SAND2017-7542C

Small Vessel Smuggling of Nuclear and Radiological Material: Innovative Monitoring Approaches for Emerging Maritime Security Threat in the Indian Ocean Region

J. David Betsill
Global Center for Security and Cooperation
Cooperative Monitoring Center
Sandia National Laboratories

INMM Annual Meeting
July 16, 2017

Sandia National Laboratories is a multiprogram Federally Funded Research and Development Center laboratory operated for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. With main facilities in Albuquerque, N.M., and Livermore, Calif., Sandia has major R&D responsibilities in national security, energy and environmental technologies, and economic competitiveness.

The Sandia Center for Global Security and Cooperation – CGSC

We seek a SAFE, SECURE WORLD

through Global Technical Engagement

RESEARCH, DEVELOP, & APPLY Innovative SCIENCE & ENGINEERING SOLUTIONS

to strengthen nonproliferation and reduce global threats

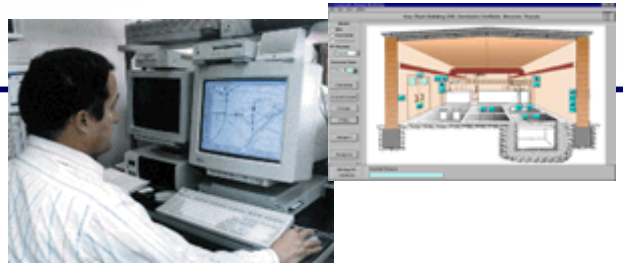
ENDURING PARTNERSHIPS

POLICY ENGAGEMENT

SYSTEM SOLUTIONS

Integrated System Approach Applied to Cooperative Security Issues

System analysis, modeling, and simulation for design and evaluation



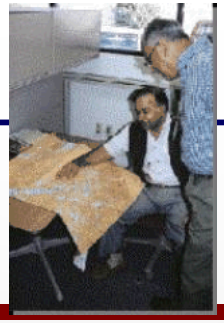
Technology integration, testing, demonstration, and operation

Technology training courses and workshops

Over 100 engagements from 120 countries

Technical collaborations and experiments

Visiting scholars program, research and analysis



Global security & threat analysis

Cooperative Monitoring Center

CMC – Achieving International Security Through Technical Collaboration Since 1994

- Address Global Security Concerns & WMD proliferation
  - Nuclear, Chemical, Biological
- Support arms control efforts
- Foster regional stability
  - Forum for technology solutions
  - Enhancing traditional and nontraditional security
- Focus on emerging security concerns
  - Radiological threats
  - Border and maritime security
  - High consequence pathogens and toxins

- Draw upon extensive laboratory background in technology development, systems engineering, and technical support
- Foster technical engagements and integration of commercially available hardware and software

CMC's Internationally Recognized Visiting Research Scholars Program

- Novel Approach to Analyze & Research Issues
- Develop Potential Techno-Policy Solutions
- In Collaboration with Sandia SMEs

