TNT Maritime Interdiction Experiments and Testbed

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In Cooperation with Dr. Dave Netzer, NPS
Dr. Arden Dougan and Dr. Bill Dunlop, LLNL
Network-Centric Maritime Radiation Awareness and Interdiction Experiments

**Objective**

Evaluate the use of networks, advanced sensors, and collaborative technology for rapid Maritime Interdiction Operations (MIO), Port Security, and Riverine Operations; e.g. for MIO, the ability for a Boarding Party to rapidly set-up ship-to-ship communications that permit them to search for radiation and explosive sources and collect biometrics while maintaining network connectivity with C2 organizations, and collaborating with remotely located sensor experts, coalition partners, and first responders.

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**Example Technologies**

- Innovative Wireless Networks and Sensors
- SATCOM on-the-Move and Orbital Ad-Hoc Networking
- Laser Communications
- Drive-by Radiation Detection
- Projectile-Based Wireless Links
- Networked USVs and UGVs
- Collaboration and Decision Making
- Situational Awareness
- IPv6
- Environmental Effects on Target Detection, Comms, and Plume Dispersion
- Forward Deployed Biometrics with Reach-Back

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![Network Diagram: MIO](image)

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![Network-Centric Maritime Radiation Awareness and Interdiction Experiments](image)
Background: TNT Experimentation and Testbed for Self-organizing Tactical Networking and Collaboration

with
Dr. David Netzer
Director, USSOCOM-NPS Field Experimentation Cooperative
# SOCOM - NPS
## Field Experimentation Cooperative

### Large Interdisciplinary NPS Team
- FY06: 28 Thesis Students
- 32 Faculty
- Includes 21 PhD, 4 PhD Students
- Course Projects: IS, OR, DA, MET
- 10 Departments and Institutes

### Programs Utilizing TNT Testbed
- DARPA HURT ACTD
- DARPA MAV ACTD
- USSOCOM Global Reach ACTD
- AFRL JASMAD
- MCWL Distributed Operations
- OSD/HD MDA

### Participating Universities
- Virginia Tech
- University of Florida
- WVUF
- Nat. Univ. Singapore/DSTA
- Swedish Naval Warfare Ctr
- Univ. of Bundeswehr
- Case
- MIIS
- NDU
- MIT
- Salzburg Research

### Foreign Country Participation in MIO
- Austria (08)
- Germany
- Singapore
- Sweden
- Australia (08)
- Canada (08)
- Denmark (08)
- UK (08)

### Broad DoD and Gov’t. Participation and Support
- USSOCOM
- USASOC
- AFSOC
- NAVSOC
- JSOC

### Participating DoD and U.S. Gov’t.
- AFRL
- DARPA
- LLNL
- NSA NTIO
- ONR
- SPAWAR
- ARL
- OSD-RTO
- USASMDC
- USMC-MCTSSA
- NSWC-Dahlgren
- TSWG
- BFC
- DTRA
- MARAD
- NRL
- ONR 113
- USCG/D-11
- OSD/HD
- STL
- JHU APL
- NIST
- NAWC-CL

### Industrial Support
- WinTec
- AGI
- Inter-4/SNC
- Redline Communications
- Lockheed Martin
- Mission Technologies
- Honeywell
- Mitre
- Space Data Corporation
- AOptix
- Chang Industries
- SCAN Pacific Northwest
- Retica
- XTAR
- DRS
- CDI
- Procerus
- L-3 Comm
- General Dynamics

### State and Local Government
- Alameda County Sheriff’s Office
- Oakland Police Dept.
- San Francisco Police Dept.
- NY-NJ Port Authority Emer. Off.
- Calif. Office of Emerg. Services
- U.S. Park Police

### National Guard
- West Virginia – Camp Dawson
- Indiana – Camp Atterbury
- California (08)
Networks
TNT Testbed: Plug-and-Play 24/7 Research Tactical Network

• Enables evaluation of the use of networks, unmanned/autonomous vehicles, advanced sensors, collaborative technology, and biometrics in realistic land, sea, riverine, and port field experiments

• Provides several layers for integrating models, tools, and experimentation procedures for research teams.

