Arctic-Related Incidents of National Significance Workshop

REPORT: ARCTIC-RELATED INCIDENTS OF NATIONAL SIGNIFICANCE WORKSHOP ON MARITIME MASS RESCUE OPERATIONS

Arctic Domain Awareness Center (ADAC)

A U.S. Department of Homeland Security Center of Excellence
21-22 June 2016
Anchorage, Alaska
Arctic Domain Awareness Center (ADAC)

A DHS Science and Technology Office of University Programs,

Center for Maritime Research

Rapporteur’s Report

Arctic-Related Incidents of National Significance Workshop

on Maritime Mass Rescue Operations

21-22 June 2016

Anchorage, Alaska

As of 6 September 2016

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Conclusions and way forward from the inaugural ADAC hosted Arctic IoNS Workshop
Introduction and Executive Overview: The following is a report of the Inaugural Arctic-related Incidents of National Significance workshop, (Arctic-related IoNS). This workshop was planned as a dedicated Canada-U.S. forum of operator driven research in support of a fictitious disabled cruise ship in Arctic Waters.

The Arctic Domain Awareness Center (ADAC), a Department of Homeland Security, Science and Technology, Office of University Programs Center of Excellence, conducted the inaugural Arctic-related Incidents of National Significance (Arctic-related IoNS) workshop at the University of Alaska, Anchorage from 21-22 June 2016.

The Arctic IoNS workshop planning commenced in early March 2016, and from the onset was an endeavor purposely planned as a Canada-U.S. forum. The first Arctic IoNS drafting team was comprised of U.S. Department of Homeland Security, Headquarters U.S. Coast Guard (HQ USCG), USCG Research and Development Center, USCG District 17 (Juneau, Alaska), Canada Department of National Defense Research and Development, Canada Armed Forces (CAF) and Canada Coast Guard (CCG).

ADAC center leadership facilitated the planning and conducted the Arctic-related IoNS workshop with select expert Arctic operators and researchers from both Canada and the United States. The workshop was built around operator defined problems from a work group comprised of CCG, CAF, USCG, National Oceanic and Atmospheric Administration (NOAA) and Alaskan Command members.

This “Arctic IoNS Work Group” leveraged USCG District 17 led Table Top Exercise NORTHWEST PASSAGE, held in Anchorage, Alaska, on 13-14 April 2016.

The scenario used in USCG NORTHWEST PASSAGE, was a disabled cruise ship in the Beaufort Sea near the extended Canada-U.S. border. USCG Exercise NORTHWEST PASSAGE provided the Arctic IoNS Operator Work Group a forum to derive operator concerns and a clear understanding of “under-researched” areas relevant to operator concerns in a maritime mass rescue scenario.

Guided by senior government participants from Canada and the U.S., the inaugural Arctic IoNS workshop underscored the purpose of the proceedings, was to save lives.

Accordingly, the Arctic IoNS workshop provided a group of skilled operators to have a dialogue of ideas, and to exchange experience in search, rescue and recovery in major response operations with select academic and industry researchers to benefit understandings to the assembled participants and to develop follow-on research questions.
The targeted outcome of the IoNS workshop was to leverage both operators and researchers’ expertise to understand science and technology gaps and shortfalls associated with responding to a major rescue operation in the Arctic maritime domain.

First responders from both Canada and the United States acknowledged the difficulty in replying to a major response associated with a disabled cruise ship in Arctic waters. These professionals relate a range of factors in rescuing passengers and crews associated with the scenario: a very senior median age; a region of remarkable austerity; distant rescue forces; harsh weather and environmental factors; limited to non-existent local logistics/life support; and extended lines of communications from centers of assistance in lower latitudes. In sum, the scenario is daunting.

Gaps in science and technology associated in effecting rescue and policy in coordinating rescue and recovery were cited by senior leadership and operators alike, as principal concern.

Arctic oriented “operators” from Canada Coast Guard, Canada Armed forces, USCG, Alaskan Command, and State of Alaska Emergency Management, all cited the need for comprehensive shared situational awareness, communications shortfalls, domain awareness and total personnel accountability, as primary concerns, with current and projected technology lagging the requirement. Achieving accountability of passengers, crew/ships company and rescue personnel as seamlessly as possible was cited by operators as a compelling and under-researched need.

Gaining critically needed shared situational awareness; improving crisis decision support; addressing medical concerns in an Arctic region mass rescue; safely conducting evacuation from a disabled ship; seeking reliable communications and accounting for a host of hazards from weather; improving sea floor bathymetry, sea-ice movement and ocean drift/current knowledge; all were key areas addressed in both the first-day plenary session of the workshop and series of breakout groups that followed on the second day of the event.

Research questions provided at the conclusion of the report provide the follow-up and follow-through needed to move the workshop from simply a gathering of professionals meeting to discuss an important topic, which will invest the right researchers to advance capabilities to close gaps and shortfall.
Following the Operator Work Group conclusions from Exercise NORTHWEST PASSAGE, ADAC developed a comprehensive research literature review and used the literature review to queue and solicit select academic and industry investigators from Canada and the U.S. Critical to the workshop was getting the right researchers who have been deeply associated with the subject area, and could expertly present current baseline of understandings. Accordingly, the following themes were developed to frame

**The Arctic IoNS workshop themes:**

- Total accountability of crew and passengers in a Major Response Operation (MRO);
- Medical/rescue technology to assist marginally or non-mobile passengers from disabled ship to recovery vessels;
- Arctic communications, specifically, nearer term solutions for necessary communications in time of crisis, for creation of localized solutions to cope with the crisis;
- Drifting sea-ice, pack ice, and weather conditions that may create hazardous conditions for further transit or further impact a disabled vessel;
- Arctic bathymetry, particularly understanding of sea floor hazards in the vicinity of a crisis;
- Shared Situational Awareness (SSA), this includes appropriate day-to-day domain awareness, pre-planning and mitigation, before an emergency exists as well as crisis response SSA.

Through comprehensive planning, and frequent updates, ADAC sought to bring together a skilled team of authoritative Arctic IoNS participants from:

- Canada and U.S. Federal government leaders;
- Canada and U.S. Coast Guard and Armed Forces operators;
- State of Alaska senior leaders and emergency operators;
- Select industry operators and research-oriented members;
- Select academic researchers.

The workshop planning team received the six “operator-determined” areas of under researched science and technology. Workshop planners then developed an operator panel and five research panels to comprise a full day of plenary meetings to present current baseline of research comprehensively. The following day’s workshop then established four breakout groups balanced across workshop participant backgrounds and areas of expertise to analyze the prior day’s proceedings and develop potential research questions associated with specific Science and Technology Gaps and Shortfalls.
The Arctic IoNS designated breakout groups were as follows:

1. Achieving total accountability of personnel;
2. Improving medical preparedness and response with rescue and recovery in an Arctic region MRO;
3. Identifying and mitigating related/relevant hazards to Arctic major response operations;
4. Advancing Arctic region rescue response coordination, awareness, and communications.

In sum, 67 “in-place” participants along with 12 additional remote participants joined in a comprehensive plenary session, and participated across the four breakout groups to identify Science and Technology Gaps and Shortfalls. These gaps and shortfalls will be presented by ADAC to U.S. Department of Homeland Security Science and Technology Office of University Programs to develop the research proposals needed to address these concerns.

As described in detail in the main body of the report, the below are 20 research questions that were discerned by the four breakout groups with follow-up from U.S. Coast Guard.

The Arctic IoNS breakout group research questions (in summary):

1. “What are the technological gaps and shortfalls associated with technologies (in primary and secondary) related to accountability methods of people?”
2. “How will Arctic maritime conditions (climate, temperatures and water immersion) interfere with tracking methods (primarily evaluating RFID or transmitting type technologies)?”
3. “What are the necessary human actions or activities in preparing for shipboard emergency and willingness to cooperatively use accountability technology in advance and during rescue and recovery phases?”
4. “What is required for a “full spectrum accountability” set of uniform industry standards to be researched, developed and implemented?”
5. “Can pre-existing medical data (mindful of U.S. and Canada’s federal statutes in patient privacy protections) be incorporated into passenger and crew personal accountability systems?”
6. “What new or alternative evacuation and rescue capabilities or technologies are needed to enhance safe personnel transfer, including mobility challenged passengers and crews, from a casualty to a rescue vessel of differing freeboard, and then from an evacuation craft (life raft or lifeboat) to a temporary place of safety (i.e. larger vessel)?”
7. “What unique communications requirements are necessary to enable telemedicine in support of a major response operation, accounting for known communication conditions in remote and austere Arctic locations?”
8. “What thermal protection requirements are necessary for survival craft and personal protective equipment (what, who, where, when) to adequately preserve and protect occupants in an Arctic maritime environment?”
9. “How can “on-demand” “local/localized”
domain awareness be achieved (via user defined parameters) and what kind of technologies can best support localized domain awareness in austere Arctic environments?”

10. “How can we improve weather and sea ice forecasting tools to better serve operators? What new innovative Arctic marine early warning system can be developed and cost effective? “What appropriate thresholds would have to be identified for these tools?”

11. “What is the practically needed performance of standard safety equipment in the Arctic?”

12. “How can we improve awareness and understanding of nearshore bathymetry across the Arctic (in particular, the North American Arctic)?”


14. “What are the optimal scales of data flow, data types, and data conversion capabilities at each level (tactical, operational, and strategic) needed to respond to a major response operation corresponding to a disabled cruise-ship in Arctic waters?”

15. “How can non-government employed citizens (“in place” or residence), in a coordinated fashion, be leveraged during and after a mass rescue operation?”

16. “What is the best method to make available to planners and responders summaries and details of past rescue and recovery activities, lessons learned or strategies, for possible use in the Arctic and elsewhere?”

17. “What measures are needed to advance crisis communications to support SAR, HA and DR. accounting for the unique challenges across the North American Arctic?”

18. “What role can remotely-stationed, launched, piloted and recovered aircraft situated in austere locations can contribute towards improved rescue response efforts and SSA)”

19. “What type of life saving appliances capable of recovering large numbers of persons (50-100), particularly in the Arctic environment, can be developed? The general approach is an easily deployable, air-dropped device to evacuate personnel from a stricken vessel, and the device should provide a safe place of refuge for at least 24 hours.”