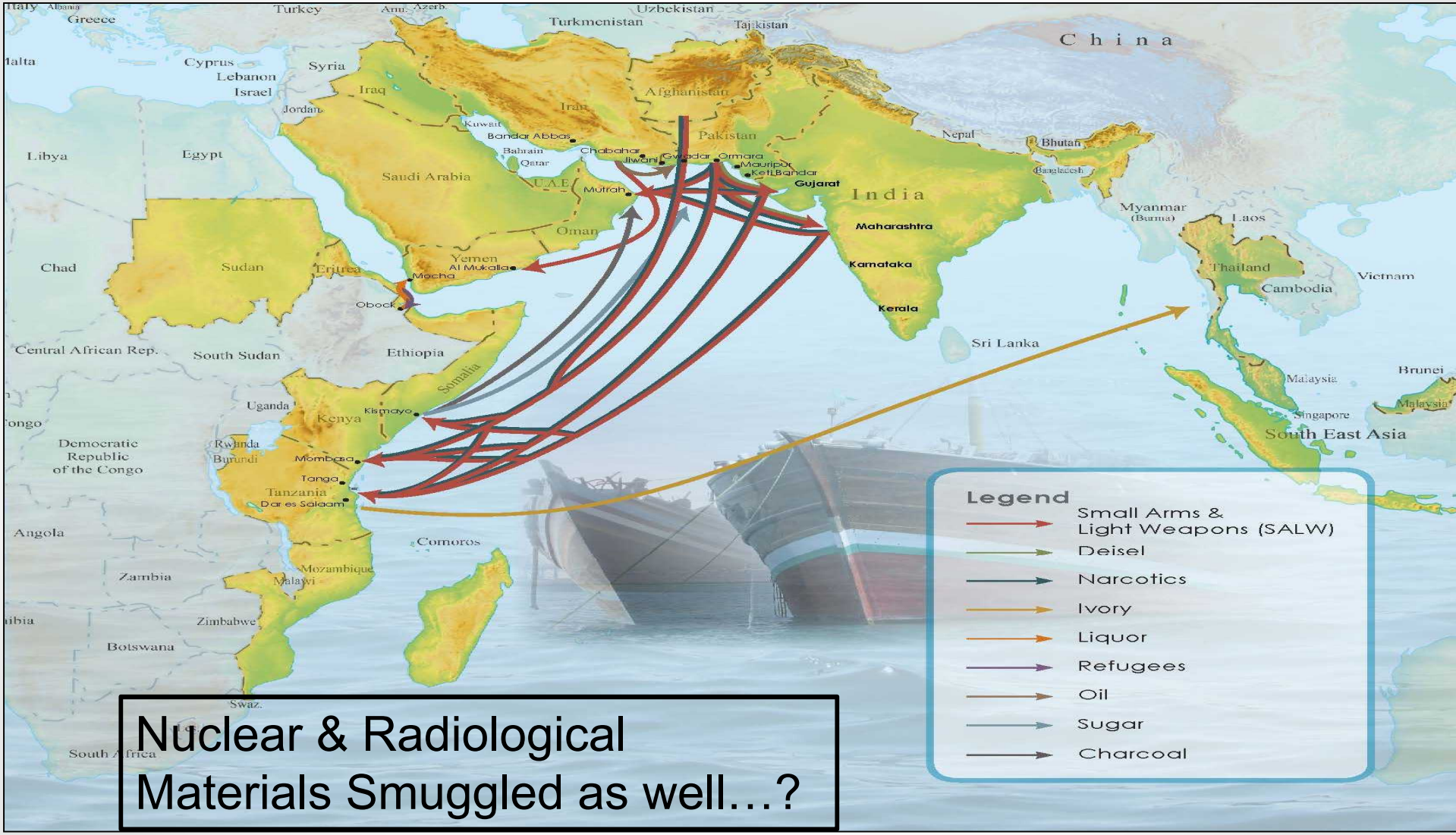
- South Asia Examples:
  - India-Pakistan Nuclear Accidents Agreement Reducing Risk Related to Nuclear Weapons Accidents
  - Pakistan and India Rear Admirals identify ideas for naval cooperation, Coast Guard interactions, fishing buffer zones, border definition, shipping and trade
  - Nuclear Terrorism in South Asia – study of the character and extent of the threat of nuclear terrorism
  - Analyze the potential for smuggling nuclear and radiological material in the Indian Ocean Region and the potential link with terrorism

New Issue: Small Vessels & Ports

Illegal, Unreported or Unregulated (IUU)

- Transport & Commerce
  - Legitimate goods transport
  - Smuggled goods
  - Organized crime
  - Links with human & endangered species trafficking
  - Link with Terrorism
- Difficult to Detect & Monitor
  - Numerous minor coastal ports & areas
  - Dated or nonexistent monitoring, communication, & reporting technology in use
  - Prohibitive Equipment & operational costs
- *Concerns – Nuclear & Radiological*
  - Don't use container ships
  - Bypass portal monitors
  - Pirate-Terrorist-Criminal Collaborations

Historical & Current IOR Smuggling Routes



Nuclear & Radiological Materials Smuggled as well…?

Source: MU Khan, 2016, SAND2017-2902

International Task Forces, Efforts, and Organizations

- **Primary Focus on Anti-Piracy, Conventional Weapons, Drugs, People**
- **Efforts also to Address Nuclear & Radiological Smuggling**

- Combined Task Force 150
  - maritime security to counter terrorist acts and related illegal activities that terrorists may use to fund or conceal their activities
- Combined Task Force 151
  - Counter-piracy operations established in 2009
- EU Naval Task Force
  - Prevent and repress acts of piracy and armed robbery off the Somali coast
- NATO's Operation Shield
  - Works with other task forces to deter piracy

Sources: after Khan, 2016, SAND2016-6673 PE, French *Monmouth* seizes drugs in the Indian Ocean, French seize large weapons cache on ship headed for Somalia

Potential Responses: Small Vessel Smuggling Nuclear & Radiological Materials of Concern

- Technology
- Information
- Methods
- People

Considerations

- Stand-off distance
- Marine Environment
- Information Synthesis
- Implementation Feasibility

A few examples discussed:

- COTS
- Emerging Technologies
- Integrating Tech, Information, & People

Technical – Autonomous Surface Vehicle - ASV

C-Worker 7 is a multi-role offshore and coastal autonomous surface vehicle

Security & situational awareness, surveying and environmental monitoring

C-Enduro is a long-endurance autonomous surface vehicle

Energy Harvesting Technology
Self-righting Hulls
Diesel, Wind, Solar

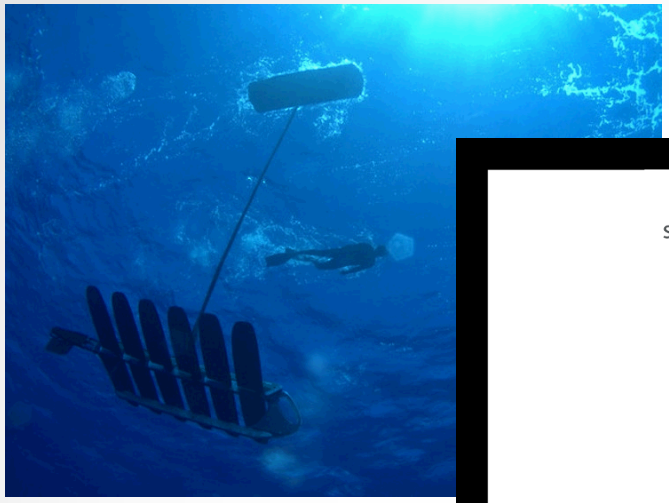
Sensor Options:

