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Testbed for Self-Organizing Networking and Collaboration / Cyber Security Summitt 2009, PowerPoint Presentation

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Testbed for Self-Organizing Networking and Collaboration

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Cyber Security Summit
2009

Motivation

•Beginning in 2002, a team of Naval Postgraduate School researchers together with sponsors from USSOCOM, and later joined by the OSD and DHS S&T Programs, started a new campaign of discovery and constraints analysis experiments (Alberts and Hayes, 2007), which is now collectively known as Tactical Network Topology (TNT) Experiments.

•The first one involves quarterly field experiments with USSOCOM, in which NPS researchers and students as well as participants from other universities, government organizations, and industry investigate various topics related to tactical networking with sensors and unmanned aerial systems (UAS) as well collaboration between geographically distributed units with focus on high value target (HVT) tracking and surveillance missions.

•The second direction involves Maritime Interdiction Operation (MIO) experiments with Lawrence Livermore National Laboratory, USCG, First Responders (San Francisco Bay, New York/New Jersey) supported by HLD and HLS S&T Programs and DoE agencies. These experiments are conducted twice a year and are also supported by the overseas partners from Sweden, Germany, Denmark, and Singapore.

Motivation

- The Tactical Network Topology (TNT) experiments are an integral part of the NPS field-testing capability.
- The TNT's multi-layered architecture of information and social networking provides a unique testbed for studying cyber attacks and defense in ad-hoc mobile tactical networks. It is also an incubator for unconventional tactical networking solutions related to cyber threats.
- We will discuss the latest findings of TNT experimentation, including project-based networking, networking-by-touch, and physical layer directional meshes.
- We believe that these unconventional networking models may lead to new tactical networks that are significantly less vulnerable to cyber attacks

USSOCOM – NPS Field Experimentation Cooperative: TNT Testbed Community of Tactizens

Large Interdisciplinary NPS Team

FY08: 27 Thesis Students
31 Faculty
Includes 21 PhD, 4 PhD Students
Course Projects: IS, OR, DA, MET
9 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	Case
University of Florida	MIIS
WVUF	NDU
Nat. Univ. Singapore/DSTA	MIT
Swedish Naval Warfare Ctr	
Univ. of Bundeswehr	Salzburg Research

Foreign Country Participation in MIO

Austria	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	BFC
DARPA	DTRA
LLNL	MARAD
NSA NTIO	NRL
ONR	ONR 113
SPAWAR	USCG/D-11
ARL	OSD/HD
OSD-RRTO	STL
USASMDC	JHU APL
USMC-MCTSSA	NIST
NSWC-Dahlgren	NAWC- CL
TSWG	

Industrial Support

WinTec	Orion Networking
AGI	CHI Systems
Inter-4/SNC	Orion Networking
Redline Communications	Trident Systems
Lockheed Martin	Cross Match
Mission Technologies	Retica
Honeywell	XTAR
Mitre	DRS
Space Data Corporation	Procerus
AOptix	CDI
Chang Industries	L-3 Comm
SCAN Pacific Northwest	Insitu
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)

TNT Testbed

ISR/HVT Operations Segment

Biometrics Task Force, WV

Camp Atterbury, IN

Camp Dawson, WV

VPN / SATCOM

NSWC Dahlgren, VA

NSW Coronado, CA

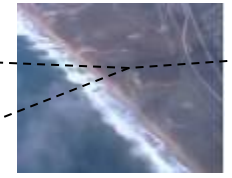
NAWCWD, China Lake

Santa Barbara County Police and Fire

U.C. Santa Barbara

Ft. Hunter Liggett, USAR

802.16



NPS Beach Lab

NOC- NPS CENETIX

Monterey Bay, Pacific Ocean

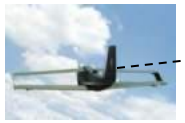
~100 mi

Camp Roberts ANG

MIO Extension

NPS/CIRPAS McMillan Field UAS Flight Facility

Typical Self-Forming Mobile Mesh Segments of TNT Testbed



Buster
UAS

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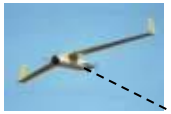
LRV at
Checkpoint

Drive-By Detection of Radiation (with LLNL)

Hilltop relay

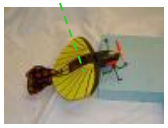


Scan
Eagle

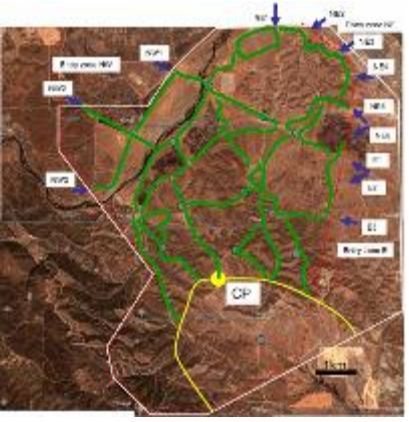
GCS

ITT or
Wave
Relay
Mesh

Self-aligning
802.16



MMALV



Optimized UAS
Search Routes

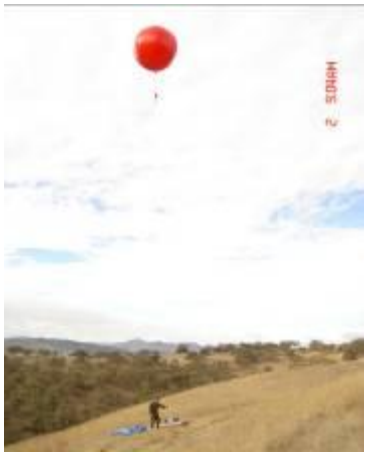
TOC

NPS and/or
Camp Roberts

Swe-Dish and Tachyon

Examples of New Tactical Applications Enabled by TNT Testbed

JHU/APL Fully Autonomous UAS Swarm for Cooperative Search and Tracking



USMC Distributed Operations – Rapid Network Deployment

Light Reconnaissance Vehicle/Mobile TOC at Checkpoint with Biometrics

Individual Identity Friend or Foe Patch

Rapid Biometrics ID: Facial Image Check

UAV-Enhanced Battlefield Medical SA and Tactical Networking – TOC

Aerial Search Optimization Model - SA Blue Force Tracking and Satellite Tool Kit for UAV Coverage