20. “For the Arctic region where infrastructure may be limited to non-existent, what are the system options for sustaining both evacuees and first responders in the short term (0 – 72 hours) during a Mass Rescue Operation (MRO)? What are the system options for sustainment over a 3 – 4-month timeframe if the MRO grows into a

Canada-US Panel discussion: Operator Challenges faced in responding to the fictitious disabled Cruise Ship in Arctic waters.
salvage, recovery, and environmental response operation? Such a system should include a testing regime to determine the extended sustainment capability over a 2-3 weeks to understand and verify capabilities, Concept of Operations, and logistics involved.”

Consequently, these research questions will be further developed by ADAC in order to propose specific research to the U.S. Department of Homeland Security, (DHS) Science and Technology Office of University Programs.

In detail: Specifics of the Inaugural ADAC hosted Arctic IoNS workshop.

Establishing the baseline: Arctic IoNS “Day 1” Plenary Session, June 21, 2016.

The Arctic-related IoNS workshop commenced with remarks by Senior Government leaders from Canada and the U.S. at the federal level, and included the State of Alaska. These leaders established the overall intent and desired outcomes for the workshop. The senior government leaders presenting were:

1. Dr. Paul Hubbard, Defence R&D Canada;
3. RADM Mike McAllister, Commander, U.S. Coast Guard District 17;
4. RDML Francis “Stash” Pelkowski, Headquarters, U.S. Coast Guard;
5. BG (AK) Laurie Hummel. Commissioner, Department of Military and Veterans Affairs, State of Alaska/The Adjutant General, Alaska National Guard.

Senior government leaders stressed the need for a workshop to serve as a “dialogue of ideas” for the purpose to save lives. Research oriented to benefit the community of Arctic First Responders in both preparedness and response missions is needed in the near term, as human activity in the Arctic continues to increase quickly. As commercial activity continues to surge, the question of the role of government in affecting rescue and recovery remains problematic.

Commercial enterprises, such as cruise ships, may need to be more prepared to effect self-rescue as numbers of vessels increase, likely outstripping the ability for mass rescue of any more than a single large passenger vessel at any one time across the Arctic region. Both Canada and US government leaders cited gaps in technology and policy in the Arctic region as a continued concern. Gaining full accountability in crisis, coping with marginal communications above 65 degrees North, addressing the urgent time and distances to respond, and addressing impacts to local populations in a large scale response along Arctic shorelines all remain challenges for operators, and mission tasks for researchers.

The need to coordinate response planning with Arctic coastal communities in advance of a crisis was cited as a specific concern with
State of Alaska leadership. Assessing current capabilities in major response and recovery in the Arctic and the kinds of tools needed to support such efforts were cited as a primary duty to address at the Arctic IoNS workshop and beyond.

In sum, the Arctic IoNS workshop provided an opportunity for an array of presentations from select researchers aligned to operator derived themes. As described, the themes were presented into one operator and five research panels.

**Arctic IoNS “Operator” Panel:** The goal of the operator panel was to hear from the select and seasoned operators of their challenges associated with responding to the scenario. General Officer/Flag Officers/Senior Government Officials presented “what is of most concern” in addressing preparedness and response to cope with the overall workshop scenario. This panel consisted of the following members:

1. Rear Admiral Mike McAllister, USCG D-17, Juneau, Alaska;
2. Mr. Mike O’Hare, State of AK Emergency Manager, Anchorage, Alaska;
3. CDR Susan Pickrell, Canada Coast Guard, Ottawa, Ontario;
4. Maj Mike Susin, Canada Armed Forces, Ottawa, Ontario;
5. Mr. Don Moore, National Oceanic and Atmospheric Administration/National Weather Service (NOAA/NWS), Anchorage, Alaska;
6. Mr. Dusty Finley, Senior Alaskan Command and Senior US Army Alaska representative, Anchorage, Alaska.

The Arctic IoNS operator panel built on remarks provided by senior government officials in describing their primary concerns in responding to a major cruise ship disaster. Echoing senior government members, was the need to establish effective accountability, for passengers, crews, responders, and support personnel located in the vicinity of the crisis. Investing wasted efforts to rescue people who are already safe and secure, can be successfully avoided if accountability measures are sufficient.

Due to virtually non-existent infrastructure, and marginal lines of logistics, responders are critically required to arrive at an Arctic region crisis scene “self-sufficient.”

Increasing communications capabilities remain a widely agreed upon acknowledged shortfall. Improving weather forecast accuracy is needed to usefully to efficiently and effectively plan and conduct response (in particular, aviation weather). Planning for significant sea states and heavy weather is needed/appropriate.

Resource sharing, collaborating response between Canada and the U.S. is critical, in
particular if/as multiple/near simultaneous ship disasters are occurring. Ice movement and ice thickness in the Arctic maritime environment remains a significant impact. Increases hazards to mariners and reduces Arctic Domain Awareness across the region.

Timely decisions in generating response are critical. Operators cited that many Ship Captains are reluctant to make the initial mayday call, trying to “manage through” the crisis with personnel and resources on-hand. Such delays in calling for help can prove deadly, as the time and distance for an effective response can be hundreds if not, thousands of miles away.

The median age of cruise ship passengers (citing the voyage of the 2016 Crystal Serenity Northwest Passage cruise as an example) complicates response, as many passengers aboard are elderly and/or have comprised mobility and health concerns. Many aged passengers have little resiliency to cope with rescue at sea in the Arctic. Immersion in Arctic waters, coping with variable deck geometries (resulting from a disabled vessel adrift in rough waters), existing medical conditions that substantially worsen in a crisis and more, hints at some of the potential complications arising from a disabled ship in Arctic waters. Safely evacuating elderly, or marginally mobile passengers from a disabled ship in rough weather may prove to be a difficult or even an impossible task.

Operators expressed concern about cruise ship readiness and emergency preparedness, especially as more cruise ships steam across the Arctic Ocean and the Northwest Passage. Operators commented some level of concern with the overall cruise line industry’s commitment and ability to be self-regulating in taking the needed extra measures needed to fully cope with an emergency in remote Arctic waters.

Until communications in the Arctic substantially improve, operators cited the need to establish a communications node in the vicinity of the crisis to effect improved crisis coordination as a potentially critical need.

Impact to local communities not prepared to receive potentially thousands of ship evacuees (and rescue personnel) under emergency conditions is not well understood and can potentially result in greater complications in handling the overall MRO. Local communities can also be of great assistance however, due to insights of local/placed based knowledge.

Due to marginal logistics capabilities associated with Arctic coastal communities in Alaska and the Canadian Arctic, response forces need to plan for self-sufficiency. Prior investments such as facilities constructed in the Arctic (particularly across the Canadian Arctic) associated with the Cold War, (now decades in the past), are deteriorating and may be of marginal use in supporting a large/crisis response operation.

**Arctic IoNS Research Panel 1:** Current and known research in Addressing Ship Total Accountability in an Arctic Emergency. Panel addressed current challenges faced in gaining total accountability in a crisis.
Overall Panel Reflections:

The first research panel established the “baseline” of what to expect in a crisis aboard ship. Current industry standards are to ensure crew and passenger accountability via cruise ship cruise cards with unique identifiers/biometrics tied to manifest data base. Positive control of personnel accountability is stressed across the cruise ship industry. Gaining accountability is normally accomplished via distributed muster stations, connected to overall muster control and guest headquarters, leveraging electronic web-based technology.

Manual back-up protocols, that include room to room searches are used as needed. The Arctic IoNS workshop participants from Princess Cruise Lines described a comprehensive set of measures that are recent industry standards in establishing accountability.

These measures are principally associated with cruise ship identity card, tied to room/berthing, meals, purchasing, etc. Emergency guest accountability is achieved first via room key scanning that ties to web-based personnel management, with backup manual accountability, which can involve crew accounting via room to room search protocols.

The use of smart cameras linked to data crew and passenger data base, which includes facial recognition software can potentially be usefully augmented into other accountability approaches. Researchers from Canada’s National Research Center and Memorial University in St John’s Newfoundland, related developing accounting systems based on Radio Frequency Identification (RFID) wrist or arm bands and associated Wi-Fi systems improve accountability over prior swipe card room key type approaches.

However, many guests and crewmembers aboard ship dislike the use of the emerging technologies, as it tracks their movement, potentially to an intrusive or perceived intrusive level. RFID can also be inadvertently negated by simple actions, such a folding arms or adding layers of clothing. The ship accountability panel continued with researchers describing limitations with the current technologies used.

Electronic cards are useful day-to-day aboard ship (these cards contain basic biometrics and are used as a ship-born charge card. In a crisis, these cards often are misplaced or lost. Video surveillance has limited effectiveness. Radio Frequency Identification (RFID) and Wi-Fi based systems also remain limited in effective accountability. New RFID technologies under development, offer potential improvements to gaining needed accountability.

Sophisticated technologies require scrutiny as to their reliability in a crisis, whether the technology is rugged enough to cope with what could be a cold and wet environment, and if too sophisticated (from a human factors vantage) to be useful when people are challenged to react coherently when the scenario may simply be physiologically and psychologically overwhelming. Facial recognition software offers a potentially less intrusive approach to crew and passenger accountability. Use of such technology at a muster station could potentially save time and effort...people simply bring themselves to gain accountability aboard the ship.
A personnel system that can gain access to the “ship in crisis” personnel data, plus all response and support forces (which could include Canada and U.S. Coast Guard, Armed Forces...along with State of Alaska National Guard forces and emergency response teams) for “total crisis asset accountability” remains elusive, due to interoperability between such systems.

Panelists further described the impacts of the fog, confusion and emergency factors at the onset of a disabled ship crisis works against gaining accountability. However, training of crew emergency management and exercising passengers in a disciplined method was described as a useful approach to reduce confusion.

Decision trees to guide on-scene coordination, was described an improved approach to crisis checklist protocols.