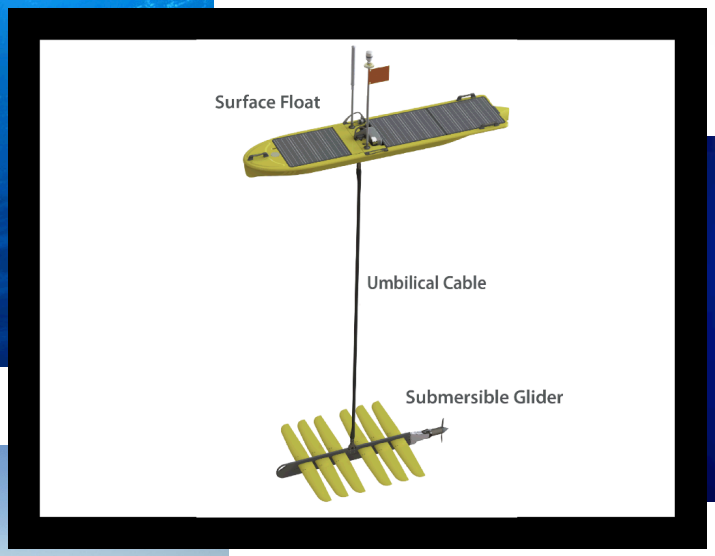
- Keel mounted or winch
- Current, Temperature, Depth
- Meteorological Sensors
- Acoustic Doppler Current Profiler
- Multi-beam Echo-sounder
- Side-scan Sonar
- Acoustic Modem
- Cameras & Imagers

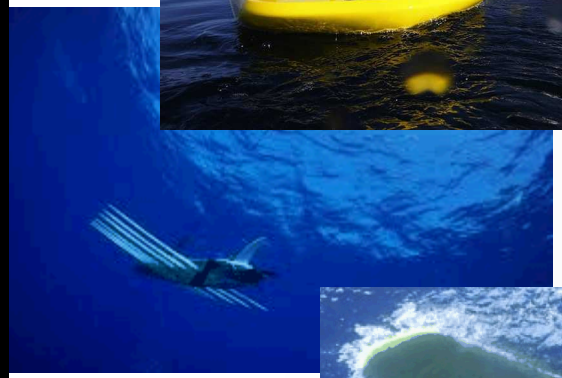
https://www.asvglobal.com/product/c-worker-7/

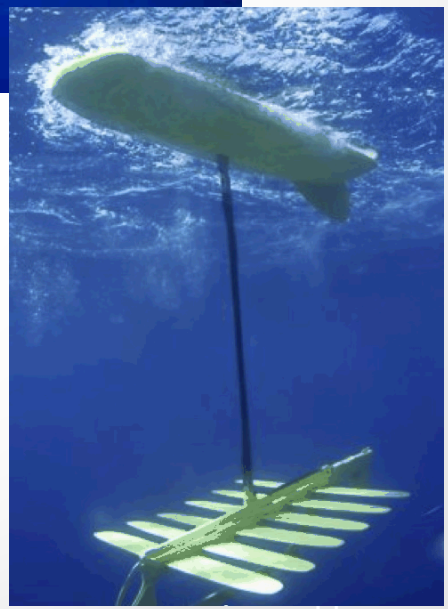
http://systems.fastwave.com.au/ocean-data-acquisition/asv/#C-Enduro

Technical – Near Surface ASV









Wave Glider

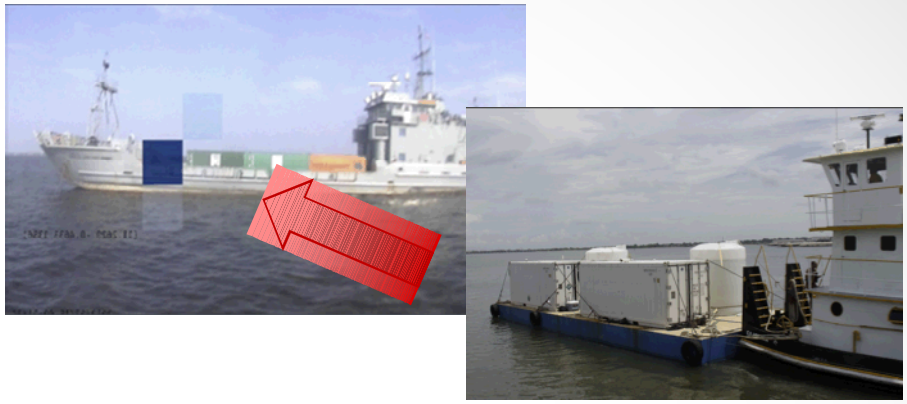
- Autonomous Unmanned Surface Vehicle
- Individual or in Fleets
- Real-time Data up to 1 Year
- Energy Harvesting – Wave & Solar
- Cameras & Sensors