UNCLASSIFIED

MIO Testbed Segment: SF Bay, East Coast and Overseas

Pacific Ocean

Sea Fox USV

Self-aligning 802.16

802.16

Riverine - Sacramento Delta

Mt. Diablo

LBNL

NPS CENETIX

LLNL

Port of NY/NJ

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

VPN / SATCOM

Bay / Port

Fort Eustis, VA - Riverine

San Francisco Bay

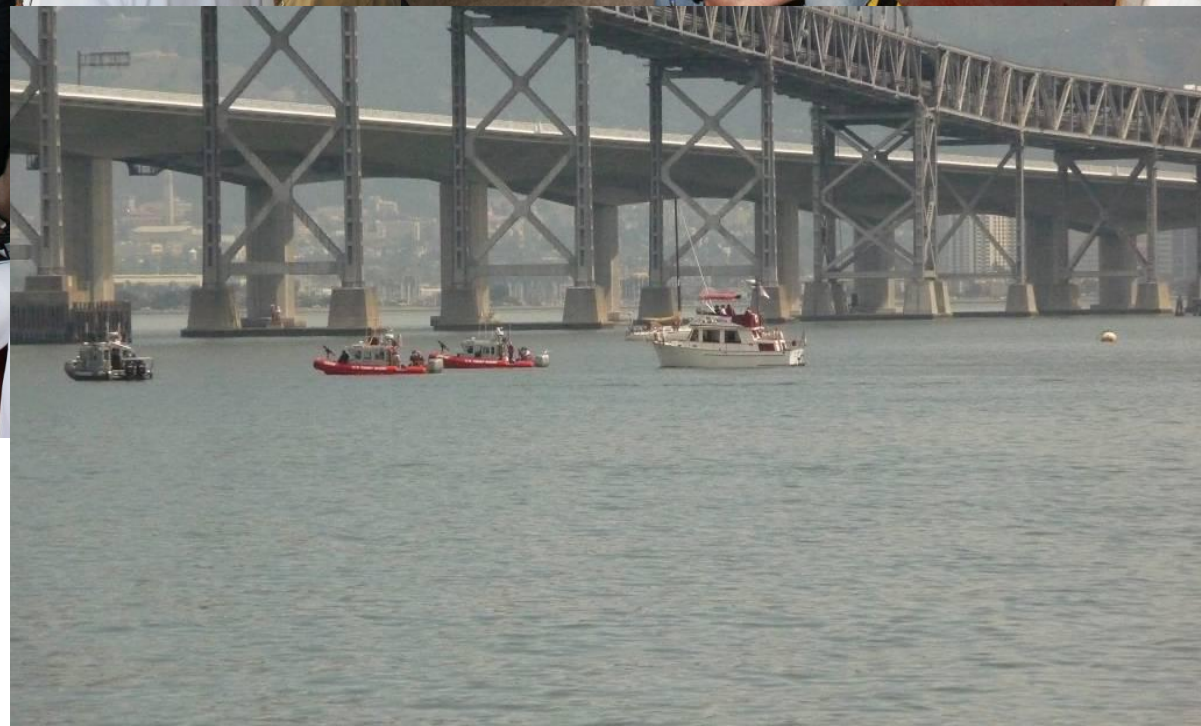
NSWC Group 4
LMCO Center for Innovation
VA

Austria, Germany, Sweden, Denmark, Greece, UK, Turkey

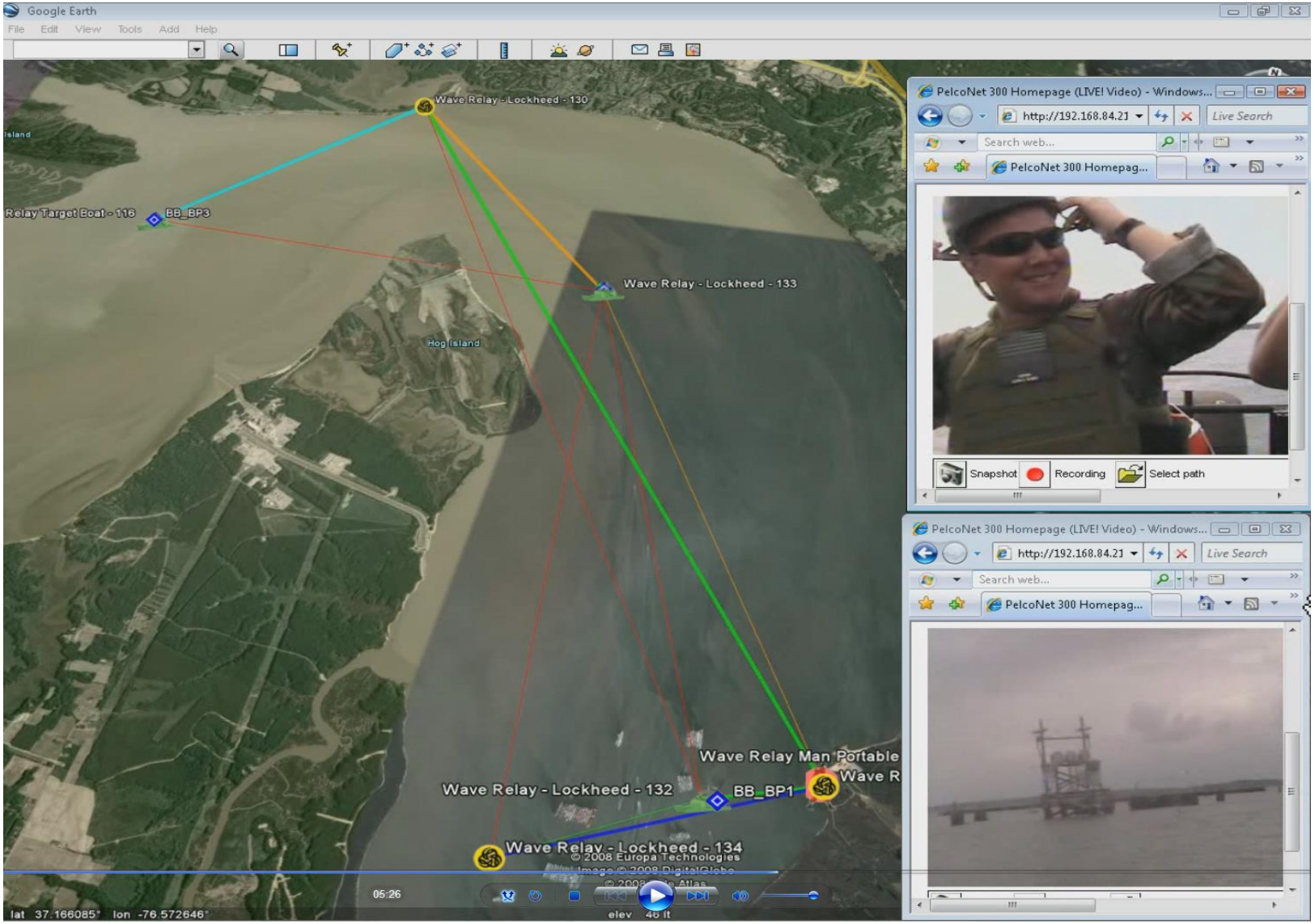
Functional Focus of the MIO Testbed Geographically Distributed Teams

