TNT Maritime Interdiction Operation Experiments: Enabling Radiation Awareness and Geographically Distributed Collaboration for Network-Centric MIO

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Objectives

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

- Extend the set of participating organizations to coalition partners (currently includes international teams in Sweden, Singapore and Austria) and first responders (currently includes San Francisco, Oakland Police, and Alameda County Marine Units).

- Provide the recommendations for transforming advanced networking and collaborative technology capabilities into new operational procedures for emerging network-centric MIOs.
TNT MIO Testbed: System of Networks and Collaborative Technology for Supporting Globally Distributed MIOs
Plug-and-Play Sensor-Unmanned Vehicle-Decision Maker Networking Testbed with Global Reachback

- Plug-and-play wide area adaptive network with global reach back capabilities and rapidly deployable self-forming wireless clusters (including student network operation services 24/7)
- Local networking clusters: ship-to-shore, ship-to-ship, ship-UAV-ship, ship-USV-ship, ship-AUV, sensor mesh mobile networks
- Operational focus: Boarding Parties support, MIO connectivity and collaboration for radiation awareness, biometrics identification, non-proliferation machinery parts search, and explosive materials detection on the board of the target vessel during the boarding party search phase
- Testbed backbone: NPS (Monterey), USCG (Coast Guard and Yerba Buena Island in SF Bay Area, Camp Roberts (Central California),
  - New sites: Golden Gate Bridge, Mt. Diablo, Sacramento River delta
- Global VPN reach back:
  - East Coast (BFC, DTRA)
  - Sweden (Navy site in Southern Sweden),
  - Austria (GATE site in Bavarian Alps-Salzburg Research)
  - Singapore (DSTA), and
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

US Marines

Biometric Fusion Center

USCG

US Navy Stilleto
### 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
TNT MIO Testbed: Self-Forming Broad Band Wireless Backbone

- U.S.C.G. Yerba Buena Island, CA
- San Francisco Bay
- Sweden, Austria, Singapore, Australia, Canada, Germany, Israel

In Progress

802.16

VPN/GIG

In Progress

DARPA MAV

Pacific Ocean

Sea Fox UGV

Mt. Tamalpais

LLNL

Mt. Diablo

OSD/OFT Stiletto, MSC Coronado

Riverine - Sacramento Delta

May 07

LBNL
Networking Solutions for Rapid Radiations Detection and Biometrics Identification

VPN Reachback and Mesh Networking with Biometrics

Device

Broadband Ship-to-Shore/Ship-to Ship Adaptive Networking: SAOFDM Solution

SAOFDM Network operated completely of the SA screens w/o experts support on board vessels
Forward Deployed Biometrics - Ship Boarding

TNT 07-2

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

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

At Camp Roberts Checkpoint:

Without ABIS, Local FAST ID 1-2.5 min
With ABIS and Full Encounter, TOC Data Base 2-4 min
Background MIO Studies: Rapidly Deployable Self-Forming Network for Maritime Interdiction Operations
### Large Interdisciplinary NPS Team

- **NPS:** - FY06: 28 Thesis Students  
  32 Faculty  
  Includes 21 PhD, 4 PhD Students  
  - Course Projects: IS, OR, DA  
  10 Departments and Institutes

### Affiliated Programs

- DARPA HURT ACTD
- DARPA MAV ACTD
- USSOCOM Global Reach ACTD
- AFRL JASMAD
- MCWL Distributed Operations
- OSD/OFT Stiletto
- OSD/HD MDA

### Participating Universities

- Virginia Tech
- University of Florida
- Case
- MIIS

### Broad DoD and Gov’t. Participation and Support

- USSOCOM
- USASOC
- AFSOC
- NAVSPECWARCOM
- JSOC

### Industrial Support

- WinTec
- Inter-4
- Redline Communications
  - Flarion
  - Northrop Grumman
  - Lockheed Martin
  - ITT
- AeroVironments
- Space Data Corporation
- Brandes Associates, Inc
- Chang Industries
- L-3 Communications
- AGI
- Mitre
- Mission Technologies

### State and Local Government

- Alameda County Sheriff
- Oakland Police Dept.
- San Francisco Police Dept.
Field Experimentation Research Areas