https://www.liquid-robotics.com/platform/overview/

Technical – Surface Detection & Surveillance

SuperMISTI – Super Mobile Imaging and Spectroscopic Threat Identification System

SuperMISTI system uses the high-resolution spectra of high-purity germanium (HPGe) detectors to detect and identify gamma-ray sources as well as coded aperture technology and NaI detectors to image and localize the detected sources.



- Large gamma-ray imaging & spectroscopy system built for the Office of Naval Research (ONR) under the auspices of the Maritime Weapons of Mass Destruction (WMD) Detection program
- Detection & identification of special nuclear material from stand-off distances
- The detection system can be used both in passive detection mode and in active interrogation mode
- unambiguous isotope identification
- Imaging provides source location
- System fits in standard (ISO) 20-ft shipping container
- Active interrogation tests with distances up to a mile
- Passive Detection and imaging distance to source > 400 feet
- demonstrated in diverse range of on-water experiments in summer 2012

https://www.nrl.navy.mil/ssd/branches/7650/SuperMISTI

http://science.dodlive.mil/2014/01/31/detecting-underwater-weapons-of-mass-destruction/

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=8&cad=rja&uact=8&ved=0ahUKEwiqv4OW8oTVAhVk2oMKHaa6AxUQFgg9MAc&url=https%3A%2F%2Fwww.chds.us%2F%3Fserve%26dl%26f%3D%2Fresources%2Fjournal%2Fsupplement%2Fissue7%2Fpdfs%2Fsupplement.7.4.pdf&usg=AFQjCNGFDp3buvhT4ez3OQPnj2nyfLAVHQ

Technical – Underwater Unmanned Vehicles (UUV)

<u>BIOSwimmer</u> robotic fish

Biomimetic, autonomous underwater vehicle (B-AUV)
Highly maneuverable
Diverse applications - port security, inspection, maintenance

Boston Engineering, sponsored by DHS Science and Technology Directorate

http://auvac.org/people-organizations/view/344

<u>Evie</u> – Ellipsoidal Vehicle for Inspection and Exploration

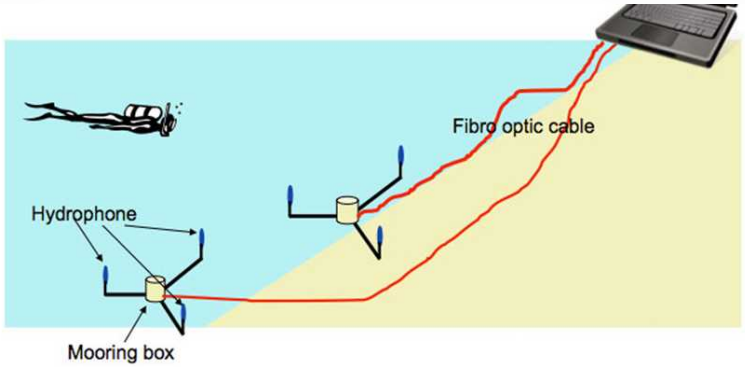
- football-sized
- still in testing phase
- ultrasound to find hollow areas for smuggled goods

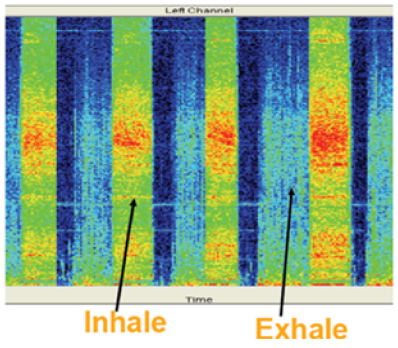
https://twitter.com/hydroswarm

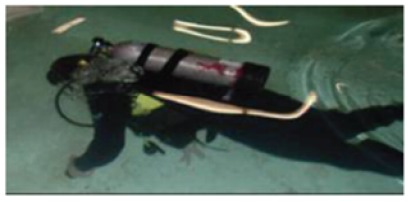
http://www.smithsonianmag.com/innovation/this-stealthy-robot-could-boost-security-at-our-ports-180952990/#EfVSVSXjXEttArkJ.99