• Users can connect their remote local area network, including command and operation centers, via the virtual private network (VPN), SATCOM, and peer-to-peer collaborative environment

• Sensors and unmanned vehicles can be added via the situational awareness environment data channels (CoT, AWarE, STK, MAAS, etc.)
Network aware air mesh nodes

TNT 05-1, Nov 2004
MESH Topology

A-170 Airship

Network camera, Rojaent Breadcrumb and 802.11h

Camera GPS Tracker SA

Self forming/ healing

Tethered Balloons: Network camera, Pelco, small laptop, Freeway, GPS, 6 hr batteries

802.11b MESH

NOC NPS

Reach-back

FL Bragg

Tampa

NMWV Camera Control

NA Sea Nodes

Cypress Sea Support Boat

Resolution Target for EO Performance Prediction

Cypress Sea NOC

Pelican 802.16/OFDM Payload

ARIES AUV

NAVBOARD

TNT 05-2 Feb 05

Cypress Sea NOC

802.16/OFDM VoIP

ARIES AUV

Cypress Sea with SA

Mine Location

NA enables seamless SA

Surrogate Light Reconnaissance Vehicle

Surrogate UAV

NAVBOARD

VC-6 with TERN UAVs

TERN Network Payload

Balloon Payload

Improved Camp Roberts TOC

Cypress Sea Approaching USCGC HAWKSBILL - Radiation Detection

802.11b or Mesh

802.11b

GSM

NA Sea

Nodes

TNT 05-2

Feb 05

Above and Below Water Situational Awareness for
Combat Diver
USSOCOM - NPS
Field Experimentation Cooperative
Plug-and-Play Sensor-Unmanned Vehicle-Decision Maker
Networking Testbed with Global Reachback

NPS CIRPAS UAVs and Manned Aircraft
Camp Atterbury, IN
Camp Dawson, WV
Local Access Ft. Ord MOUT
NPS Beach Lab
NSWC Dahlgren

U.S. Army SATCOMSTA
Biometrics Fusion Center, WV

Monterey Bay, Pacific Ocean
Camp Roberts
ANG

Camp Dawson
US Army SATCOMSTA
NPS/CIRPAS McMillan Field UAV Flight Facility

~100 mi
802.16
VPN/GIG Connectivity for Live Participation

NPS CIRPAS UAVs and Manned Aircraft

802.16
VPN/GIG Connectivity for Live Participation

Camp Roberts ANG
USSOCOM - NPS
Field Experimentation Cooperative
Tactical Network Topology Testbed - MIO

802.16
Self-aligning 802.16

802.16
LBNL

U.S.C.G. Yerba Buena Island, CA

San Francisco Bay

VPN

Pacific Ocean

LLNL

NOC - NPS CENETIX

Sea Fox UGV

OSD Stiletto, Norfolk, VA

San Francisco Bay

In Progress (08)

Austria, Germany, Singapore, Sweden, Australia, Canada, Denmark, UK
Rapidly Deployed, Agile, Adaptive Networks

- Buster UAS
- Hilltop relay
- Optimized UAS Search Routes
- LRV at Checkpoint
- Scan Eagle
- GCS
- TOC
- NPS and/or Camp Roberts
- ITT or Wave Relay Mesh
- MMALV
- Drive-By Detection of Radiation (with LLNL)
- Self-aligning 802.16
- Swe-Dish and Tachyon
New element: Three Boarding Parties simultaneously conducted in the open waters, inner bay, and the riverine area
Network-Centric Maritime Radiation Awareness and Interdiction Experiments

with

Dr. Arden Dougan and Dr. Bill Dunlop,
Lawrence Livermore National Laboratory
NPS-LLNL MIO Cooperation Partners

### NPS Team
- Networks: ship-to-ship, ship-to-shore
- Collaborative Technology
- Operations & Command Center
- VPN reachback
- Unmanned vehicles
- Biometrics

### LLNL Team
- HOPS
- Export Control
- Radiation Reachback
- Plume Modeling
- Radiation Sources
- Radiation Detection
- Ultra-wide band Communication
- Explosives Detection

### Participating DoD and U.S. Gov’t.:
- USSOCOM
- OSD/HD
- Biometric Fusion Center
- NIST
- MARAD
- USCG/D-11
- US Marine Corps
- DOE Radiological Assistance Program
- OFT
- DTRA

### Foreign Partners:
- National University of Singapore/DSTA
- Swedish National Defense College/Swedish Naval Warfare Center
- Salzburg Research
- University of Bundeswehr at Munich