CENETIX
- OSD/OFT WolfPAC – Stiletto Experiments

OSD/OFT HA/DR Project
- NJ Health Emergency Medical Response Network

OSD/HD NPS Maritime Security Program
- USMC Field Experiments

SOCOM - NPS Field Experimentation Cooperative
- Agile, Adaptive Tactical Networks with Long-Haul Reach-back; Ground, Airborne, Ship, Underwater
- Collaboration Technologies
- Integration with GIG-EF via DREN (CONUS), GIG-BE (theater locations, satellite links), and Abilene (Internet 2 backbone) (overseas clusters)
- Shared Situational Awareness
- Unmanned/Autonomous Vehicles
- Network Controlled UASs
- Networked Sensors
- Dual-use Technologies for Post-Conflict Reconstruction, Stabilization, HA/DR
- IED Detection and Jamming
- Smart Antennae
- Precision Tracking and Targeting
- Network Vulnerability Assessment
- Red Team Intent
- Human Systems Integration (Warfighters as Users and Evaluators)
- CONOPS
- Individual Identity Friend or Foe
- NGO-Warfighter Combined Operations

Sites:
- Camp Roberts
- Ft. Hunter Liggett
- Monterey Bay
- San Francisco Bay
- Avon Park, FL
- etc
Background: Prior NPS-LLNL experiments focused on sending data and video in real time within a boarded ship to external networks.

Feb 05 TNT: 802.11B affected by radar

May, August 05 TNT UWB communications demonstrated within Cutter

Suisun Bay: UWB able to transmit between holds of a container ship with holds closed!

UWB on board USCGC Munro (multi-deck, no radar)

Collected system performance data on operational ship (Point Sur) UWB WORKED in difficult high multipath environment

Polar Star – Planned experiment w/ USCG R&D Center
Target Ship Enters Monterey Bay; Collaboration with TACSAT for Ship ID

Ship-to-Ship Ad-Hoc Mesh
MIO Networking Accomplishments
TNT 06-1 MIO Network Topology: Forming the Boarding Party network to the target ship
Stretching OFDM Man-Pack Boarding Party Network to Target Ship (15 min)
Sending Target Crew Biometrics via Boarding Party Wireless Mesh network to the BFC (4 min)
Stretching the UWB link below the deck to the Radiation Detection officers
Sharing UWB Video with DTRA via Groove
MIO Adaptive Ship-to-Ship and Ship-to-Shore Networking On-the-Move: First SAOFDM node
Adaptive Ship-to-Shore link with Boarding Vessel operational behind port structures in the Oakland Channel
Adding Unmanned Systems to MIO Network: Drive-by Search by Sea Fox USV
Video Feed on the Target Vessel Provided by Unmanned Surface Vessel
Adding Unmanned Systems to MIO Network: Drive-by Search by USV, UAV Relay to the Fast Boat, UGV in the Tunnel

USV provided radiation detection in small-boat drive-by with real-time expert reachback; network-controlled USV & UGV
MIO Testbed Operation Challenges: NOC Response

View of the tactical wireless OFDM 802.16 link behavior

View of Performance and Fault Management Monitors
NOC Adaptive Management Model: Facilitator/Coordinator Feedback Loop
Network-aware nodes in UAV-based HVT operations: mapping SNMP data into the SA view
Adaptive Networking at the Situational Awareness Interface Level: Network-on-Target

- The NoT process starts at the level of Situational Awareness Interface used by the local or higher echelon commander, to point onto the Target, which in this case is the site to be reached by the self-configuring network.
- In response the mobile networking node, i.e. small boat, light reconnaissance vehicle, or operator are moved to the area to extend the tactical mesh.
- If the site is too far, or the preceding links are about to break down, the UAV is deployed to stretch the network further to the remote most node, or to heal the overstretched intermediate link.
NoT at Work: Remote and Self-Alignment of Broadband Point-to-Point Antennas

- This in turn would require rapid and frequent re-alignment, of the antenna assets including panel switching and tune-up decisions made right at the level of local commander situational awareness view.
- More so, the commander’s remote advisers, located thousands miles away of surveillance and targeting area would be able to see the effects of the healing assets deployment in the Situational Awareness view and assist the commander in re-aligning and stretching the mobile network to the target area.
NoT (SAOFDM Solution) at Work
Collaborative Technology
Geographically Distributed Collaborative C2 and Data Fusion Environment

Distributed team of Experts and Command Officers: Mobile Command Post (C2 input), DTRA (machinery smuggling), LLNL (radiation detection), SOCOM (ops advice)
Boarding Party Self-Synchronization with TOC and DTRA in Groove
TNT MIO 06-4 : Feasibility of using innovative self-aligning broadband wireless solutions to support boarding and target vessels on-the-move, boarding party real time collaboration with coalition partners and first responders

(August 30-September 1, 2006)
MIO 06-4 Collaborative Network

District 11 MSST

TOC / Logistics (Yerba Buena)

Boarding Vessel

Boarding Team

BFC

LLNL

DTRA

Sweden

Austria

NOC (NPS)

Singapore

Technical Reach back
NPS
Class on Collaborative Technologies
Network Operations Center and Data Collection site via groove
Network Support team and Experiment Control (act as back up to make all necessary inject should network connectivity problems exclude certain players).