- **San Francisco**: *All new sensor, unmanned systems, and networking technology; data sharing and collaboration with USCG and marine police units, multiple small boat interdiction, DoE reachback*
- **Ft. Eustis:** *Riverine operations, data sharing and collaboration with NSW, USSOCOM, Army Divers*
- **PANYNJ:** *Data sharing and collaboration with NY-NJ area Police and FD first responers, interoperability with DHS JSAS*
- **Swedish NWC:** *Wearable sensor and USV swarm, interoperability with BFT*
- **Danish Naval Systematic Center:** *Diver detection in the Port security area, interoperability with NATO Maritime Boarding Systems*
- **University of Bundeswehr:** *Check points in the smuggling routes, tagging and monitoring*
- ***NATO MIO TC in Crete:*** *Expert Center for Small Boat interdictions in Mediterranean and Black Sea*

Interagency Collaboration: Cargo Vessel Search by Multiple Boarding Parties in SF Bay Area and Seven Small Craft Drive-by Search



Operator interface: video clients and SA View in the Riverine Operations



TNT Testbed: Layered interfaces for integrating models, tools, and experimentation procedures

- The TNT *tactizens* can integrate their sensors and mesh networking elements in the unclassified but closed IP space of the TNT testbed by getting fixed IPv4 and lately IPv6 addresses.
- Users can connect their remote local area network, including command and operation centers, via the virtual private network (VPN) client on top satellite or commercial IP cloud services,
- Sensors and unmanned vehicles can be integrated with the TNT Situational Awareness Environment via the applications layer interoperability interface. The current option includes Cursor-on-Target (CoT) integration channel, initially developed at MITRE (Miller, 2004), comprised of the CoT message router and CoT XML adapters for each node needed to be integrated

TNT Testbed: Layered interfaces for integrating models, tools, and experimentation procedures

- In the very near future we will consider adding the Common Alert Protocol (CAP), which is becoming widely used by the DHS community,
- Human layer interface: Operators (both remote and local) can access the testbed collaborative environment via the collaborative portal or peer-to-peer collaborative clients, situational awareness agents, video conferencing room , and video client.
- At the physical level the testbed reaches to even lower levels (like multiple mesh network enabled unmanned systems), which permit researchers to experiment with such things as airborne sensors and cooperative control without having to be concerned about network connectivity.

Networking Edge: Unmanned Systems-Sensor-Decision Maker Cooperative Networks

- **Self-Organizing Mesh Wireless Networks**
  TNT Reports from 2005-2008

- **Network and SA controlled UAVs, USVs, UGVs:** Unmanned vehicle is controlled by submitting the way points via tactical N-LOS mesh network. An ongoing study with Bourakov, Clement, Jones, Dobrokhodov, Kaminer (Clement, et.al., 2009) and (Jones, et. Al., 2009)

- **Network-on-Target:** Peer-to-peer links configured from the top of Common Operational Picture interface, self-aligning directional antennas (Bordetsky & Bourakov,2006)

- **Hyper-Nodes with 8th Layer**: Tactical Self-Forming nodes as miniature network operations centers (Bordetsky & Hayes-Roth, 2007)

- **DMs as sensors to unmanned systems:** Operators decision space MIB available to the unmanned system agents. First results accomplished in the thesis project of LCDR James Gateau**, (**Gateau &Bordetsky, 2008)

- **Networking-by-touch:** Transmitting data via highly adaptive human network by using physical or electronic touch. First results accomplished in thesis of Rideout & Strickland (NPS), continuing research with Bourakov (NPS) Elman (MIT), and Lindeman (WPI):
  (Rideout and Strickland, 2007), (TNT 08-2 QLR), (TNT 08-4 QLR)

Networking Edge: Self-forming Unmanned systems-Sensor-Decision Maker Cooperative Networks:

- **GPS denial navigation :** An ongoing study since 2007 with Bourakov and MIT team (TNT 07-4 QLR, 2007), (TNT 08-2,QLR 2008)

- **Ultra Wideband (UWB) Mesh networking**: Integrating the UWB link into the peer-to-peer wireless mesh network. An ongoing study with Bourakov (NPS), Win and Weymereesh (MIT) (TNT 08-4 QLR 2008)