Technical – Under Water

The Stevens Passive Acoustic Detection System







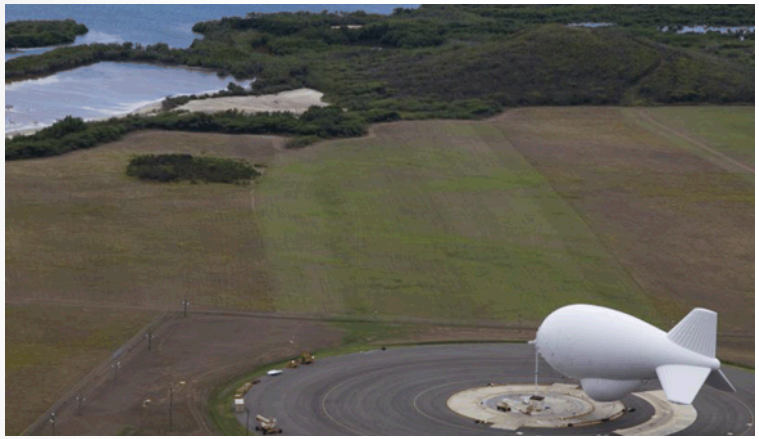
- Stevens Institute of Technology Maritime Security Center
- Homeland Security University Programs

- harbor and ship based security systems and monitoring
- advanced passive acoustics
- detect, track, and classify underwater sources of sound
- signatures of divers, boats, ships, submersible vehicles, construction equipment, and other vessels

(http://www.stevens.edu/msc)
https://www.hsuniversityprograms.org/technologies/passive-acoustics-detection/

Technical – In the Skies

Tethered Aerostat Radar System – TARS



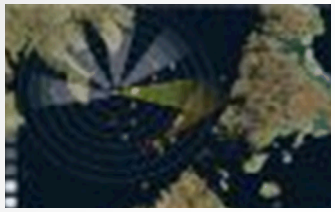
- Maritime Domain Awareness
  - Radar
  - Camera
- Moored to the ground with a nylon fiber cable
- Raised and lowered with powered winch

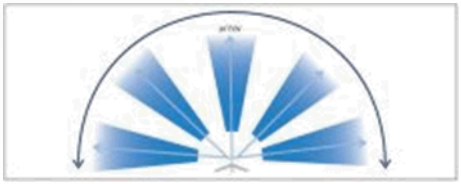
U.S. Customs and Border Protection

https://www.cbp.gov/frontline/frontline-november-aerostats

Technical – In the Skies

ViDAR Visual Detection and Ranging





ViDAR, developed by Sentient Vision Systems in Melbourne Australia, provides autonomous, real-time, wide-area search capability, optically, from unmanned aerial vehicles (UAVs) or manned aircraft. ViDAR acts as an optical radar, using high-megapixel video or infrared cameras to search the ocean over significantly greater operational coverage areas

- ViDAR consistently detects vessels, fishing buoys, rafts, and people in the water in a wide variety of weather and environmental conditions
- Scans over 1 mile ahead
- 20NM search swath
- high-resolution digital camera that continuously scans the ocean in a 180-degree arc in front of the air vehicle
- Software autonomously detects any object on the surface of the ocean and sends the ground control station real-time image and location coordinate of each object detected
- electro-optical (EO) and infrared (IR) aerial full motion video (FMV) from manned aircraft and UAVs

http://www.unmannedsystemstechnology.com/2017/07/sentient-vidar-demonstrated-european-maritime-surveillance-agencies/

http://www.techbriefs.com/component/content/article/ntb/features/application-briefs/26476

http://www.unmannedsystemstechnology.com/2017/07/sentient-vidar-demonstrated-european-maritime-surveillance-agencies/

Technical – In the Skies – UAVs

DroneRad Detector System FlyCam UAV Cypher 6 with DroneRad Sensor

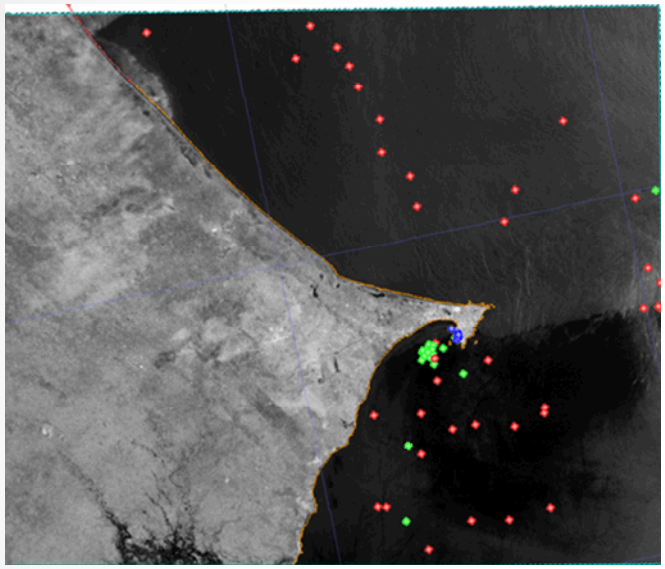
Dronemaker FlyCam UAV partnered with US Nuclear Corp. radiation detection company