### State and Local Government
- Alameda County Sheriff
- Oakland Police Dept.
- San Francisco Police Dept.
- California Office of Emergency Services
Example Scenario and Global Partners

Intel: Nuclear device shipped from Persian Gulf onto 2 possible ships

Swedish Navy

Austrian Border Patrol

Singapore Navy

Naval Postgraduate School

LLNL reachback

USCG

US Marines

Biometric Fusion Center

US Navy Stilleto
New element: Three Boarding Parties simultaneously conducted in the open waters, inner bay, and the riverine area
Networking Solutions for Rapid Radiation Detection and Biometrics Identification

Mesh Networking with Radiation and Biometrics

Broadband Ship-to-Shore/Ship-to Ship Adaptive Networking: SAOFDM Solution
(Eugene Bourakov)

SAOFDM Network operated completely at the SA screen level w/o experts support on board vessels
Environmental Effects on Target Detection and Communications

Approach: Use in situ measurements, satellite information and computer model results to determine weather and ocean surface impacts on special operations and homeland defense.

Examples of input sources:

In situ measurements

- Wind
- Air Temperature
- Humidity
- Sea Temperature

Satellite

Color satellite image showing fog entering the Golden Gate near the area of MIO vessels

Instruments on “Boarding Vessel”
Collaboration and Operational Innovations
Participants in Singapore successfully monitor the experiment via 5 live video feeds
USV provided radiation detection in small-boat drive-by with real-time expert reachback; network-controlled USV & UGV
ARAM – Adaptable Radiation Area Monitor used for Drive-by detection of Nuclear Materials (Dave Trombino, Brian Agrawal)

- Real time radiation monitoring system
- Spectral data analyzed to quickly provide actionable information
  - flow of commerce not impeded
  - secondary search possibly not necessary
  - Spectra transmitted to reachback

Drive-by detection of radiation sources in small boats; With Reachback 6/6 sources correctly identified
Communications throughout ships easily achieved with ultra-wide band

Without error correction, 3% BER across seven decks

–Under development by DTRA

Live video

Sending Crew Biometrics via Wireless Mesh/OFDM network to the BFC (3-4 min)

Collaborative Workspace Between Boarding Officer and Forward Deployed Data Base
Data input at TOC

Day 1: Data captured on target vessel

Total response time from beginning to enter thumb prints on suspect to receipt of ID:

~5 sec if “bad guy”
~35 sec if “other”

Ground search checkpoint 2-4 minutes
MIO 07-4: Small Craft Interdiction and Collaboration on Radiation Awareness and Biometrics Identification
Small Craft Intercept Objectives

- **Simultaneous Search in the Open Waters, Inner Bay, and Riverine Areas**
  Feasibility and major constraints associated with collaboration and data sharing between several boarding parties engaged in the interception and search of multiple small craft penetrating large metropolitan area

- **Global Monitoring and Biometrics Link Analysis**
  Identifying the relationship between several loosely-coupled crews interdicted or observed in the geographically distributed locations

- **Port Security Response Integration**
  An immediate coordination of emergency response activities with local first responders based on results of continuing vessel search and nuc/rad experts response (D11/HQ C2 Center-PANYNJ/JSA).
Experiment Participants

Dr. Alex Bordetsky, MIO Principal Investigator, NPS
Dr. Dave Netzer, NPS Advisor, USSOCOM-NPS Field Experimentation Cooperative
Dr. Arden Dougan, LLNL MIO Coordinator
Dr. Bill Dunlop, LLNL Advisor

NPS Faculty:
Dr. Alex Bordetsky, Eugene Bourakov, Mike Clement, Dr. Peter Guest, RADM Raymond Jones (retired), Dr. Kevin Jones, Dr. Dave Netzer, Dr. Frank Shoup, Marianna Verett, RADM Richard Williams (retired), Ben Wring, Sean Kragelund

LLNL Researches, Corporate and Overseas Partners:
Dr. Arden Dougan (LLNL), Dr. Bill Dunlop (LLNL), Dr. David Trombino (LLNL), Dr. Gary Mattesich, CDR Leif Hansson (SNWC-Sweden), Kurt Badertscher (WinTec), Kelly Hanlon (WinTec)

NPS Students:

ONR Reserve Unit: Rich Thorne

Critical Assets provided by Federal, State, and Local Governments:
USCG D11, USCG San Francisco, Alameda County Sheriff’s Marine Unit, Metson Marine, San Francisco Police Marine Unit, Oakland Police Special Operations Unit, USCG Rio Vista, WinTec, IST, PANYNJ, LBNL, Vallejo Unified School District, Rastech-Norway
MIO 07-4: Next Step Towards 12 nm Zone Objective

• Conducting MIO outside 12 nautical mile zone in the open waters

Challenge: Rapid adaptation of agile self-forming ship-to-ship and ship-to-shore network to rough open waters conditions
Test Bed Objectives

- Tests cutting edge technology to evaluate the use of networks, advanced sensors and collaborative technology for globally-supported Maritime Interdiction Operations
  - Quarterly since 2005
  - Communications in harsh environments, between moving ships at sea
  - Network-centric collaboration with global partners
  - Situational Awareness
  - Scenario-based
  - Prototype WMD sensors & biometric instruments
  - Integrated with UAVs, USVs & UGVs
Simultaneous Interdiction and Search in the Open Waters and Inside SF Bay
Riverine Link Integration
Stretching the Riverine Link to the Boarding Vessel via the Air Balloon
Small Craft Interdiction Groove Workspaces: Primary Source of Information Sharing

Re: Boarding parties Report in SF and Sweden status
By Jonas Hedlund/Naval Postgraduate School on Sat 13, 2007 13:26:34 AM

Boarding completed
Destination Balik
ETD: UTC 00:00
Comm status CVI
Video Feed OK! See http://192.168.65.52/pushed.htm
Situation Update -
Small Craft Detection And Interdiction in Progress
Small Craft Drive-by Detection: Placing the ARAM Sensor to Sea Fox USV (Brian Agrawal, Ben Wring)
Reading the Networked ARAM-Sea Fox Feed on Board Boarding Vessel
Receiving SA Tracks, Video, and Biometrics Data Feeds from the Overseas Sites (Sweden)
Flattening Hierarchical Interagency Boundaries: Collaboration on the Response in the MIO Shared Workspace

Forensics analyzed a laptop acquired from a recent raid on a Terrorist Cell operating in Eastern Europe. Emails still resident on the hard drive reveal the names of five known terrorists which appear in our terrorist database. The files have been posted to the HQ C2 workspace.
HQ C2-D11 Collaboration for PANYNJ Response: Video feed of SF Bay Interdiction Events and Boarding Parties

NPS MAJ Carlos Vega, USCG-D11 LT Kelly, PANYNJ Jim Cooper, Erica Paulson
Small Craft Interdiction Alerts Propagation to HLS-PANYNJ JSA System
Summary of the Critical Tasks Accomplished

• Provided for small craft Rad/nuc network-controlled detection and ship-to-ship broadband networking in the open waters
• Added Riverine area of operations
• Proved feasibility of simultaneous interdiction and data sharing between boarding events conducted in the open waters, inside the bay, and Riverine area

• Integrated unmanned assets, which actively participated in conducting drive-by detection with nuc/rad sensor onboard (Sea Fox) and relaying the Riverine network to the police boat on-the-move via the air balloon

• Achieved success in biometrics data sharing and alert propagation with the overseas site in Sweden and HLS response system in PANYNJ Center

• Some of the solutions for simultaneous video feeds sharing between boarding parties didn’t work as expected, providing us with good lessons learned for the subsequent application networking improvement

• The projectile-based sensor survived the landing and was able to communicate afterwards. The Triggerfinger device for entering data onboard the fast boat appeared to be a promising solution

• The HQ C2, Riverine network segments in the VUSD area, and the HLS PANYNJ site became new "nodes" of the MIO Testbed
MIO 08-2: NETWORKING AND COLLABORATION ON INTERDICTING MULTIPLE SMALL CRAFT POSSESSING NUCLEAR RADIATION THREAT

Europe/San Francisco Bay
Experiment Focus:

The MIO 08-2 introduced several unique new elements, including tagging and global monitoring of suspect vehicle, multiple small drive-by detection, data sharing between the boarding party searching large vessel under the deck and Riverine area stand-off detection.
Monitoring Phase (March 3-7)

- **The monitoring phase** unfolded in Europe. It started with tagging the suspicious car at the simulated border control check point in the Bavarian Alps, including biometrics identification and nuclear radiation source detection on board the vehicle.