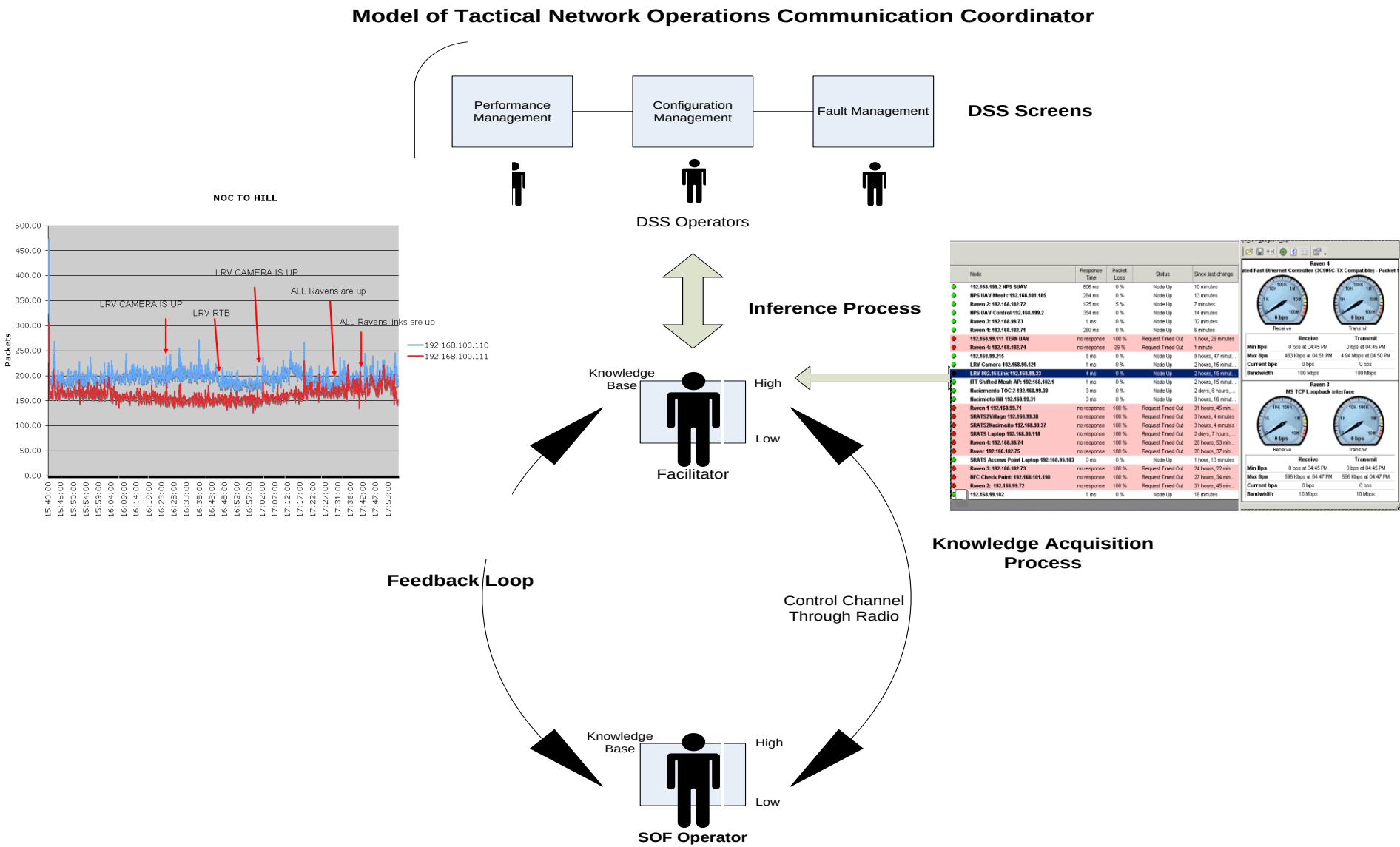
- **Projectile-based Networking**
  TNT MIO 07-4 After Action Report, 2007

- **Small Distributed Unit Private Tactical Satellite Network**: Study started in 2007, first results accomplished in thesis project of MAJ Conrad and LCDR Tzanos (Conrad and Tzanos, 2008)

- **Small Distributed Unit Private Tactical Cellular Network**: Study with Bourakov started in 2008 (TNT 08-4 QLR, 2008)

Platform for Tactical Cyber Security Experiments: NOC Rapid Feedback on Network Behavior

(with Clement and Bourakov)