A specific summary of panelist presentations is provided below:

1. **Mr. Tom Schofield/Representative, Princess Cruise Lines Los Angeles, California.**
   In an emergency, crews are checked off against paper a Muster List and guest are scanned electronically in their assigned Muster Station. Electronic mustering has reduced response time, increased flexibility and better accountability. Safety measures such as a compulsory guest drill, Passenger assistance party, desk supervisors, and search and rescue party increase the overall safety. Future innovation may include electronic mustering for crews and use of RFID wristbands for guests.

2. **Mr. Rob Brown, Memorial University, St Johns Newfoundland.**
   Traditional methods of accountability on passenger ships are slow and unreliable.

Transferring rescued personnel accountability for the rescued as they move onwards to definitive care was described as yet another time where accountability gaps occur.

Improvements in technology such as video surveillance, bar code scanning, and Wi-Fi based systems help to better muster check. RFID faces some challenges in large crowds, metallic structures and passenger wearing them. Research needs to include expected performance for ideal and less than ideal conditions.

3. **CAPT, USN (Ret) Jim Pettigrew Mary Kay O’Conner Safety Center (MKOPSC), Texas A&M University, College Station, Texas**
   Emergency Egress and Rescue (EER) strategies address the entire process by which personnel are removed from a major incident event to an ultimate place of safety. The process includes escape, evacuation, and rescue. MKOPSC develops and analyzes the probability of success of EER strategies.
MKOPSC has created the framework for creating a Best-in-Class safety culture. However, existing strategy is not sufficient for extreme Arctic environment conditions.

4. Dr. Joan Mileski Texas A&M Galveston, Texas.
A captain’s perspective on ship capabilities depends on the DMA (Defense Mapping Agency) [now National Geospatial Agency (NGA)]. Passage planning includes exercise results, speed, port capabilities and assets. Officer availability such as environmental officer, pilot, USCG officer, polar navigator, play an important role. Aspects of emergency equipment to consider are size, ship ice class, communication, life boat capabilities, exposure suits, liability, maintenance record, and inspection. The most important steps when waiting for help are not to hit anything and keep the engines running.

5. Mr. Eric Velte, ASRC Federal Mission Solutions, Mount Holly, New Jersey.
A cruise ship emergency could take many forms such as terrorist attacks, infectious diseases, lost passengers, etc. The goal is to support decision-makers without hindering freedom. There are many promising technologies such as RFID bands. RFID offers a wide array of features and offers 99.9% reliability. Studies suggest the “break-even” point is within five years because of the decreased cost of using RFID.

Arctic project areas include oil in ice, Arctic communications, Arctic operations support, Arctic Domain Awareness Center initiatives, Arctic navigational safety, and polar ice breaker program. Decision trees are used to frame the issue of rescue and evacuation. Research modeling can maximize success. The mass rescue goal is to remove persons from peril and deliver interim place of safety.

Arctic IoNS Research Panel 2: Current and known research gaining Arctic emergency response Shared Situational Awareness (SSA), which includes appropriate day-to-day domain awareness, pre-planning and mitigation, before an emergency exists as well as crisis response SSA.

Overall Panel Reflections:

Shared situational awareness benefits from resiliency and redundancy.

SSA includes accounting for appropriate elements of the crew, passengers, ship’s bridge reporting/command, and the entirety of responding rescue forces. In the Arctic IoNS scenario, SSA is a bi-national challenge, complicated by the need to gain interoperability from a number of different reporting systems and data bases existing across two nations.

Gaining “heat maps” of human positions/activity located at and in the vicinity of the crisis is useful and can aid response coordination among various rescue teams to orient and potentially prioritize response to correlate to areas of highest concentration of rescue victims.
As more cruise ships plan to ply Arctic waters, designing augmented capabilities to increase redundant communications systems to transmit emergency data can greatly aide SSA, particularly in the opening segments of the emergency.

Community-based observers can contribute to SSA throughout the crisis by seeing and reporting on factors that may not otherwise be noted. Enabling community-based observers with rugged reporting equipment and established reporting protocols, better ensures their reporting supports mission needs of rescue and response forces.

Leveraging social media can greatly aide SSA, from passengers, crew, and participating rescue forces. Social media use among coastal communities in the vicinity of a rescue scenario can aide SSA, and can contribute to follow-on recovery efforts. In sum, social media has so far been underutilized in disaster management and is an area where targeted research can develop solutions to the benefit of operators, logistics, transportation, medical and other essential rescue contributors.

Panelists noted the Arctic’s austere communications environment greatly complicate SSA, in particular the Arctic maritime regions.

Gaining access and leveraging existing authoritative data through skilled data management approaches, while continuing to pursue developing decision support development collaborations directly correlates to SSA in a crisis.

Gaining “sensors on scene” in the early stages to increase focused SSA is critical. However, SSA “on-scene” can be compromised since unmanned air platforms are not generally available and manned platforms are very small in number, distant from the scene, and subject to a limited operational weather window.

A specific summary of panelist presentations is provided below:

1. Dr. Theresa Jefferson, Loyola University, Maryland.
   The three levels of situational awareness are obtaining data, understanding data, and predicting the future. The elements of Arctic-related IONS are danger, distance, and demographics. 60 to 70 percent of accidents in commercial seafaring are influenced by human factors. Complex systems almost always fail in complex ways. The goal is for decision makers to infer consistent meaning and implications for required action.

2. Dr. Dennis Egan and Dr. Paul Kantor, DIMACS and CCICADA, Rutgers University New Brunswick, New Jersey.
   Situational awareness requires getting the right information, at the right time, to the right people. Information on weather and sea conditions come from many sources and
weather changes fast. CCICADA experience includes working with floods of information, analysis of emergency needs, studied social media data, situating emergency response, and using media in emergency response. Research challenges include natural disasters, cell phone communication and equipment.

3. **Ms. Molly McCammon, Alaska Ocean Observation System, Anchorage, Alaska.**

AOOS is congressionally directed, stakeholder driven, science-based and policy neutral. AOOS improves marine operations, mitigates coastal hazards, tracks trends, monitors water quality, and develops products. The system maintains observations and fills gaps by providing data. The regional data assembly center is the largest collection of data in Alaska and is connected/integrated with national level elements in Washington D.C.

4. **Dr. Kenrick Mock, UAA ADAC, and Mr. Tom Heinrichs, UAF ADAC (Arctic Information Fusion Capability (AIFC) PIs), Anchorage and Fairbanks (respectively), Alaska.**

AIFC is a collection of activities, systems, and expert standards executing the complicated process of data transformation. AIFC seeks to address the challenges of user support and the existing gaps. The work of AIFC can be broken into identifying the Arctic information and defining and designing the fusion capability. Near term AIFC will continue to leverage and fuse existing sources, capabilities, and models to provide operational decision support. Long term AIFC will research Artificial Intelligence component to assist decision-makers and partner with ASRC-Federal Mission Solutions to work with end users for data integration, commercialization, and transition to a fully operational product.

5. **Mr. Robb Wright, NOAA Environmental Management Response Activity (ERMA), Seattle, Washington.**

ERMA is an online mapping tool for visualizing environmental information relevant to oil spills and natural disasters. ERMA provides customizable web-based mapping application that provides centralized access and visualization of integrated data. ERMA has recently provided support to US Agencies and Trustees for the Refugio Beach pipeline spill (CA), Green Canyon spill (GoMex), Tank Barge Argo lightening (Lake Erie), Oregon Train Derailment. Data sharing is out of protected layers. The next steps for Arctic ERMA include supporting Arctic Chinook, partner with ADAC/AIFC and continue best practices for data sharing.

6. **Dr. Lil Alessa, University of Idaho ADAC, PI for Community-based Observer Network for Situational Awareness (CBON-SA), Moscow Idaho.**

Different IoNS require different data streams to inform a range of responses. Data feeds need to be simplified to reduce the potential number of up-or down-cascades that can occur because of SA cohesion or failure.
In remote regions the lack of monitoring instrumentation can be off-set by working with local communities and high fidelity observers therein. These individuals can provide SA data immediately with precision, drawing on local knowledge to help guide Coast Guard and other crisis responses.

**Arctic IoNS Research Panel 3:** Current and known research addressing Cruise Ship Medical Rescue/Technology.

**Overall Panel Reflections:**

Cruise ship rescue technology is useful for emergencies, but research conducted at the National Research Council and Memorial University at St John’s Newfoundland, highlight the risks to personnel evacuating a disabled cruise vessel. In particular, wind and waves, create conditions that can cause injury, and potentially life-threatening medical conditions when passengers and crews seek to egress a disabled cruise ship.

Ship rescue capabilities and in particular, egress systems were cited as less than fully capable and potentially hazardous. Reliability of life boats to safely launch can be negatively impacted based on the scenario. Egress systems from the side of a ship many feet higher than a rescue platform can result in injury, perhaps severe injury as a person evacuates down an egress slide. Complicating a ship’s company to address timely emergency scenarios includes sometimes reluctance with the Captain to issue a Mayday call. Emergency readiness of the ship’s company or the passenger’s willingness to take preventive action seriously is often a factor. Electrical failure of ships power, may complicate or negate emergency egress, depending if sufficient back-up systems are in place or capable of operating in a cold weather emergency. Gaps in data of ship rescue and egress systems limit emergency systems engineering.

Addressing medical needs of rescued passengers and crew, injuries, existing medical conditions and complications from egressing ship, to include coping with water temps of frigid sea water that can quickly immobilize and overwhelm (particularly aged and infirm personnel). The time to evacuate a ship safely to rescue vessel(s) can take considerable time, and is impacted as well by wind, waves and the stability of the disabled vessel. Careful consideration on when
Evacuating a ship, vs shelter in place needs to be factored, particularly if risk factors associated with egress are high or extreme. Life boats are a considerable factor in cruise ship rescue technology. Depending on the conditions that caused a ship to be disabled, (such as listing to a side due to the impact of sea-ice) some number of lifeboats may in turn be unable to launch. Further, while the developing Polar Code, has established a minimum level of life boat thermal protection, insufficient insulation, coupled with weather, conditions and temperatures, may result in life boat occupants to readily suffer hypothermia.