- Radioactive Particulates
  - Alpha
  - Beta
  - Gamma
- Gas collection option
  - Chlorine
  - biological particulates
  - aerosols such as anthrax and nerve gas
- 10 lb. payload
- Real-time data acquisition

http://www.popsci.com/drone-company-puts-radiation-detectors-on-flying-robots
http://www.flycamuav.com/product/dronerad-detector-systems/
http://www.flycamuav.com/aerial-radiation-detection/

Technical – In the Skies – Satellites

Kongsberg Satellite Services AS (KSAT) – IUU Fisheries monitoring



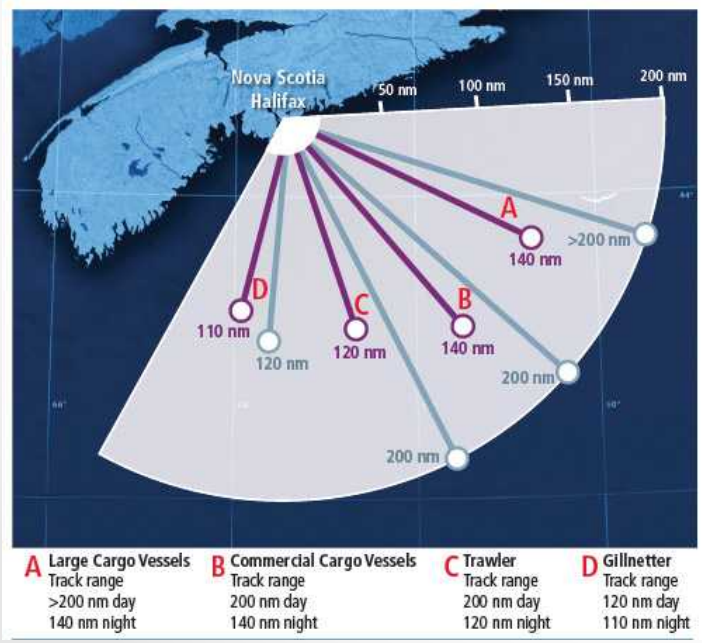
Vessels engaged in Illegal, Unreported and Unregulated (IUU) fishing, smuggling or trafficking of goods or people, or piracy can turn off or tamper with their transponders attempting to hide their behavior

- KSAT provides end-users with information on the location of vessels, position, speed, heading, and behavior fused with satellite images and other data sources
- Detect suspicious or anomalous signatures of vessels at sea
- Satellite Synthetic Aperture Radar (SAR)
- Used in combination with Automatic Identification System (AIS) data stream
- Match vessels in SAR satellite image with AIS
- Detect vessels that should be broadcasting an AIS signal
- Highlights non-reporting targets

Kongsberg Satellite Services AS (KSAT) is a commercial Norwegian enterprise providing ground station and earth observation services from polar orbiting satellites

http://www.ksat.no/en/services%20ksat/vessel%20detection%20service%20-%20page/#

Technical – Onshore Vessel Monitoring



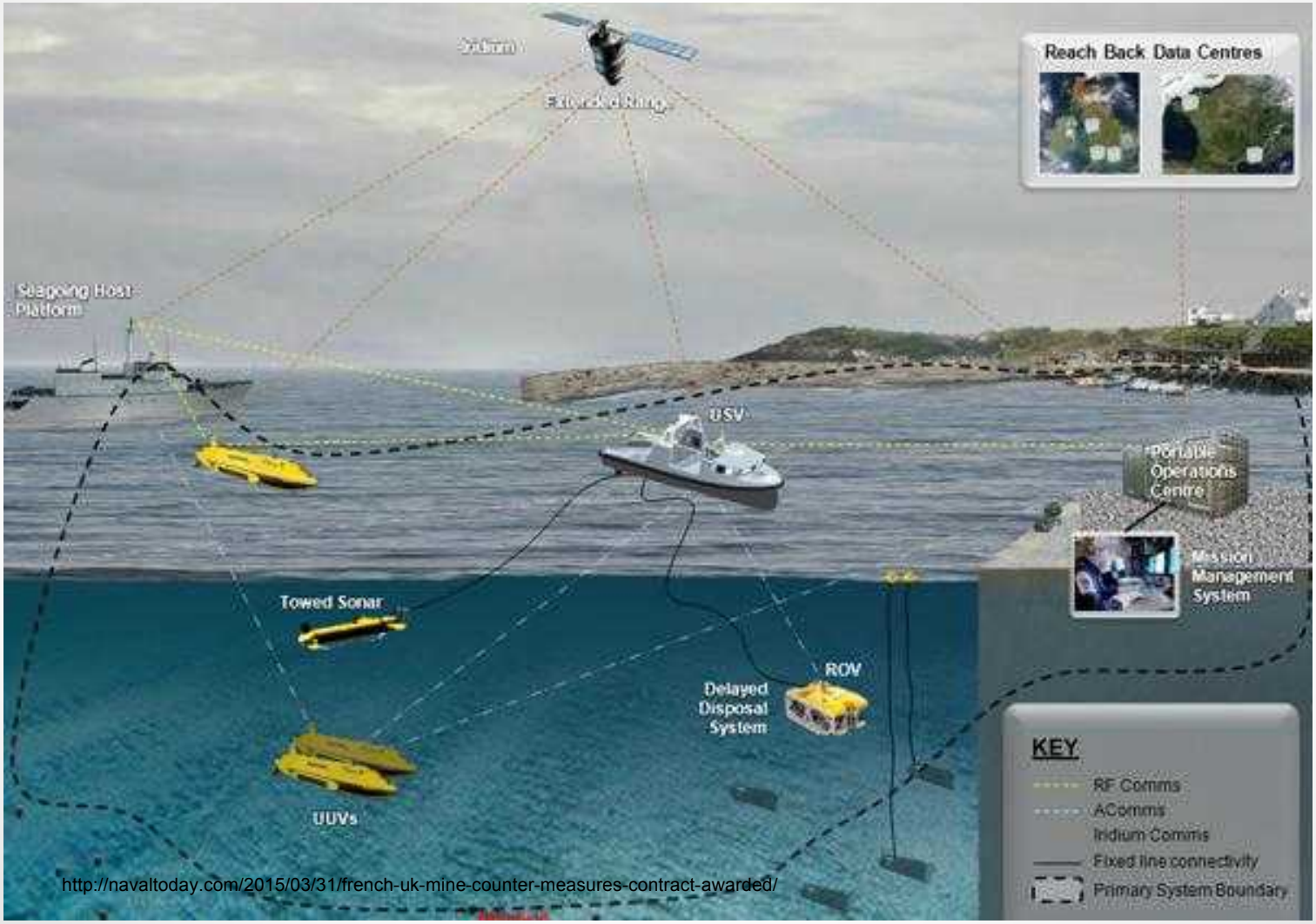
Raytheon's High Frequency Surface Wave Radar (HFSWR)

