S. Coast Guard Office of Emerging Policy—“Evergreen;”
- U.S. Coast Guard District 17 Arctic Planners;
- U.S. Coast Guard Academy Center of Arctic Study and Policy (CASP);
- Kawerak Incorporated;
- Bering Straits Native Corporation;
- U.S. Arctic Research Commission;
- National Oceanic and Atmospheric Administration;
- National Weather Service;
- Pacific NW National Laboratories;
- ASRC Federal Mission Solutions;
- Raytheon Corporation;
- Conoco Phillips;
- Alyeska Pipeline Services;
- State of Alaska Departments of Environmental Conservation, Military and Veterans Affairs and Public Safety.

As stated at the workshop to all participants, this report will pair with an ADAC funded solicitation seeking solutions to the HQ U.S. Coast Guard desired research questions stemming from the report. ADAC anticipates a subset from 32 research questions will be approved by HQ USCG and DHS S&T UP.

In closing, ADAC thanks all the participants and planners in the planning and conducting of this workshop and in the accomplishment in creating of this report.





Appendix

A list of developed research questions that received one vote or less using the Delphi Prioritization method are listed below:

Breakout Group 1:

1. A research question/task consisting of two parts:
 - a. Creation of a research knowledge product on baseline and identifying gaps. This research should utilize existing communications reports and focus on existing systems both nationally and internationally that may work in the Arctic environment as well as which of these systems are transferable with minimal investment. As part of this, a survey may be conducted using the following matrix:

Table 13. Proposed survey matrix for identifying knowledge gaps in existing communications systems.

	Landline	SATdata	Radio
Voice			
Data			
Video			
Text Messaging			
Email			
AK Net			
Social Media			
BC + Handheld FM Radio			
AM Radio			
Spot or In Reach Systems			

- b. How do we leverage existing communications systems for communities and responders working in these communities to address redundancy and develop best practices for communication? For example, how to go from one system to another when the first one fails? Is there a way to develop compatibility between systems (e.g., VHF Marine, statewide oil spill radios, HAM radios for communities, FirstNet)? The systems considered must address implementation, maintenance, and power.
2. What economic model might incentivize redundant systems?
3. What are possible solutions for a “one node” replacement for a download radio tower?

Breakout Group 2:

1. What are low cost communication alternatives to maintain minimum contact with villages?

Breakout Group 3:

1. How do we disseminate actionable big data?
2. How can we integrate the common operating picture into communities?
3. How can we iterate tethered drones that are autonomously launched, to provide real-time situational awareness and communication via satellite?
4. How can we perform response force tracking (things and people, as well as gap analysis)?
5. What remote sensing technology is deployed, and how can we leverage it during a response?
6. How do we use current smart technology to create internet of infrastructures?
7. What are the facility self-health assessment needs for a response (similar pipeline and self-detection but for other infrastructure)?
8. How do we disseminate actionable big data?
9. How can we integrate the common operating picture into communities?

Breakout Groups 4, 5 and 6:

- Not applicable. All questions had at least two votes for each question.