Swedish Team
Maritime Security Office of the Port of Oakland
observing and supporting experiment control by scenario injects made via groove, SA, and by video feed (with CDR Leif Hansson in Lead)

Austrian Team
Port of Hong Kong (where the containers were loaded)
observing and supporting experiment control by scenario injects made via Groove, SA, and by video feed (with Dr. Ulrich Hofmann in Lead, Ulrich Wagner as Technical POC)

Team in Singapore
Shipper of the cargo containers
observing and supporting experiment control by scenario injects made via Groove, SA, and by video feed (with Dr. Yu Chiann in Lead)

DHS Science & Technologies CounterMeasures Test Beds
Office of Emergency Services
Assists CalOES and DOE RAP
Participating Units

Alameda County Sheriff’s Office Marine Patrol Unit Boat and RHIB—Boarding vessel, deploys boarding party and does drive by (carries IST detector) Oakland Police Boat 35 the target vessel OFT Stiletto Ship—remote early warning command post en route to San Diego area USCG District 11 Watch Officer PAC Area Watch Officer MSST Level Two capable boarding team with radiation detection equipment?
LLNL
Providing source, source security, and data files for detection teams (if necessary)
Providing remote analysis cell from Livermore via Groove
Provide mapping facility of bay showing critical facilities (HOPS), radiation detection reachback and atmospheric modeling reachback
LLNL Watch Officer – remote cell (operating from NPS)
2 members of Boarding Party (with radiation detectors)

BFC (Biometrics Fusion Center)
Providing data files for detection teams,
Providing remote support for exercise database search and results reporting via Groove collaborative software

SOCOM Observers
Remote Navy Asset: OFT Stiletto Ship in San Diego
Getting Drive-by Search Feedback from Sweden
Source Detection Feedback from Singapore

Re: M/V Sheikh of Oman arrives in Singapore

By Singapore 1 Dec 2006 12:33:31 PM  Modified on 1 Dec 2006 12:39:36 PM

Radiation detected!
Radiation data files posted in TNT 07-1 Singapore folder.
LLNL radiation feedback requested, please.
Note that Singapore video feed is not operational.
EWall Integration with Groove: Combining Biometrics Identification (NBFC row), Radiation Detection (LLNL row) and Groove events at the distributed locations (Alerts row)
MIO 06-4 Findings

- SAOFDM-based experimental adaptive on-demand ship-to-shore network provide expected connectivity and level of bandwidth capable of carrying on several video streams and data sharing situational awareness applications. While on the move at speeds 3-5 nm/hour and zigzag maneuvering of the Boarding Vessel trying to chase the Target, the SAOFDM node by using designed self-aligning algorithm applied via the control channel enabled to keep ship-to-shore directional link intact, providing transmission rates up to 5 Mbps.

- Collaborative technology (shared workspaces, SA, video tools) performed well, enabling simultaneous radiation detection and analysis taking place in different geographically distributed locations.

- We observed successful SA integration with early drive-by detection of radioactive source on board of truck in Bavarian Alps (upper right view), by the first time in action Stiletto ship in San Diego (lower right view) and plum detection of the boat in SF Bay (lower left view). For the first time three surface nodes and three overseas command posts (Swedish Navy, Singapore DTSA, and Austria (Salzburg Research) acted together with District 11 (CG), YBI TOC and NPS NOC.
Tactical Network Topology Maritime Interdiction Operation Experiments: Enabling Radiation Awareness and Geographical Distributed Collaboration for Network-Centric Maritime Interdiction Operations

December 5-8, 2006
Arden Dougan
International Maritime Domain Security Symposium

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TNT Maritime Interdiction Operation Test Bed

• Tests cutting edge technology for WMD detection and communications in maritime environment
  — Communications in harsh environments, between moving ships at sea
  — Netcentric collaboration with global partners
  — Situational Awareness
  — Scenario-based
Drive-By Radiation Detector: ARAM – Adaptable Radiation Area Monitor

- Real time radiation monitoring system
- Spectral data analyzed to quickly provide actionable information
  - flow of commerce not impeded
  - secondary search possibly not necessary
Radiation Sources used in TNT

• Naturally occurring radioactive materials (NORM)
  — Radium smoke detector
  — Thorium lantern mantles
  — Calibration Sources
  — Moisture gauge

• Surrogates
  — Fiestaware
  — Uranium-238
  — Plutonium surrogate
Surrogate Radiation Sources used to simulate special nuclear materials

- **Plutonium surrogate**
  - Mimics Pu for 1st response detectors
  - DOT Limited and Excepted Quantity for easy transport
  - Field life 2-3 months (renewable)
Explosives detection kit - ELITE