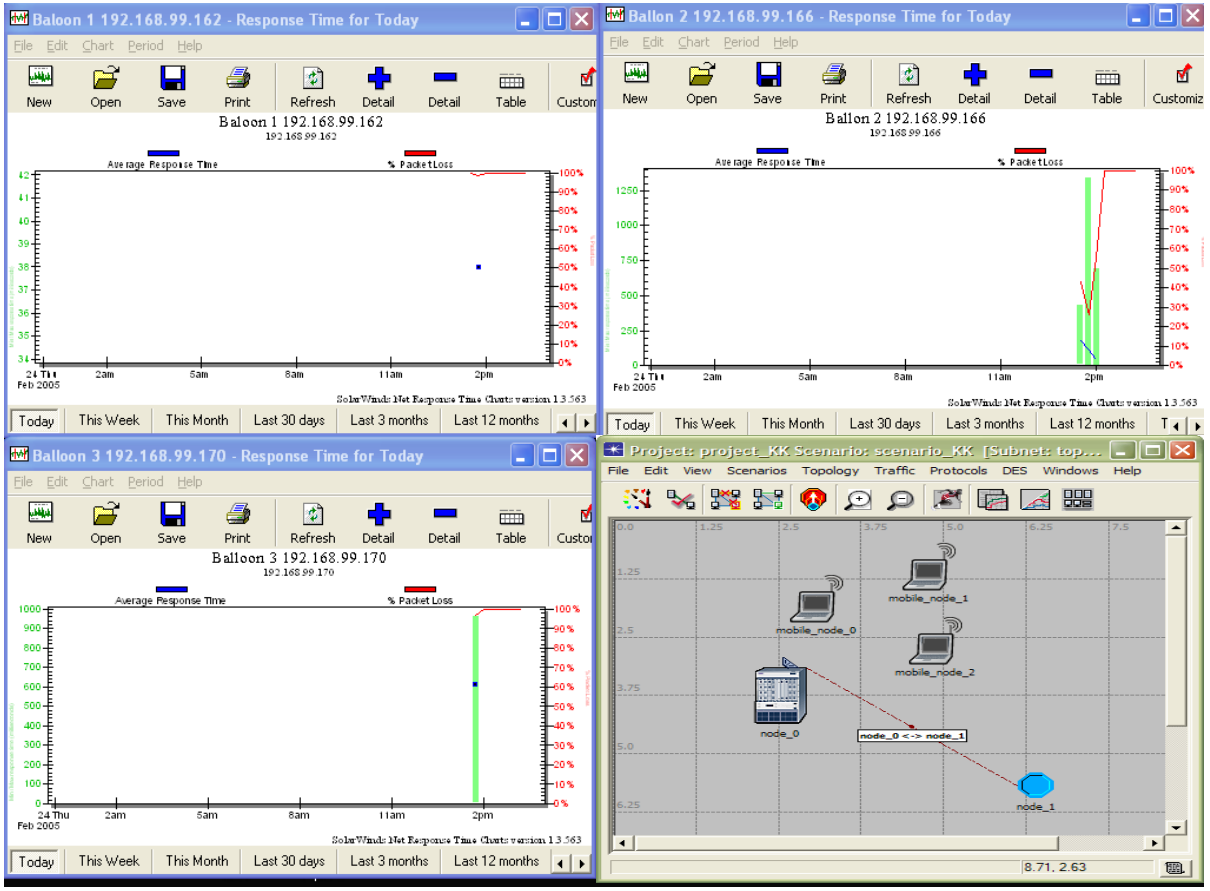


Hyper-Nodes (with Rick Hayes-Roth):

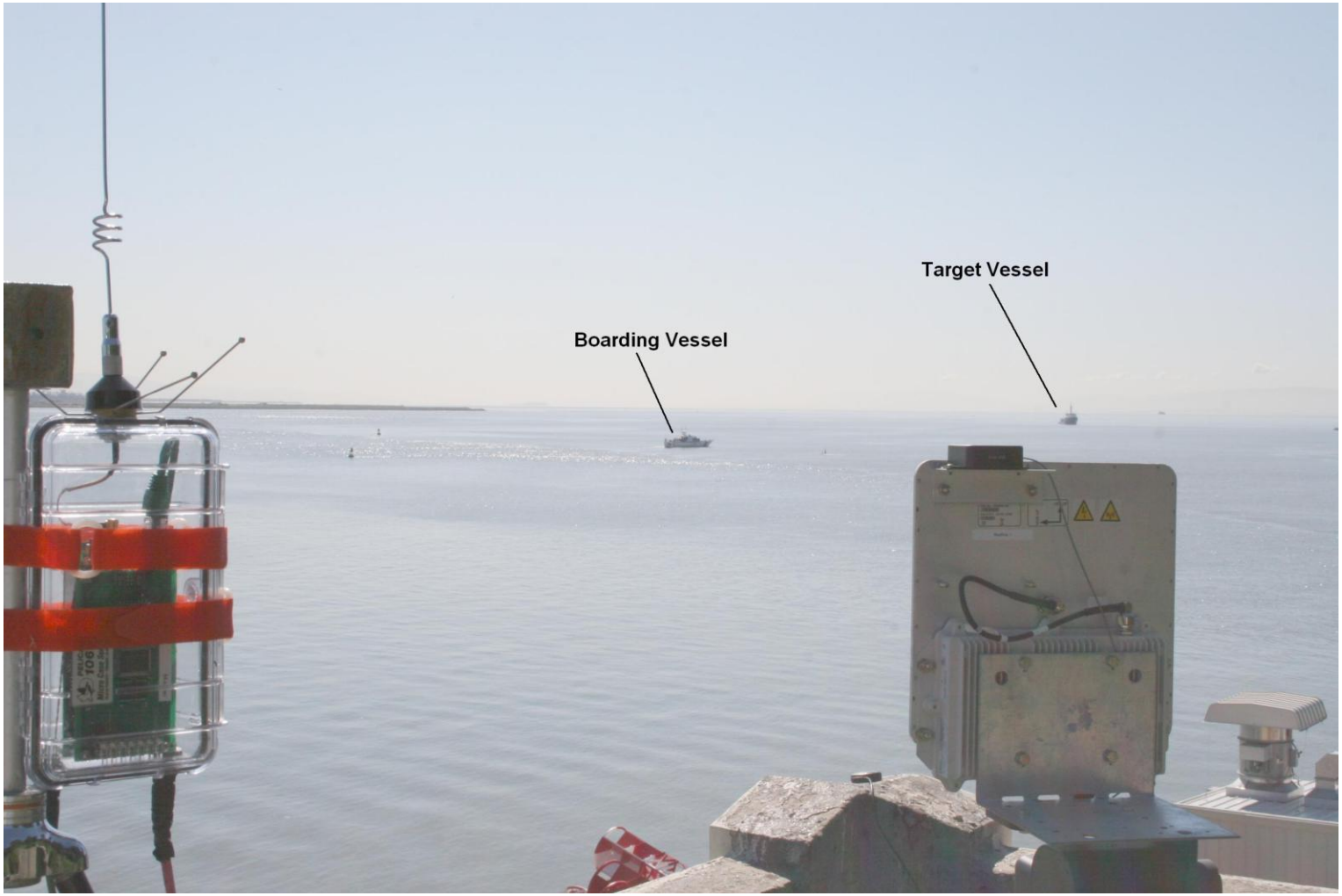
- Define new adaptive management concept enabling mobile networking node to become a small-scale Network Operations Center (NOC)
- Such node could be thought of as hyper-node and it's adaptive self-control NOC functionality as the content of 8th layer in the OSI stack
- Apply the concept of hyper nodes and 8th layer to adaptive management challenges for self-organizing sensor-unmanned systems-decision maker networks

Simulating Tactical Network for Diverting Cyber Attack (Honeypots, SVN), Field Attack-Defense Gaming