Addressing medical needs of rescued passengers and crew, injuries, existing medical conditions and complications from egressing ship, to include coping with water temps of frigid sea water that can quickly immobilize and overwhelm (particularly aged and infirm personnel). Leveraging remote tele-medicine where skilled medical expertise situated in cities such as Anchorage or Fairbanks or elsewhere can be leveraged (communications permitting) to a shipboard or triage site to facilitate emergency care to stabilize injured personnel when medical “on-scene” capabilities are limited or non-existent.

Evacuating injured and immobilized personnel from ship to rescue watercraft is exceedingly difficult, and research is needed to develop capabilities that reduce safety risk factors and increase speed (in order to handle a number of personnel in a constrained/reasonable time).

Specific summary of panelist presentations is provided below:

1. Dr. Jon Power National Research Council of Canada, St Johns, Newfoundland, Canada.
   Eight locations across the Canadian North were selected for research based on current and expected marine traffic. Predicted survival times (PST) for hypothermia were generated using the Cold Exposure Survival Model (CESM) across a range of clothing ensembles for 50th percentile 60-70 females.
Survival times were estimated if submerged, wet, and with wind. For 1600 evacuees you need 12 slides/chutes simultaneously to evacuate in under 30 minutes.

2. Dr. Rob Brown, Memorial University St Johns, Newfoundland, Canada.
Cruise ship medical and rescue technology must include evacuation survival and rescue. It is pointless to evacuate if you cannot survive until rescued. Both evacuation and survival research have ample research available, but rescue research is limited. Each area has research gaps.

Arctic IoNS Research Panel 4: Current and known research advancing Arctic Communications. Specifically, nearer term solutions for necessary communications in time of crisis, for the creation of localized solutions to cope and other constructs were presented.

Overall Panel Reflections:

Communications across in the Arctic remain an acute vulnerability and an enduring concern.

Any significant or major response operation will likely require the establishment of a temporary communications station in the vicinity of the rescue operation to effect operational coordination.

High Frequency (HF), Very High Frequency (VHF) and Ultra High Frequency (UHF) radios are all well-established legacy systems that have and will continue to be used in the Arctic. All three systems are expensive to maintain and have well-known/existing limitations. While long range (a useful attribute in the vast Arctic) HF is often subject to atmospheric anomalies (particularly present in the polar regions), VHF and UHF are subject to substantial and very substantial respectively range limits “to and from” the transmitting antenna. UHF frequencies are generally associated with military communications.

Satellite communications are subject to a limited number of overhead platforms which are traditionally operating in low earth orbit and “fly” over the Arctic region in a cycle/pattern and timeline.

Cell phone coverage is normally associated with Arctic villages, and is very limited or non-existent outside of those villages.

Improvements via establishing the Quintillion Network (current construction of a high-speed fiber network) will help connect established populations as it is being built across the North American Arctic, but will likely prove to be of limited impact/worth to support an “at sea” incident as described in the Arctic IoNS scenario.
A new communications capability, Mobile User Objective System (MUOS) a next-generation narrow-band tactical satellite communications system being developed by U.S. Department of Defense, and will be of value to military operations, but operates in UHF ranges, again, normally associated with military operations.

Accordingly, access and equipment limitations of the system, limit associated utility in an unclassified rescue event.

In sum, a combination of communications capabilities is available to support a major response operation in the Arctic maritime domain. However, limitations in access and equipment, atmospheric conditions, along with range and distance are some of the factors that create gaps and shortfalls in comprehensive and reliable communications in the High North.

**A specific summary of panelist presentations is provided below:**

1. **Ms. Holly Wendelin, U.S. Coast Guard Research and Development, Washington DC.**

   Overall recommendations include a new considering the establishment of a High Frequency (HF) antenna at Fairbanks and Pt. Barrow Alaska. Mobile User Objective System (MUOS) is planned to be operational in summer 2016, and Department of Defense (DoD) will eventually cease supporting the legacy systems function. The USCG should consider making Distributed Tactical Communications System (DTCS) a program of record by leveraging the DoD program of record solution. Described USCG Exercise Arctic Chinook (22-24 August 2016) which involves rescuing 100+ passengers who have abandoned their “cruise ship” and landed at an isolated “beach” near the Bering Strait in northwest Alaska. Arctic Chinook provides a useful forum for Arctic operators to “think through” coordination measures in effecting a simulated major response event.

2. **Dr. Steve Spehn and Dr. John Walsh, NASA-DoD Arctic Collaborative Environment (ACE), Huntsville, Alabama and University of Alaska Fairbanks, Alaska.**

   IoNS will occur in the Arctic. A variety of organizations will have overlapping missions to various aspects of the IoNS. Coordination of resources and actions are key to addressing Arctic IoNS. ACE provides and open source software application provides monitoring, analysis, and modeling. ACE also enhances local, regional, and international cooperation and coordination.

3. **Dr. Nettie La Belle-Hamer, UAF Geophysical Institute, Fairbanks, Alaska.**

   Challenges of the Arctic include geology, geography, ecosystems and the rate of ecosystem change, culture, infrastructure, climate and lack of data. Satellite communications cannot provide adequate resolution. Very small satellites “CubeSat’s” are cheaper and faster and can provide more
coverage by a small flock or a highly elliptical orbit. These are relatively affordable, as they cost roughly $40K dollars a copy. Unmanned Aerial Systems/Remotely Piloted Aircraft could be used from high latitude platform stations. Such platforms if configured as remote launch, fly, recover and reconfigure to relaunch, could prove invaluable in getting sensors on scene.

4. Mr. Eric Velte, ASRC Federal Mission Solutions, Mt Holly, New Jersey.
Energy Services has maintained a network of seasonal, regional, and community call centers (ComCenter’s) since 2007. All Com Centers have trained personnel, and basic operating equipment. Com Center’s primary function has been conflict prevention and resolution. Conflicts tend to arise when parties fail to report information.

Com Centers provide local resources and local assistance and are often the front line for current information in the midst of a SAR response.

5. Mr. Kenneth Kucharzak, Alaskan Command J-6, Joint Base Elmendorf-Richardson, Alaska.
Reliable communications are fundamental to the future of operations in the Arctic Region. Lack of Line of Sight(LOS) Communications Architecture in the North Polar Region and insufficient beyond LOS communications create problems above 65 degrees. Continued collaboration and partnership with government and private industries is a must. Before a communications initiative is pursued, evaluate who will use it, to what extent, with the honest realization of what it costs to do business in the Arctic.

Arctic IoNS Research Panel 5: Accounting for Drifting Sea and Pack Ice, mitigating Arctic weather hazards in rescue scenarios and improving understanding of Arctic Bathymetry in an emergency.

Overall Panel Reflections:

A disabled ship’s ability to cope with sea-ice is a significant risk factor. Knowing the conditions, movement, and thickness of sea ice in the vicinity of a disabled ship are all vital information needs. The cruise ship industry is highly unlikely to invest in ice-hardened vessels, making their ability to cope with more than superficial amounts of sea-ice unlikely. A disabled ship’s drift path and the associated sea-floor bathymetry is highlighted as another critical need. Tide and sea-floor bathymetry across the North American Arctic remains poorly understood. For example, only 10% of the Canadian Arctic has accurate sea-floor soundings, and very limited tide tables are available for the Arctic region. Weather and environmental factors (such as wind, waves and sea-ice), along with existing poor communications across the high north, make Arctic rescue and rescue coordination difficult. Due to lagging and lack of data, predictive aviation weather remains difficult for weather forecasters.
across the Arctic.

Weather and sea floor bathymetry are complicating factors. Low visibility due to fog and low clouds, (which tends to occur relatively frequently across the Arctic Ocean region in summer) along with significant storms, which generate wind and waves, can make what could be a routine rescue in clearer or calmer weather, virtually unmanageable to accomplish.

Only about 10% of the Canadian Arctic has accurate soundings, and there is yet to be developed accurate tide tables for the Arctic region across North America. In sum, operators and researchers alike expressed a concern that environmental data and overall domain awareness lags behind the operational requirement.

**A specific summary of panelist presentations is provided below:**

1. **Ms. Darlene Langlois, Canada Weather Service, Ottawa, Ontario**
   Sea ice limits motion of vessels, can create large waves and iceberg projectiles, and can grow rapidly over a large area. Water can cause persistent fog, freezing spray, strong winds and strong currents. Ice modeling can show where ice is forming and melting and where it may be moving. Challenges related to the provision of ice and weather include modelling near the shore, forecasting over a long time frame, portraying uncertainty, having common terminology, ensuring the formats are compatible and handling large volumes of data.

2. **Dr. Larry Mayer, University of New Hampshire, Durham, New Hampshire.**
   The Center of Coastal and Ocean Mapping at UNH is a NCOE in ocean mapping focusing on new technologies and software to support the safety of navigation and many other aspects of ocean mapping (e.g. fisheries habitat, Law of the Sea, ocean exploration, coastal and marine spatial planning) and training. Given the grossly inadequate state of much Arctic bathymetry, grounding represents a very real danger to vessels. Should a grounding occur, (as was the case of the M/V Clipper Adventurer) it may not be possible to get close enough to extract passengers or send relief vessels without further bathymetric survey. In the case of the Clipper Adventurer, a multi-beam sonar equipped barge that was carried by the CCGS Amundsen was able to map a safe route for relief and salvage vessels, averting disaster. Other approaches to establishing safe routes for relief vessels for a grounded vessel could involve airborne deployed LIDAR or careful analysis of satellite or airborne derived imagery.

3. **Ms. Becki Heim, NOAA/NWS, Anchorage, Alaska.**
   NOAA’s National Weather Service provides forecast services to protect life and property, to enhance the national economy, and to fulfill NOAA’s obligations under international treaties for the safety and security of maritime shipping, energy exploration, and tourism activities. Major stakeholders and partners, including the U.S. Coast Guard and the State of Alaska, require weather, water, and sea ice information for planning and decision-making to serve communities and to manage the region’s many resources. Challenges include ice concentration, drift, and thickness.