- Colorimetric explosives detection system
- Simple to use swipe test, immediate results, requires little training
- Detects over 25 explosives and their precursors
- Low nanogram detection limits
- Swipes and tests potentially contaminated areas
- Enables easy detection of color change

**LITE detects:**
- nitro aromatics (including TATB)
- nitrate-esters
- nitramines
- picric acid
- inorganic nitrate compounds

- Small, disposable, one use system
- Easy to use, no training required
- Minimized heating requirements
- Uses a swipe material for improved sampling
- Inexpensive to manufacture
- Detects aromatic, aliphatic, and nitrate explosives
- Utilizes three types of chemical reactions
  - Meisenheimer complex
  - Griess Reagent
  - Zinc reduction of nitrates
• **Radiation Experts**
  — Analyze radiation spectra
  — Determine quality of data
  — Ask for additional information (background spectra, photos)
• **Consequence Analysts**
  — Plume modeling
  — Access to maps, atmospheric modeling, hazardous chemicals database
• **Export Control Experts**
  — Analyze photos of items
• **Emergency Response Coordinators**
  — Advanced planning (direct movement of ships, area vulnerabilities, etc.)
Examples of Radiation Reachback

Who: unknown
What: A truck loaded with an cargo container
When: A time ago (exact time unknown)
Where: Entrance into the Hong Kong seaport
How: Portal monitor
Specials: No neutrons observed, just gamma radiation

There is one item that was added to CalMart’s shipment, not normally part of their shipment. This item is sent by George Koncher to the "Citizens Against Nuclear Things."
Request worst case scenario for vessel carrying materials listed above. Current location is 37-47.04N 122-21.28W. winds from SW.
The TNT MIO Node in Singapore

Dr Foo Yu Chiann
Project Manager
Defence Science and Technology Agency
Experiment Set-up

- The Singapore node is connected to the MIO collaborative environment through a Virtual Private Network (VPN) established between DSTA and NPS.

- 3 wireless laptops connected via 802.11g to the Internet

- Location:
Video Feeds

Stiletto

Boarding Vessel

TOC

Sweden

Austria
Role for MIO-06

- Singapore played the role of the shipping company that had unknowingly transported the radioactive cargo (via Port of Hong Kong) as part of its shipment
- Provided the shipping manifest of the cargo containers to Port of Hong Kong and MIFC to aid investigations
Role for MIO-07

• Simulated the boarding & search of a vessel that may have a nuclear device
  – Radiation profile and photo of the suspicious item sent via collaborative environment for reachback analysis at LLNL

Figure 9-9. Moisture Gauge
Observations

• The Experiments have provided insights on the possible new operational capabilities that could be achieved with collaborative networking
  – Allow boarding team immediate access to remote expertise during boarding operations
  – Shorten decision-making processes

• Way ahead
  – Explore how such collaborative technologies could be applied for our own operations
Swedish Naval Warfare Centre
Wireless Broadband supporting Maritime Security in Littoral Waters
TNT 07-1

Sweden acted as a counterpart MIO agency, conducted the same operations and exchanged real time information that was analysed by the reachback organisation.

Radiation data (provided by the CBRN centre)
Calculated radiation spread (provided of the CBRN centre)
Live video feed
Observer at SF Bay
Result: Connectivity with all participants
Posted files were analysed
Video feed to/from all participants
VPN connection LAN-to-LAN
The Swedish goal for participating in the TNT experiments

- Use the experiments as stepping stones to be able to conduct the Swedish TNT experiment fall 2008
Swedish Operational Concept - Maritime Security

- AOR
- SPOD
- Minedanger depth
- TACAIR, MPA
- Civil traffic, Fishing
- Harbour Protection
- Ground Forces, Force Protection, NGS
- CIMIC, Hum op
- NTG
- NCAGS
Vision for Swedish TNT experiment fall 2008

Boarding Ship

Suspect vessel

BP

Link

Tactical C4I

NBCR Centre

IP

CG

CS

Police

Int partners

Link
Wireless Broadband supporting Maritime Security in Littoral Waters
Sensor and communication jacket

Demonstration vest developed in collaboration with Combitech and the University of Umeå
Sensor and communication jacket

Key features:
• Real time communication of voice, data and sensor information
• Integrated in the combat suit (jacket)
• Adapt sensors to the specific mission/task
• Possibility to supervise physiological status and position of the soldier
• Presentation of alarm and data to the soldier (MMI)
Sensor and communication jacket

- Camera
- Explosives detector
- CW/TIC detector
- Radiological detector
- Display
- Control panel
- Microphone
- Earpiece
- Vibrator
- LED Bar
- MMI
- CPU
- Inertial nav
- GPS
- Body temp
- Heart
- BAT
- MMI
- ROO
- GMT
Questions?