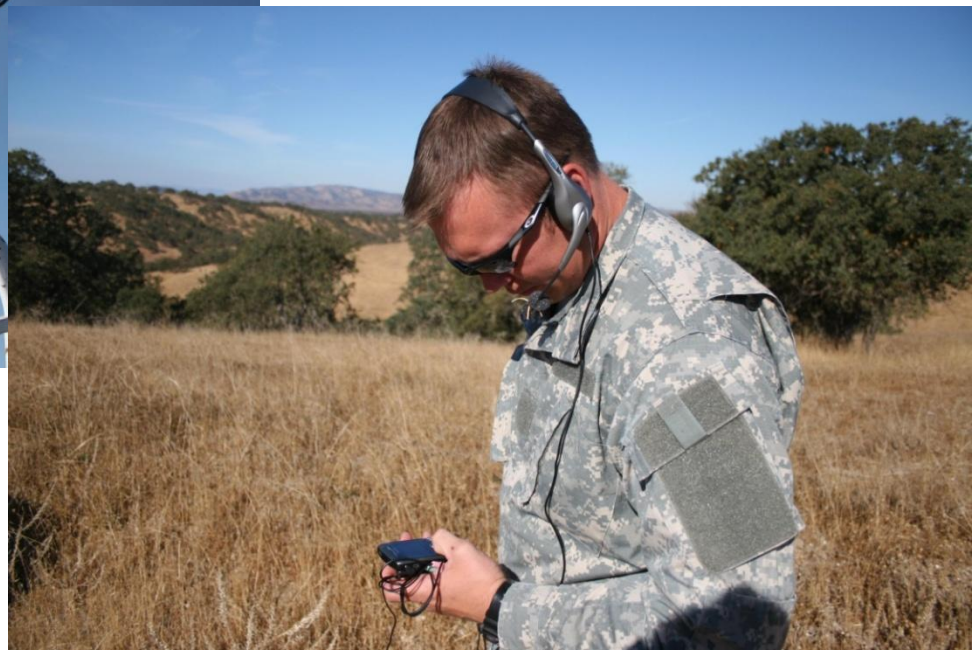
Solar Winds Network Management System Reacts to OPNET/Honeyd Simulated Aerial TNT Nodes (with Maj Hill and LT Sal



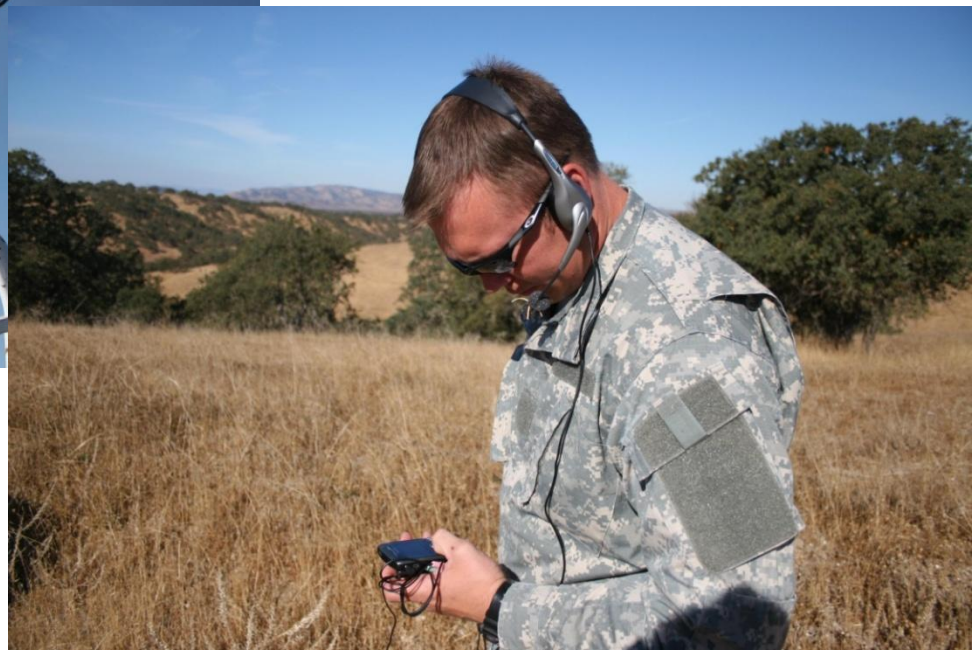
An Unconventional Solution: Physical Layer Directional Mesh, Self-Aligning Directional Networking Nodes (with Eugene Bourakov)



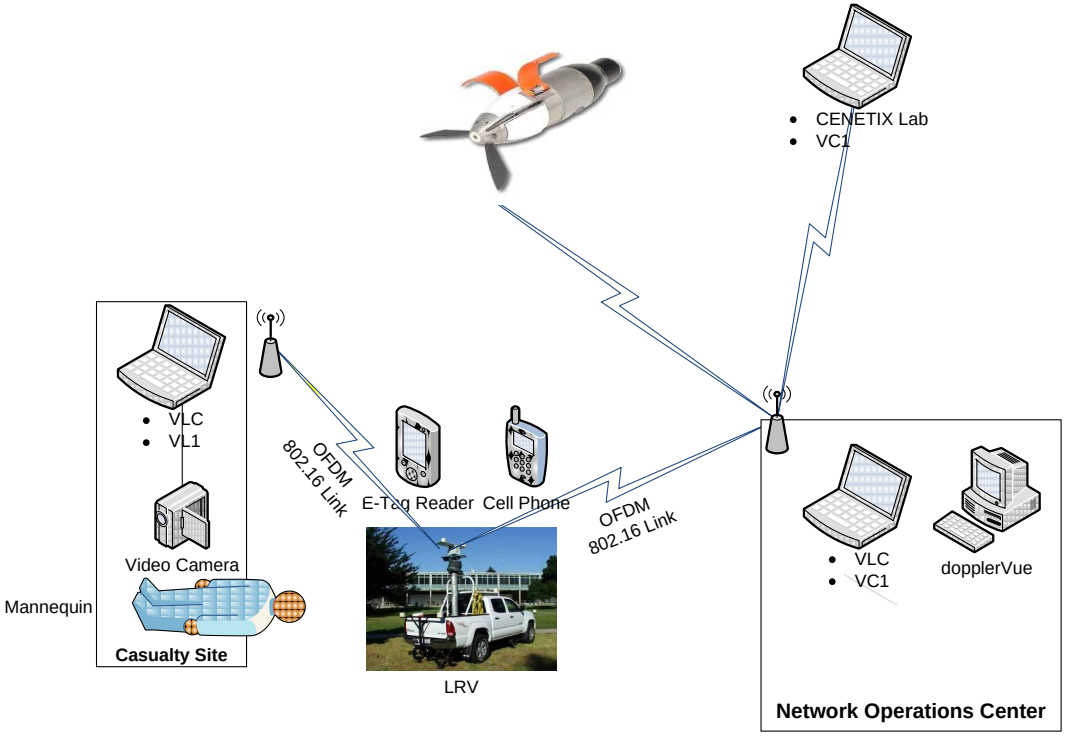
Next Step: Self-Aligning Directional Mesh Links for Hand-Held Nodes