4. **Dr. Tom Ravens, UAA ADAC, Anchorage, Alaska, (in coordination with Dr. Jinlun Zhang, University of Washington Polar**
Sciences, Seattle, Washington). Ice forecasting models include modeling real-time forecasting of sea ice concentration, ice thickness, ice velocity, and ocean currents. HIOMAS aims to predict sea ice thickness, concentration and velocity and ocean currents days to months in advance. More model validation using observations would be useful especially in coastal settings. ADAC is working with NOAA NWS to develop a high-resolution circulation/surge model for the north coast of Alaska.

5. Dr. Andy Mahoney, UAF ADAC, Fairbanks, Alaska.
Sea ice is a common topic in world news. Passive microwave satellite data allow tracking of sea ice on a daily basis at a 25-km grid scale. UAF ice radar data is used in real world applications by Barrow Search and rescue.

Ice motion can be high complex, particularly near coasts, rapid reversals are possible and differences in velocity can create hazards. Marine radar is a robust technology that can provide scientifically and operationally valuable data which is ideal for coastal applications, but more development needed for vessel-based deployment.

Assessing the risks of marine vessel traffic can be done by vessel drift simulation. The simulation model parameter includes millions of trajectories. This same simulation can be used for Japanese tsunami marine debris. The simulation shows beaching changes over time using different routes.

Leveraging the Baseline to Assess Gaps and Shortfalls: Arctic IoNS “Day 2” Breakout Groups, June 22, 2016.

Arctic IoNS Breakout Group 1: Achieving total accountability of personnel in a crisis.

Facilitators: Dr. Larry Hinzman, ADAC and UAF, and Dr. Rob Brown, Memorial University, St. Johns, Newfoundland.

Note taker: Mr. James Matthews, UAA.

Panel Participants:

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Reflections of the breakout group on the task.

Breakout group #1 discussions were devoted to comprehensively understand facets of accountability of people, from cruise ship passengers, crew, response/rescue and coordination forces. These understandings are reflected in the following attributes of accountability and discerned technology gaps and shortfalls. The following describes the group’s analysis:

Need to determine localization methods. Specifically, how to identify personnel, gain appropriate biometrics and maintain awareness through the rescue and recovery process.

The first step is to identify the practices that are currently being used throughout related industries. The 21 June Arctic IoNS workshop “Day 1” Plenary session presented what serves as the baseline in the cruise industry, noting there may be some exceptions. In sum, further investigation may yield further understandings of business practices.

As discussed, the cruise ship industry primarily uses issued identification cards which serves as room swipe access and a ship board credit/charge card. While such products are useful day-to-day, Arctic IoNS “Operator Group” believed this capability is inadequate to task in an emergency and has previously been viewed as a vulnerability in mass rescue operation. The next step is to determine which of these localization technologies would be most useful in an Arctic cruise ship crisis? In particular, which method should be used as the principal tracking method, and what others should be used as redundant methods (in order to better ensure accountability if/as a primary system fails).

The work group discerned several examples principal methods involved in using RFID or associated transmitter technologies. Commercially available products that could potentially be adapted, modified or leveraged such as Fitbit or Apple Watch type technologies could be useful for ship accountability, but costs may prove to be a factor (particularly in larger scale/cost considered cruise lines).

As described in the plenary session, RFID technologies are not universally welcomed by passengers, in particular, those who do not wish to be tracked/monitored continuously. However, in an emergency, RFID technologies (particularly those which are ruggedized and capable of functioning in a wet and cold environment) likely have the best chance of gaining and maintaining
accountability through the rescue and recovery process.

Several examples of secondary methods include bracelet with a barcode, passengers providing access/accountability via personal use cell phones, video surveillance (with/or without associated facial recognition technology) and Bluetooth & Wi-Fi based systems. These secondary approaches are likely useful to gain accountability at the start of the emergency as personnel muster to depart a disabled ship, but are unlikely to be able to provide continuous accountability as a person moves throughout the rescue and recovery process.

Arctic IoNS Workshop Question #1: “What are the technological gaps and shortfalls associated with technologies (in primary and secondary) related to accountability methods of people?”

Further details:

• For primary accountability methods, can RFID technologies be ruggedized, and enduring in cold and wet environments to operate in the extended timeframes associated with rescue and recovery?
• What climates/conditions and endurance timeframes can RFID technologies operate. What technological advances need to be made to enable increased timeframes and to improve a ruggedized RFID to operate in an Arctic maritime environment?
• What are the costs associated with these measures and are the costs feasible and acceptable?
• Specifically, as a continuous RFID has privacy concerns in conditions other than an emergency, is it possible to develop a personal use bracelet that is worn continuously that only activates in a crisis (perhaps through a centrally activated command feature?)

For secondary accountability methods:

• Can video surveillance coupled with facial recognition technologies be made interoperable to move between Ship-board software systems and Government first responder organizations in Canada and the U.S.?
• Can Bluetooth and Wi-Fi based accountability approaches be usefully developed as an alternative to RFID?

Arctic Interference. The breakout group understands the Arctic maritime environment creates conditions ultimately counter to most technologies, in particular electronic and telecommunications. Transmitting devices (such as RFID) can be made unusable simply due to heavy clothing being placed over the top of the equipment.

Further, Arctic maritime environments in a summer cruising season, are still generally viewed as wet and cold (water temperatures range from approximately 0-8 degrees C in summer months across the Arctic).

Arctic IoNS Workshop Question #2: “How will Arctic maritime conditions (climate,
temperatures and water immersion) interfere with tracking methods (primarily evaluating RFID or transmitting type technologies)? “

Particularly, what are the impacts of the following conditions:

- Personal protective equipment or clothing. If the technology were a chip, would heavy clothing affect the signal?
- Effects of cold air temperatures. At what temperature, does the technology, particularly batteries, fail?
- Effects of a transmitting type of technology to function while submerged, or following submersion in sea water?
- Effects of the Arctic’s electromagnetic environment? Does an increased amount of electromagnetic activity impact transmitting and receiving technology?
- Effects of excess or deficient exposure to the sun? Does the Arctic region’s thinner atmosphere (roughly ½ the density of the Earth’s atmosphere at the equator) and exposure to increased sun radiation due to high solar declination in summer months, impact transmitting and receiving technology?
- Effects on shipboard accountability measures and technology if the ship loses power?

**Human Cooperation.** As described and discussed in Literature review, plenary session and breakout group, people can enable or defeat accountability technologies and measures.

In an Arctic maritime region crisis, it is believed that many/most cruise ship passengers and crews will readily seek to be accounted during rescue and recovery. However, in advance of such an emergency, gaining accountability through people cooperating is generally viewed with uneven success.

As described by the Arctic IoNS cruise ship industry panelist, gaining accountability in advance of the crisis is important, if not critical to ensure accountability in crisis. Gaining cooperation of passengers focused on vacation activities to participate in emergency drills and practice mustering is generally difficult.

**Arctic IoNS Workshop Question #3** “What are the necessary human actions or activities in preparing for shipboard emergency and willingness to cooperatively use accountability technology in advance and during rescue and recovery phases?”

Particularly:

- Will passengers adopt the localization technology?
- Is it easy to use and keep track of?
- Is the technology too intrusive? What is the divide between “acceptable” and “too intrusive?”
- Should there be training on the method? How extensive? At a minimum, gaining understanding of passenger accountability technologies and measures, such as “What it is for?” “How it is used?” “What to do in the case of an emergency?”
• What reinforcements can be used to drive acceptance? For example, can accountability multipurpose technology – i.e., act as a key card, meal ticket, provide discounts, prizes, and interactivity?
• Would passengers respond correctly to informative signs and signals directing them where to proceed in an emergency?

Ensure Full Accountability. “Full spectrum accountability” is achieved through the right personal wear device, filled with the appropriate biometrics, connected to either a transmitting capability (or having access to a station to transmit) and a data-base and management system interoperable with responding forces and their command and control leaders/ma. Accordingly, does “full spectrum accountability” achieve the intended goal?

A Major Response Operation in the Arctic has the potential to require an extended time frame to conclude. Accordingly, the breakout group notes it will be important to make the accountability data accessible to everyone connected in the response and recovery throughout the process. As such, can access to accountability data be made available to:

• First Responders;
• Cruise Ship Crew Members;
• Passengers (and potentially Family Situational Awareness – for example, would they be able to account for their family members using this method)?

Uniform Industry Standards. Achieving full spectrum accountability in an Arctic maritime emergency will not be realized unless accountability measures are interoperable to an array of responding forces (both Canada and the U.S.). Thus, any new initiatives in accountability research and development need to be designed from the very beginning via adherence to industry standards.

Arctic IoNS Workshop Question #4: “What is required for a “full spectrum accountability” set of uniform industry standards to be researched, developed and implemented?” Supporting this question are “component aspects” such as:

• Data Standard;
• Storage Standard;
• Communication and information relay standard.

Additional considerations from the group that helps to inform accountability research development. The following attributes were offered by the breakout group to consider when developing the research needed to scope workplans associated with the research questions. These attributes are provided simply to inform.

• If the ship loses power will the technology still work?
• Should survival gear be kept at the muster point?
• Can active technology be used to ensure an efficient muster?
  ◦ Conduct research and develop a program to produce the best plan/model for the scenario.
• Man-overboard awareness;
  ◦ What are the technologies used to detect if someone goes overboard?
• Using technological advances in ocean current detection to predict the location of a lost life boat or personnel.
**Arctic IoNS Breakout Group 2: Improving medical preparedness and response with rescue and recovery in an Arctic region MRO.**

**Facilitators:** Dr. Ioannis Kakadiaris, University of Houston, and Dr. Douglas Causey, ADAC

**Note taker:** Mr. Kyle Alvarado, UAA

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**Reflections of the breakout group on the task:**

Breakout group #2 discussions were devoted to comprehensively understand facets of medical preparedness and response, rescue and recovery, oriented to the Arctic IoNS workshop scenario. These understandings are best described by viewing a Major Response Operation in “stages.” Stages included viewing the spectrum of preparedness and response beginning prior to passengers and crew commencing a voyage across the Arctic; to evacuation from a ship following a major vessel disabling event; to survival of passengers and crew after evacuation and prior to responders arriving; to the appearance of rescue forces (removing victims from hazards); to staging those rescued from on-scene location to definitive recovery/permanent safety. The following describes the group’s analysis.