- surveillance of ship traffic
  - large expanses of marine protected areas
  - country's exclusive economic zone (EEZ) - 200 nautical miles
- track vessel patterns
  - potentially identify illegal or anomalous vessel activity

- unmanned shore-based radar system
  - detects & tracks vessels irregular or suspicious movement
  - Ideal for nations with limited resources and a large EEZ
  - manned patrols can be sent out only when necessary

RAYTHEON TECHNOLOGY TODAY, p. 26, ISSUE 2, 2012,
http://www.raytheon.com/news/technology_today/archive/2012_i2.pdf

Technical – Information Integration



http://navaltoday.com/2015/03/31/french-uk-mine-counter-measures-contract-awarded/

Technical – Information Integration

- Concurrent use of ground-based, maritime, aerial, satellite data and information provides a wealth of maritime domain awareness

  - **Systems Approach**
  - **Multidimensional**
  - **Integrated**
  - **Networked**
  - **“Big Data”**

Technical – Information & Integration

Global Fishing Watch – Global Vessel Monitoring & Tracking

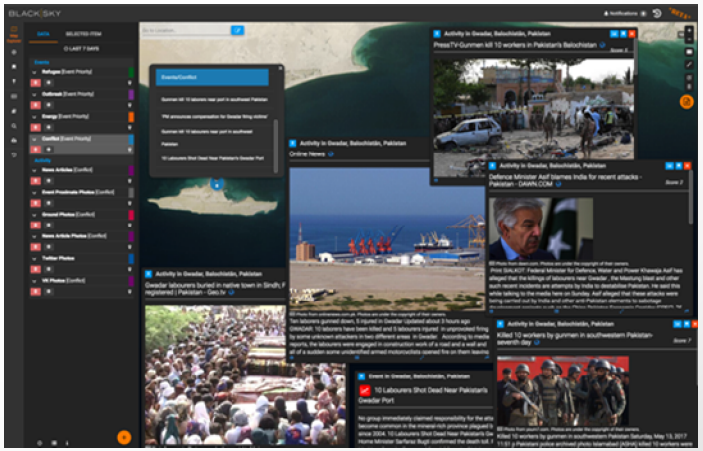
http://globalfishingwatch.org/map/

Technical – Big Data Information Integration

BlackSky – Global Information Platform

- Show events worldwide in the past 24 hours using thematic topics – Conflict, Energy, Natural Disaster, Outbreak, and Refugee
- Observations derived from local and regional news articles, photographs, and limited social media
- Events are automatically processed using high-volume data science and “big data” computing techniques, complex event stream processing, machine learning, natural language processing, machine translation, and geo-accuracy processing

- Combine maps, satellite images, event descriptions, and related photographs into a briefing-style snapshot view of a particular incident
- As new information arrives, the view is updated
- Gives a tailored Global Risk Dashboard of “situational awareness”



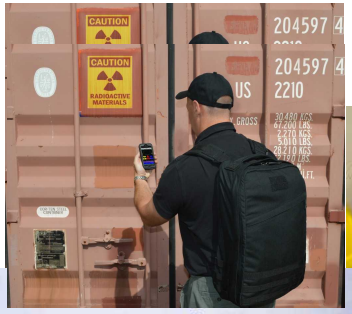
https://www.blacksky.com/2017/05/17/anatomy-of-an-alert-how-blacksky-monitors-events/