Next Step: Self-Aligning Directional Mesh Links for Hand-Held Nodes (nano satellite antenna control link)



An Unconventional Solution:
Projectile-Based Networking (data collection and relay network with 2-8 sec life time, 3D space dispersed)

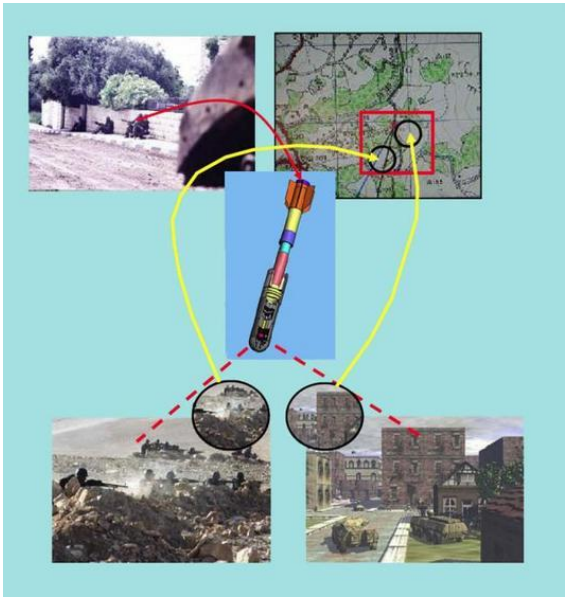


Projectile-Based Networking (data collection and relay network with 2-8 sec life time, 3D space dispersed)

Rafael Firefly 40 mm LV video round (Israel), 40 x 46 LV Other Grenades

The projectile contains two CCD color video cameras with a resolution of 20 cm per pixel at the maximum altitude of 150 m, at which a coverage of 1,200 m² is provided. The maximum flight time of the projectile is 8 seconds. The signal from the cameras is sent back to a hand-held computer for storage and analysis

TASER International Inc. XREP wireless 12-gauge Neuro Muscular Incapacitation (NMI) projectile.