The purpose was to identify gaps and areas to be resolved and to address problems not answered yet. Currently, there are gaps in knowledge, technology, policy, acquisition, regulations, and training. Those affected by disaster include travelers, providers (cruise lines), emergency response agencies, affected communities in the vicinity of the response, and an array of supporting entities.

Research leads to development which increase capabilities and ultimately can and will save lives. Success is generally not reliant on our capabilities, but on standing relationships and collaborations. This is in effect known as the “science of logistics.”

In order to clearly understand the gaps and seams, it is important to view what would become a major search, rescue and recovery via a series of phases or stages. Accordingly, the such a major response mission is viewed as five distinct stages.

The first stage is “prior to the voyage.” Preparations to cope with and acquiring necessary data to support search and rescue...happen before and during initial embarkation. Elderly or infirm passengers with complex or preexisting medical problems need time and effort for extra preparation, and potentially be provided extra considerations.

For example, support staff offering assistance to the elderly during cruise may be useful during evacuation or survival. Training passengers in awareness of their emergency locations can be done by incentivizing the effort to find muster stations or know where safety equipment is located aboard ship. Rewards can also be given to incentivize successful training.

Quarantine capabilities on the ship should be established in case of an illness break.

Specific evacuation equipment for vulnerable population needs to be identified. Adapting to a mass rescue to the Arctic environment should also be done beforehand using existing methods. Crews must be able to delegate what is needed and where. Bracelet technology can be useful to sense health status of passengers.
As presented in Arctic IoNS “Day 1 Plenary panels, elderly and/or infirm with complicated medical problems could pose a challenge, perhaps significant challenge when evacuating ship.

The use of bracelet technology systems as described in Arctic IoNS breakout group, provides the ability to view and keep track of the health status of passengers, which may give insight on a passenger’s injury.

Arctic IoNS Workshop Question #5: “Can pre-existing medical data (mindful of U.S. and Canada’s federal statutes in patient privacy protections) be incorporated into passenger and crew personal accountability systems?”

The second stage is evacuation. Location matters when evacuating. As discussed previously in the report, ship board evacuation systems which result in crew and passengers departing ship decks to Inflated rafts do not function well in high winds and rough waters. Mobility challenged passengers, which may include the aged and infirm, may simply not be capable to safely egress a disabled ship, using current egress systems. Specialized equipment tailored for mobility challenged passengers may simply not be swift enough to enable debarkation fast enough in an emergency to a rescue vessel with considerably less freeboard.

Arctic IoNS Workshop Question #6: “What new or alternative evacuation and rescue capabilities or technologies are needed to enhance safe personnel transfer, including mobility challenged passengers and crews, from a casualty to a rescue vessel of differing freeboard, and then from an evacuation craft (life raft or lifeboat) to a temporary place of safety (i.e. larger vessel).”

The above question needs to fully account for research already conducted by existing egress research, particularly at Canada’s National Research Centre and Memorial University at St John’s Newfoundland and Texas A&M University’s Mary Kay O’Conner Safety Center.

A subset of this question include the need to account for a rapid egress of mobility-challenged passengers and crew in the case of a quickly foundering vessel.

The medical infrastructure across the North American Arctic is sparse, particularly across Canada’s High North. Accordingly, leveraging remote/telemedicine can “virtually” extend the size and scope of on scene staff. However, effectiveness of telemedicine relies on effective communications, in particular, communications that provide a visual component.
**Arctic IoNS Workshop Question #7:** “What unique communications requirements are necessary to enable telemedicine in support of a major response operation, accounting for known communication conditions in remote and austere Arctic locations?”

Domain awareness measures for cruise ships to understand locations for safe refuge, in the wake of a ship disabling event. For example, it may be useful to seek to intentional ground a vessel, to enable passengers can shelter in-place/remain on ship without being exposed to the Arctic environment, while also reducing risk in foundering at sea. Accordingly, an “on-demand” bathymetry capability may prove critical for vessel captains and/or rescue/response forces. The associated research question will be presented in (combination with other facets) in breakout group #3.

**Stage three is survival.** Timing, planning, and staging are much more significant for Arctic region than other rescue and recovery.

Gaining medical treatment as soon as possible following injury or exposure is crucial and is the difference between survival or not. Necessary shelter or equipment include; thermal protection, ability to generate heat, and energy conserving techniques. Once the cruise ship has been evacuated, the lifeboats are generally the most secure shelter passengers and crew will occupy until met by rescue and recovery forces. As presented during the Arctic IoNS “Day 1” Plenary session, lifeboat insulation is an under-researched component of safety equipment. Accordingly, conducting research to understand what a minimum lifeboat thermal-protection requirement is important to acquire in Arctic maritime conditions.

**Arctic IoNS Workshop Question #8:** “What thermal protection requirements are necessary for survival craft and personal protective equipment (what, who, where, when) to adequately preserve and protect occupants in an Arctic maritime environment?”

Similar to Arctic IoNS workshop question #6, accounting for research conducted or underway at academic or industry research is a vital pre-condition to address this question.

**Stage four is the rescue.** This involves rescue and response forces making contact with passengers and crews, administering first aide, relocating to initial safe zones, and stabilizing the situation as much as possible. If communications and technology permit, leveraging telemedicine to improve outcomes and increase survival time before reaching primary-care facility is likely warranted.

Since time after injury may determine the survival of a passenger, mobile medical care may be an imperative part of rescue and staging (as opposed to the transport of injured passengers to a primary-care medical facility).

What if the disaster was intentional (perhaps caused by a passenger or crew member)? In essence, there is a potential a major response operation could also be a significant crime or terror/security event. Accordingly, it may be useful for rescue teams to be equipped to potentially cope with terror and crime type events.

A consideration should be provided for rescue responders who may injured and needing medical care.

Further considerations should be made to
prepare, maintain deliver and recover logistics and life support capabilities to stabilize a large scale mass rescue operation in the Arctic.

The fifth and final stage is the “staging.” This is the least known and least researched for mass rescue groups. The primary gap is lack of infrastructure and resources. Resources do not exist on sight. Resources are necessary for a staging area so crews must resupply after leaving. Prepare resources without losing it to community or animal “theft.”

Success in staging is impacted by local domain awareness. Understanding geography, fresh water sources, shelter capabilities, topography, exposure to wind, weather and waves and onward evacuation capability are important. Having “on-demand” localized domain awareness with user defined factors may be pivotal for success or failure in shelter selection following ship evacuation.

**Arctic IoNS Workshop Question #9** “How can “on-demand,” “local/localized” domain awareness be achieved (via user defined parameters) and what kind of technologies can best support localized domain awareness in austere Arctic environments?”

There are potentially local citizen considerations to “staging.” Consider bringing hundreds of ill passengers into a village/community who do not have appropriate immunity? What if the community gets sick after cruise passengers leave? In order to mitigate consider a portable building for quarantine or other medical use. Certainly each nation and likely native/first nation corporations will wish to exercise appropriate authority. Could funding present a problem for tertiary medical care?

In the likely case of population overload, it may be necessary to seek out private sectors for additional help. Wi-Fi usage by mass number passengers in small communities will lead to quick depletion of data. Communities are not ready logistical demands from mass rescue operation involving a couple of thousand people.

Many fundamental gaps (but most are logistically oriented) are found in the staging phase, in view of the magnitude of passengers that need support from a clear lack of infrastructure and resources.

In any case, there are various technological challenges to a major rescue operation in the Arctic, which include limited communications. It is important to note that communities in the vicinity of the crisis need to be prepared for to cope with the challenges a major response operation would create to local inhabitants.

How can we grasp these research opportunities? Recommendations from the breakout group on what are the proposed next steps for each opportunity.

The group envisions that the proposed research would lead to regulatory and/or procedural changes, where the regulatory piece would be covered by both the SOLAS (IMO) and Chicago Accord (ICAO) Agreements, resulting in changes to the IAMSAR (International Aeronautical Maritime Search and Rescue) Publications. When speaking from a larger voice, letters of support for changes in the Arctic would have more impact coming from the Arctic Council.

With that in mind, the EPPR (Emergency
Prevention Preparedness and Response
Working Group of the Arctic Council has in its mandate Search and Rescue. Specifically, this group focusses on articles nine and ten of the Agreement, so the EPPR would be a natural entry point to the regulatory bodies governing the Arctic.

The current timelines for work within the EPPR work well with those planned for Arctic IoNS. Suggested POC is the US Chair of the EPPR, Amy Merten form NOAA. The panel believes that funding can be most expeditiously be provided by industry, as it is in their interest to understand the future of the Arctic business environment to be sustainable. Off Shore Oil & Gas and the AECO (Arctic Expeditionary Cruise Organization) would be two points of entry. Another source would be community partners such as the Nunavut Research Institute.

References
1. Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic.
2. Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic.
3. Nunavut Research Institute (NRI) Call for Proposals 2016-17

Arctic IoNS Breakout Group 3: Identifying and mitigating related/relevant hazards to Arctic Major Response Operations.

Facilitators: Dr. Andy Mahoney, UAF, and Ms. Amy Holman, NOAA

Note taker: Mr. Seth Campbell, Bethune-Cookman University

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**Reflections of the breakout group on the task.**

Breakout group #3 discussions were devoted to comprehensively understand facets of identifying and mitigating related/relevant hazards to Arctic Major Response Operations. Leveraging respective Arctic IoNS “Day 1” Plenary panels, the breakout group discerned compelling shortfalls in operationally precise weather, sea-floor bathymetry, sea-ice development, thickness and movement and associated hazards that impact commercial activities (such as the mishap cruise ship scenario) and rescue/response forces. The following describes the group’s analysis.

**Need to improve operational forecasts in the Arctic Domain.** An overall research question posed by the group: “How can we improve weather and sea ice forecasting tools to better serve operators?” As discussed by panelists in Arctic IoNS “Day 1” plenary session, weather and sea ice forecasting accuracy (while echelons better than previously), is not reliably precise, which in turn adds risk factors to operational decision making. Increased human activity, projected to continue to rise across the Arctic, (particularly in the maritime domain), warrants continued efforts to increase weather and sea ice forecast accuracy. Current efforts in research underway by ADAC in precision sea ice thickness and movement models and Arctic Information Fusion Capability (planned in close coordination with NOAA’s Arctic ERMA platform) will aid maritime decision makers as the research continues and concludes.