Methodologies – Resources & People Power

- Follow the money
  - Wildlife smuggling and trade
  - Fishery exploitation
  - Human trafficking
- Look for anomalies
  - "Dark" transport or fishing vessels
  - Unusual routings
  - Suspicious behavior
- Team with "nontraditional" maritime anti-smuggling entities
  - Fisheries
  - Wildlife
  - Environmental
- NGOs
  - Stimson – Secure Oceans
  - National Geographic – Pristine Seas
  - Global Fishing Watch

Methodologies – Resources & People Power

- LowTech
  - Color-coding fishing vessels
    - Port
    - Owner
- Incident Reporting
  - NATO Shipping Center
  - International Maritime Bureau
  - Community Waterways Watches
  - Disaster relief coordination organizations
- Higher Tech
  - Handheld & Backpackable radiation detectors for boarding parties
  - Mobile phone & Satphone



The Hindu, February 05, 2015

http://bubbletech.ca/product/flexspec-backpack/

Methodologies – People Power

The Maritime Security Centre – Horn of Africa

DISTRESS CALL | **MARLO / NATO / EUNAVFOR**

☎ : Royal Omani Police-Coast Guard - +968-2471-4888

☎ : Djibouti Coast Guard - + 253-2135-6298

☎ : Yemeni Rescue Coordination Center - +967-1344-671

☎ : Indian Coast Guard Rescue Centre - +91-22-24388065

VHF RADIO: **CH 16**

Report the following information:

Vessel NAME
1. Date & Time of Incident
2. Position
3. Course
4. Number of Persons Onboard
5. Contact Details *(Cell-Phone, INMARSAT, VHF)*
6. Vessel DESCRIPTION *(i.e. Colour, markings)*
7. Type of Incident *(Suspicious Approach, Attack)*
8. Number of Pirates
9. Pirate Weapons & Equipment *(i.e. Guns, RPG, Ladders)*
10. Pirate Craft Used *(i.e. Type, number)*
11. Owner Contact Details *(Name, Phone, Email)*
12. Next Port of Call

Guidance to Dhows

ENGLISH DHOW FLASHCARD TO PREVENT PIRACY

The Maritime Security Centre – Horn of Africa (MSCHOA.org)

Putting it all together – Small Ports & Vessels

- Is a challenging problem to address

- Technologies available to assist in detecting & deterring smuggling of nuclear and radioactive materials
- New technologies continuously emerging
- Integrated Systems Approach
- Takes money, cooperation, persistence, situational awareness, and Time

"Can you imagine this scenario?"

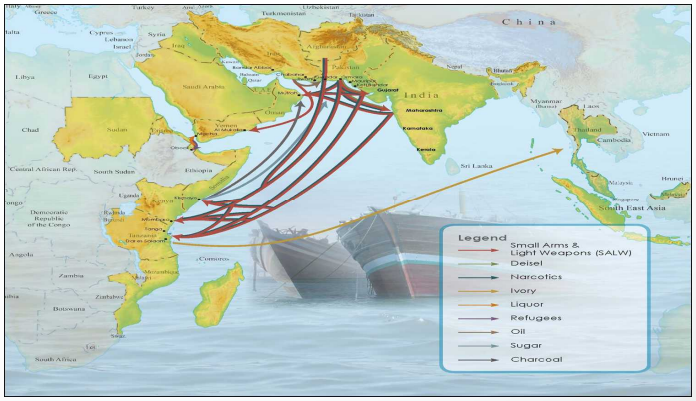
Putting it all together – Small Ports & Vessels

Implementation, Application, and Indigenous Ownership

- Discover the local community's concerns & how to integrate, serve, or solve problems
- Integrate approach with existing local issues – fishing rights, endangered species
- Involve local organizations, officials, NGOs
- Ask the local community for their solutions
- Encourage local and regional leadership
- Use appropriate and relevant technology
- Small Vessel Voluntary Reporting System
- Establish Maritime Risk Reduction Centers
- Use of Crisis/Crime Informatics Software
- Sustainability – Takes money, cooperation, persistence, situational awareness, and Time

Summary – Smuggling Nuclear or Radiological Materials

- Challenging Issue – Smuggling via Small, Unregulated Vessels & Ports
- Integrated Systems Approach Needed to Reduce Global Threats
- Must Involve Local & Regional Entities
- Takes Time & Resources



Caveats & Acknowledgments

- The technologies and methodologies described in this presentation are just a sampling of COTS and emerging approaches and are merely intended to give the viewer a sense of the depth and breadth of individual, integrated, and/or systems and approaches that could potentially be applied to address the issue of detecting, tracking, and identifying small, unregulated maritime vessels plausibly capable of smuggling nuclear or radiological materials in areas of concern

- *For illustrative purposes, only – Sandia does not endorse any technology, vendor, service, or company mentioned in this presentation*

Questions?

"Achieving International Security Through Technical Collaborations"