- **One goal** was for the expert teams at LLNL and BFC to get immediately engaged in the analysis of source/crew nature and develop rapid situational understanding by means of real-time collaboration with the check point cell, comprised of the small command post at the University of Bundeswehr (UoB), Munich, and the mobile check point 70 mi East of Munich in the Alpine area.

- **The critical new goal** was to tag the vehicle and keep monitoring its movement through Germany to Poland and on to the ferry heading towards the Karlskrona, Sweden. The SNWC MIO team in Karlskrona, Sweden, and the command post at the UoB would be addressing the challenge of continuing monitoring, by resolving the difficulties via the TNT MIO Operations Center at the NPS CENETIX in Monterey. The goal for the Swedish team was to find the vehicle on board the ferry and take for further biometrics and nuclear radiation detection, including the sensor vest and Kockums unmanned service vehicle.
Monitoring Phase Results

- Nuclear Radiation detection in Bavarian Alps went smoothly, the LLNL crew was able to communicate data with LLNL watch officer in Livermore and bring the results back to checkpoint. The vehicle was tagged and tracked on the way through Germany, Poland to Sweden. An important data on difficulties with switching GPRS and GSM services during tracking through the countries was collected. This became especially important when the Iridium computer got burned out.

- The UoB (Germany), SNWC (Sweden) and PANYNJ were able to coordinate lost of tracking in their SA views via the NPS TOC.

- The UoB command post successfully used NPS Situational Awareness (SA) tools for monitoring, while the NSWC was also combining it with the SNWC/KOCKUMS Blue Force tracker. The Cursor-on-Target (CoT) message router will be installed at the CENETIX TNT MIO Operations Center for transferring CoT-formatted alerts to different situational awareness systems. Several observer nodes were set up to for getting access to the monitoring process, including the HLS Port Authority NY-NJ site.

- The interdiction in Sweden went very well. The LLNL sensor worked on board Swedish USV via the TNT MIO network. Data sharing with LLNL reach back succeeded, providing detection results on time. Biometrics data was successfully shared with VPN site at CDI.
Interdiction and Search PHASE (March 10-14)

• The objective for this task was to explore feasibility and major constraints associated with collaboration, data sharing between boarding parties engaged, and the ability of command centers to come up with the scale of threat imposed by the multiple small craft penetrating the metropolitan area.

• This operation unfolded in three San Francisco coastal areas:
  - East of the Golden Gate Bridge,
  - San Francisco Bay, with the TOC at Yerba Buena Island, and
  - Sacramento River Delta

• In addition, Danish Navy/Systematic team in Aarhus, Denmark will be doing open waters vessel search, providing real time complementary data on crew biometrics and nuc/rad detection. The team in Denmark will plug-in their ship search network into the TNT MIO testbed. This was the first MIO, in which two globally distributed interdiction teams will also be trying to monitor and partially manage each other network on remote
Interdiction and Search PHASE Results

• Combined SAOFDM and Wave Relay network delivered drive-by detection of 8 suspect vessels simultaneously
• Sea Fox (unmanned) and two manned boats equipped with detectors executed the drive-by detection. Visual and sensor data was shared with LMCO site on the East Coast, PANYNJ, LLNL, and team in Denmark
• Of three different CONOPS for drive-by detection only the third one, involving circling around the small craft produced good detection results
• Once two sources were identified the plume was depicted for NY area and PANYNJ initiated police search events in different locations
• The major failure of OFDM reachabck occurred in the middle of drive-by activities. The situation was fixed by the switching to point-to-point Swe-Dish satellite link, which worked flawlessly.
• During the second day Wave Relay technology enabled to deliver the biometrics files from under two decks of the Liberty ship and provide for two-way video sharing with the Riverine area.
• The Satellite reachback and air balloon links to the chase boat in the Riverine area delivered video sharing for a short time. Network management service is need for future experiments
• The Blackbird Tech satellite tags allowed to monitor all target and intercept vessel, exchanging data between the tags and MIO SA via the satellite links.
In general the MIO 08-2 appeared to be a significant step forward. It produced vital results for tagging and monitoring, allowed to identify most successful drive-by CONOPS, demonstrated excellent performance of new mesh networking ship-to-ship/ship-to-shore platforms as well as satellite point-to-point reach back solutions and produced good results on different command and expert sites collaboration.
QUESTIONS?

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