**Arctic IoNS Workshop Question #10** “How can we improve weather and sea ice forecasting tools to better serve operators?” What new innovative Arctic marine early warning system can be developed and cost effective? “What appropriate thresholds would have to be identified for these tools?”

An Arctic marine early warning system could identify hazardous combinations of weather and ice ahead of time based on the ship’s planned route. Even if existing models are not completely sufficient for early warning, information can still be gleaned from these existing models based on certain thresholds. These thresholds could be weather variables such as sea surface temperatures, ice coverage, and wind speeds and physical aspects of the ship such as tonnage and hull characteristics. These thresholds could be user-defined or thresholds could be observation-based similar to Canada’s Arctic Ice Regime Shipping System (AIRSS).

A product could be created that could automatically alert USCG based on these thresholds. Likewise, the USCG or other SAR operatives could track ships based on these
thresholds and anticipate when and where ships could be in a hazardous situation.

Weather conditions that forced previous ships off-course could be hind casted and used to advise ships to avoid or be aware of dangerous events.

Addressing the performance standards of safety equipment in the Arctic region. The second overall question asked by the breakout group was to determine “what is the performance of standard safety equipment in the Arctic” (with specific reference made to the particular safety equipment placed aboard the Motor Vessel Crystal Serenity for the summer 2016 Northwest Passage voyage)? As discussed by panelists in Arctic IoNS “Day 1” plenary session items such as lifeboats, shipboard egress systems, emergency equipment and logistics, etc. may be insufficient to cope with the Arctic maritime conditions.

**Arctic IoNS Workshop Question #11: “What is the practically needed performance of standard safety equipment in the Arctic?”**

Specifically, in terms of cruise ship equipment standards for U.S. (and Canadian) Arctic waters, the purpose of this research question will be to analyze:

- What cruise ship safety/emergency equipment is available?
- What are its limits?
- What are the expected operating conditions, and are these expected conditions sufficient?
- Is the equipment and crew training to use that equipment performing as expected in a cruise ship Major Rescue Operation?
- What is the probability of the environment exceeding safety equipment thresholds such as high seas, temperatures or wind?

The Arctic IoNS breakout group #3 assumes the average/median age of Arctic adventure cruises will be senior citizens. The associated logic, is factored on the length of time and costs involved, which generally will preclude many/most working age adults. In an emergency situation aboard ship and at sea, if the crew is not present (admittedly not likely, but there are recorded examples where crews have failed to respond adequately in an emergency at sea), there is uncertainty as to whether or not the average Arctic adventure cruise passenger would be able to use the safety equipment in rough weather/heavy seas, etc.

Even if passengers were able to use the
equipment, there is uncertainty as to whether the safety equipment will perform as expected under Arctic conditions. Although most cruise ships are likely to operate in the summer months (i.e., when weather is more favorable) there are still questions about the efficacy of the equipment.

Need to improve awareness and understanding of nearshore bathymetry across the Arctic (in particular, the North American Arctic). As described at length in Arctic IoNS Plenary Research Panel #5, the North American Arctic seafloor (in particular, Canada’s High North maritime reaches) is insufficiently mapped.

Compounding this insufficient nearshore bathymetry is lacking tide table information. Until nearshore bathymetry awareness improves, risks of accidental groundings remain. Accordingly, the likelihood of groundings will increase as more cruise ships ply Arctic waters, seeking points of interest in the nearshore environments. Lastly, knowledge of suitable grounding locations may actually be warranted by a foundering ship.

**Arctic IoNS Workshop Question #12** “How can we improve awareness and understanding of nearshore bathymetry across the Arctic (in particular, the North American Arctic)?”

The purpose of this research question will be to analyze:

- What is considered nearshore?
- What quality data do operations need?
- How can we get nearshore bathymetry on demand?
- How can we reduce the time and cost of collecting bathymetry in the Arctic?
- How can “on-demand” bathymetry be used to safely ground a foundering ship, for refuge, allowing shelter in place aboard ship for passengers and for the ship’s crew?

The Arctic IoNS breakout group #3 believes it is hard to define what nearshore bathymetry is. For example, is such bathymetry defined on depth or on proximity to the shoreline? Particularly, in the Arctic, very shallow water can extend offshore for several miles. One suggestion was defining nearshore as within 6 miles of land. Another suggestion was to define nearshore as depth-based.

In any case, a significant concern was how to obtain reliable, cost-effective bathymetry data. Some suggestions included using Remotely Piloted Aircraft (RPA) and radar satellite (in particular, Low Earth Orbit Synthetic Aperture Radar) and wave analysis based on satellite imaging. Depending on their characteristics, waves will break at a certain depth due to shoaling (reduction of water depth). This may be the most cost-effective approach to operationally defining near-shore bathymetry, but wave data is needed.

Shallower shoals might be identifiable by visual examination of satellite imagery. Water condensation and freeze associated with Arctic maritime aviation weather might render RPA sensing unfeasible. The Arctic IoNS breakout group #3 believes bathymetry data should be available prior to an Arctic region maritime MRO. If it’s not possible, then it should be available on quick demand. Nearshore Bathymetry is critical for identifying ports of refuge for lifeboats, hence the discussion about what constitutes nearshore bathymetry. Ports of refuge
should be identified before a MRO occurs.

In addition to the research questions above, several other knowledge gaps and observations were identified:

- Current weather and sea state models don’t provide rescuers with adequate granularity/precision needed for operations and operational decision making.
- Observations for validation of Wavewatch III and other new weather models are necessary.
- Observations to improve circulation hind cast and forecast models in the Beaufort basin are needed.
- The ability to forecast fog and visibility would help mitigate environmental hazards.
- More Information is needed on the following characteristics of sea ice:
  - Sea ice forecasting (to include near shore/shore fast ice formation).
  - Sea ice thickness and probability of strength.
  - Sea ice absence and presence.
  - Time of sea ice freeze-up and associated reliable indications of sea-ice freeze-up.
- Model outputs and uncertainties must be presented in a way that is clearly communicable and understandable.
- Ports of refuge in the Beaufort Sea should be identified.

The Arctic IoNS breakout group #3, concluded the primary points of reflection centered on the need to reduce uncertainty, whether in modeling, ability to land helicopters on sea ice, and many/most other aspects of accounting for weather and bathymetric impacts to conducting rescue and recovery in a major response operation.

The three discerned research questions and subsequent views were pulled from a reflection of the gaps and shortfalls based on the workshop literature review, the prior day’s plenary session and team member’s background and experience.

### Arctic IoNS Breakout Group 4: Advancing Arctic region rescue response coordination, awareness, and communications

**Facilitators:** Dr. Lil Alessa, University of Idaho and Dr. Dennis Egan, Rutgers University

**Note taker:** Mr. Leif Hammes, UAA

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Reflections of the breakout group on the task.

Breakout group #4 discussions were devoted to the levels of communication as information flows both up and down a chain of coordination or command as well as laterally between operators during a response operation. Broadly defined for discussion purposes, there are three echelons/levels of communication and response that were considered by the group in discerning follow-on challenges in rescue and recovery coordination:

- Tactical: on-scene coordinators and/or the first responders reacting to a situation.
- Operational: coordination, command and control level coordinating the response effort. In the case of a Canada-U.S. combined response to an Arctic region major maritime response operation, this would likely comprise facets of each nation’s Coast Guard, Armed Forces, and associated inter-ministerial/inter-agency, in both regional and functional communities. Rescue, recovery, medical, environmental, logistical, transportation, etc.
- Strategic: responsible for policy and overall response effort at the province, state or national level.

The breakout group sought to understand the mechanics and approaches in coordinating the emergency response between response agencies envisioned to participate in the workshop scenario. This included establishing the current reference baseline flow of existing communications, information flow, and capacity, etc., at the tactical, operational, and strategic levels. In the Arctic this baseline should be considered across the Canada-U.S. capacity as assets are often shared.

The following describes the group’s analysis.

Shared situational awareness, accounting for an array of factors and assumptions. A disabled cruise ship in the North American Arctic region, will quickly gain the attention...
across Canada and the United States, out of a concern for the passengers, crew and environment. Accordingly, it is reasonable to assume that both national governments in Ottawa and Washington will wish to reflect urgency in response and lead proactively to marshal rescue and response activities.

As described in Arctic IoNS “Day 1” Plenary, creating SSA tailored to the response, involves gaining access to an array of data from multiple sources, leveraged through appropriately conducted through information technology to serve multiple customers. SSA needs to accommodate the entirety of range of data associated with the emergency and response.

The breakout team discerned that SSA with local context “accounted for” is often useful and may even be required for the information to be optimally actionable. Accordingly, data for SSA should include that from formally and informally aligned Community Based Observing Networks (CBONS) that currently exist in both Canada and the U.S. In a coastal region, CBONS may represent the first eyes and ears on the ground in areas where alerts and responses can be delayed.

Gaining SSA should be a synthesis as much of the work already exists, and account for the need to tailor/view SSA based on each user’s defined operational/response needs and consider the uniqueness of the rescue and recovery environment of the Arctic (which includes the austerity for communications as described earlier in this report). There is a tendency to have a one size fits all approach to data sharing etc., but organizations inevitably want/need different data, and have different uses for data. The complexity grows as the situation becomes more complicated.

As discussed previously within the challenging communications environment in the Arctic, Data needs to be intelligently prioritized for rescue and recovery forces and their echelons of command and coordination centers directing their actions. On-scene in the maritime or coastal environments, rescue and recovery data will have to account for the communications austerity associated with the region. In order to meet the needs of SSA, gaining the kinds of communications capabilities to move information which is capable of conveying detailed instructions and contexts to an operator who may be under duress.

For the Arctic IoNS scenario, it is a useful planning assumption to consider “on-scene” coordination will grow as the recovery commences, continues and concludes and likely, the complexity of the on-scene communications to support SSA will evolve accordingly.

**Arctic IoNS Workshop Question #13:** “How do assumptions of human reactions in crisis response compare to actuality? “What reasonable assumptions of human reactions can be incorporated into crisis mitigation strategies?”

Supporting context:

- Irrational decisions are often made during a crisis human response can be predicated on perceived risk rather than actual risk.
- Current models and response protocols in the Canadian and U.S. “first responder” community are based on assumptions of standardized behaviors which may
mean that they may not be as effective as they could become.

**Arctic IoNS Workshop Question #14:** “What are the optimal scales of data flow, data types, and data conversion capabilities at each level (tactical, operational, and strategic) needed to respond to a major response operation corresponding to a disabled cruise-ship in Arctic waters?”

Subsets of this question would include:

- Is there ubiquitous data for an operation? In other words, what key information for SSA are consistent across different types of Search & Rescue, Humanitarian Assistance and Disaster Response (SAR, HA and DR)?
- With the different types of data, is there an optimal standard, and a way to convert from one set to another fast and easily.

Supporting elements include the ability to appropriately manipulate data to allow a common set of data (such as a field report) to flow through and be managed through different data management protocols, without necessarily corrupting a report’s original format. Such an approach would have applications well beyond the Arctic IoNS workshop. As relating to the scenario, the breakout group generally agreed that there is no need to necessarily develop a “one size fits all” approach or one data set standard or a “portal of portals” construct.

**Arctic IoNS Workshop Question #15:** “How can non-government employed citizens (“in place” or residence), in a coordinated fashion, be leveraged during and after a mass rescue operation?”

A subset of this question is: “how can local communities be best partnered with by government in order to provide SSA so as to leverage local and place based knowledge which consists of specific and unique knowledge and skill sets?”

A further subset is “how can academic researchers systemically contribute/volunteer data, models, experience, etc. to operators, in advance and during a crisis response?” During the oil disaster Deepwater Horizon/Macondo oil spill in the Gulf of Mexico in 2010 such research support was offered and used, albeit in an “adhoc” manner. In the Arctic, researchers may be the some of the only people to have visited remote Arctic locations they may have extremely useful knowledge that even local citizens don’t possess.

**Arctic IoNS Workshop Question #16:** “What is the best method to make available to planners and responders summaries and details of past rescue and recovery activities, lessons learned or strategies, for possible use in the Arctic and elsewhere?”

**Arctic IoNS Workshop Question #17:** “What measures are needed to advance crisis communications to support SAR, HA and DR. accounting for the unique challenges across the North American Arctic?”

Subsets of this question include researching utility of developing technologies, such as very small satellites (CubeSat’s), or adapting communications technologies developed for other purposes. As an example, (and presented in Arctic IoNS “Day 1” Plenary session) assessing the feasibility of prior government investments such as the former USAF High Frequency Active Aurora Research
Program (HAARP) located in interior Alaska to better enable HF communications may be a consideration.

**Arctic IoNS Workshop Question #18:** “What role can remotely-stationed, launched, piloted and recovered aircraft situated in austere locations can contribute towards improved rescue response efforts and SSA?”

Effecting coordination by launching small/affordable and long endurance remotely piloted aircraft in order to place cameras and sensors “on-scene” / when weather, distances or tasking’s may preclude launch of manned platforms. Such a capability (if research proved feasible, suitable and acceptable) may prove pivotal to rescue and recovery.

**Elaboration and discussion.**
Communications are needed by everyone, and leads to discussion of inter-operable systems both hardware (radios, frequencies, systems) and process (acronyms, procedures, etc.). There was a discussion of inter-operable systems between US-Canada-military-police/first responder communities, which exceeded the breakout team’s charge to address. The team investigated the current status of communications, the U.S. is using HF and VHF radios, with loss in the High North and often need to use relays, along with satellite (Iridium). Canada communications is generally based on a satellite network connectivity. There are opportunities for data sharing but these need to be clearly articulated.

Discussion of SSA at the tactical, operational, and strategic levels. Likely first responders to an incident will be locals, often training is for small scale events (i.e. clean seas for oil, village health aid for medical). Canadian participants briefed on the Canadian Ranger model. The need to explore a parallel model in the U.S. was emphasized.

The group also discussed the psychology of rescue: what are e.g., passengers’ and cruise ship industry’s assumption about rescue? How and when should the limitations of a rescue be discussed and, more importantly, built in to industry and technological procedures and products?

Shared response requires shared awareness information that is authoritative and trusted. Trust of data, observations, is more important than the amount. There is a need for a common place for diverse data and information to be accessed by user need because one size does not fit all.

Further emphasis was placed on the need to be critical and careful about “academic” data needs (e.g., for research) versus data needs that are essential to precise SAR operations.

What does data fusion look like? Currently, there is no agreed upon definition of what this means. The tactical level needs very little data and can become overwhelmed by too much. There is a timeliness/expiration to all the data also. There is a need to map out—who needs what and when. Does the fusion include; analysis, overlays, or can it be converted back and forth. Related to this, the group discussed user specified (i.e. ask a question) data vs the common operating picture where everyone has the same data and all the data.
Operators voiced concerns over reliability and time sensitivity. Also pointed out that simple user interfaces are important because often operators are working under duress. Information or interface cannot be too complicated. Related to this, there is a need for conversion tools from one system to another (i.e. csv to kml to shape file). Conversion tools may be more important than trying to make a one size fits all, however this is a more mechanical issue and not one that enters into the system approach(es) to shared situational awareness and response.

Human interpretation of data in the form of trusted eyes and ears on the ground is still a critical need: electronic and remote sensing can only do so much and, while some models can be good at predictions there are inaccuracies. Accordingly, how do we establish a network of human observers and data streams that fuse with data from other networks across the Arctic?

**Post Arctic IoNS workshop research questions from Headquarters U.S. Coast Guard.** Following review of the initial draft Arctic IoNS report, Headquarters USCG reflected the need to include an additional two questions to the report for research investigation consideration. These are:

**Arctic IoNS Workshop Question #19.** “What type of life saving appliances capable of recovering large numbers of persons (50-100), particularly in the Arctic environment, can be developed? The general approach is an easily deployable, air-dropped device to evacuate personnel from a stricken vessel, and the device should provide a safe place of refuge for at least 24 hours.”

**Arctic IoNS Workshop Question #20.** “For the Arctic region where infrastructure may be limited to non-existent, what are the system options for sustaining both evacuees and first responders in the short term (0 – 72 hours) during a Mass Rescue Operation (MRO)? What are the system options for sustainment over a 3 – 4-month timeframe if the MRO grows into a salvage, recovery, and environmental response operation?”

Such a system should include a testing regime to determine the extended sustainment capability over a 2 -3 weeks to understand and verify capabilities, Concept of Operations, and logistics involved.”

**Conclusions and way forward from the inaugural ADAC hosted Arctic IoNS workshop.**

The inaugural Arctic IoNS workshop was fortunate to gain the needed ingredients required to substantially advance Canada and U.S. intellectual investments in addressing needed science and technologies and possible first responders in Arctic communities.
for a crisis scenario in the High North. The workshop planners believe the research questions developed by the select team of operators and researchers will support preparation and response to prevent and mitigate what could be a catastrophic outcome if the fictitious cruise ship disabling in the North American Arctic where to actually occur.

An important lesson learned by the center, was the success of leveraging university student researchers in mining the international body of published journal articles to discover prior research and the researchers themselves to participate with current operational leaders in the inaugural Arctic IoNS workshop. Without such a diligent effort in determining the body of research most applicable to the “Operator determined themes,” the investigation and questions for follow-on research would have been far less insightful and ultimately useful.

The members of the ADAC team salute the remarkable participation from the Government of Canada and the participating members of Canada’s academic community. A major response operation in the North American Arctic would almost inevitably invest search, rescue, recovery, medical, transportation, logistics, communications and the need for close coordination between Ottawa and Washington, and a workshop such as the one concluded in Anchorage on 22 June 2016, would have brought substantially less value without the committed and talented participation from Canada.

ADAC respectfully acknowledges as well, the array of invaluable contributions from the participating leadership and operationally savvy members from the U.S. Department of Homeland Security, USCG, other U.S. federal agencies and the State of Alaska. Priceless insights to describe relevant requirements and kinds of technologies needed to cope with the operational demands, truly did drive the academic response in needed research.

Lastly, Center leadership wishes to acknowledge fellow academic and industry researchers for their willingness to participate in this initial Arctic IoNS event. Without the skillful insights, by these expert Arctic and operationally useful researchers, there would have been no appropriate academic baseline to present.

![Evening discussions after dinner.](image)

It is the conclusion of ADAC, the first IoNS conference was timely, substantial, authoritative, and potentially transformational. The presentations and baseline understandings showed superb understanding as to current capabilities, and many research reflections revealed superior insight. The results of the second day of working groups helped identify the gaps and lapses in knowledge—some of was surprising to the center, simply based on prior assumptions problems had been identified earlier and the solutions now common practice. For example, to learn that lifeboats aboard ship may not be suitably insulated to cope with Arctic ocean temperatures or that
the issues of mustering and identification of passenger are mostly unresolved is surprising.

The potential for research relevant to prepare and respond to such a potential Arctic emergency coming from academics may unprecedented. The 20 research questions that the Arctic IoNS Working Groups identified are each critical, actionable, and potentially decisive. Successfully addressing these will be important in helping structure how Major Rescue and Response providers (US & Canada Coast Guard, local medical and community assets), industry, and support agencies should integrate.

This rapporteur’s report will accompany an ADAC released formal Request for Proposal, to compete U.S. government resources to pursue for the needed onward investigations.

Finally, ADAC leadership acknowledges the center’s plan to conduct these Arctic IoNS workshops on an approximately annual basis, and plans as well to host Arctic-focused Medium and Long Term Environment (MaLTE) “futures” workshops. The Arctic IoNS and MaLTE events are planned to be off-set from each other by an approximately 6-month window.

ADAC wishes to close with our commitment to work with dedication and commitment to realize the investment of all who participated in the inaugural Arctic IoNS workshop to gain needed future capabilities to save lives if such a mishap as described in the scenario were to occur.