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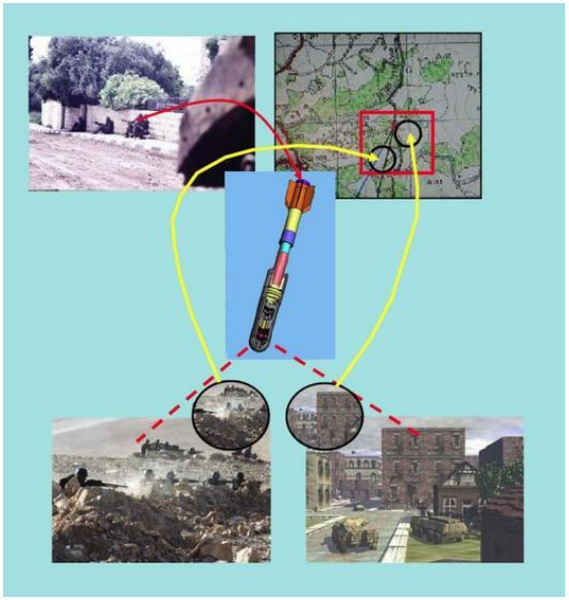
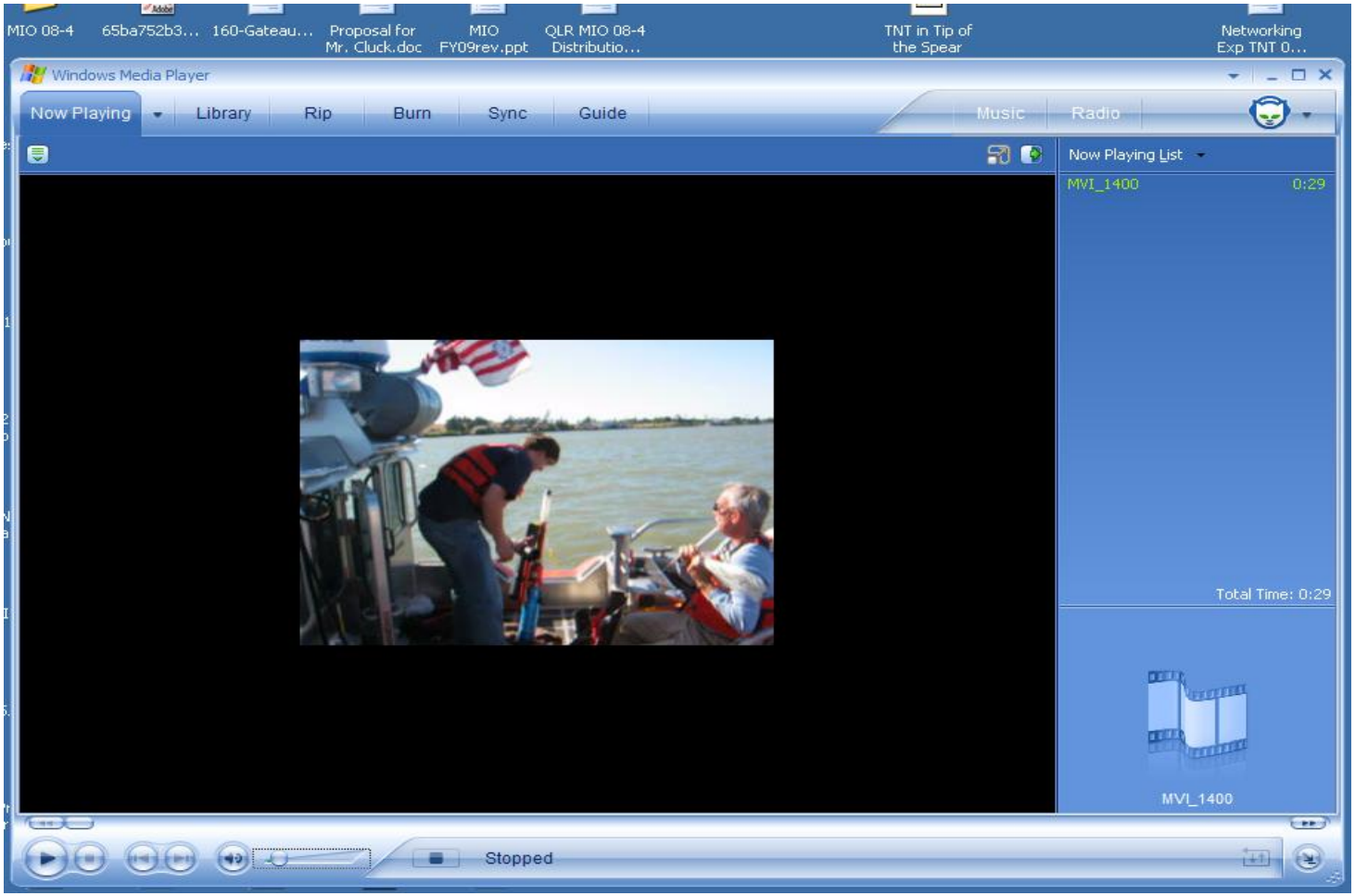
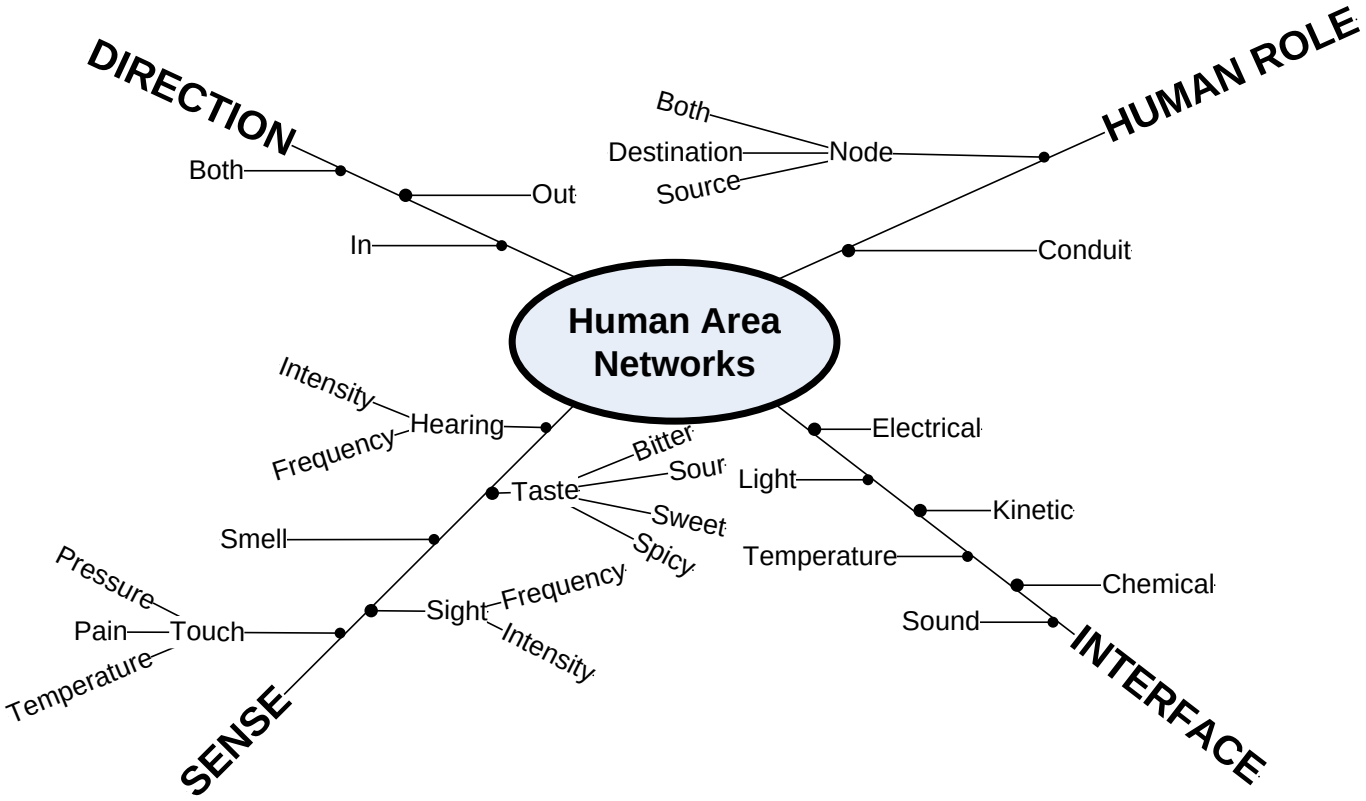


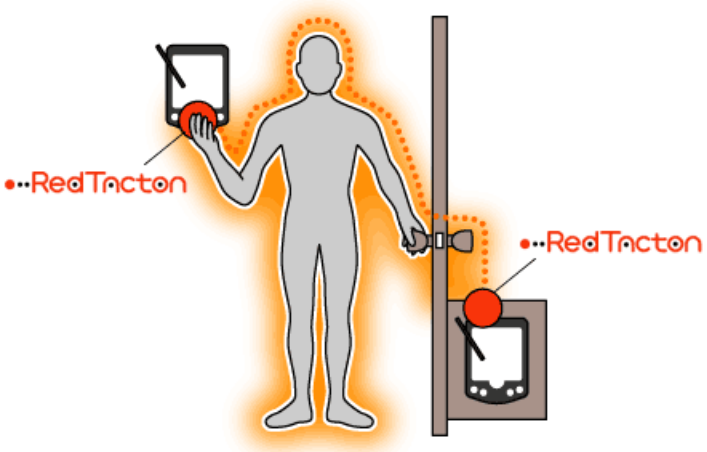
Projectile-Based Networking in MIO Experiments: Small Boat Drive-by Detection at High Speed

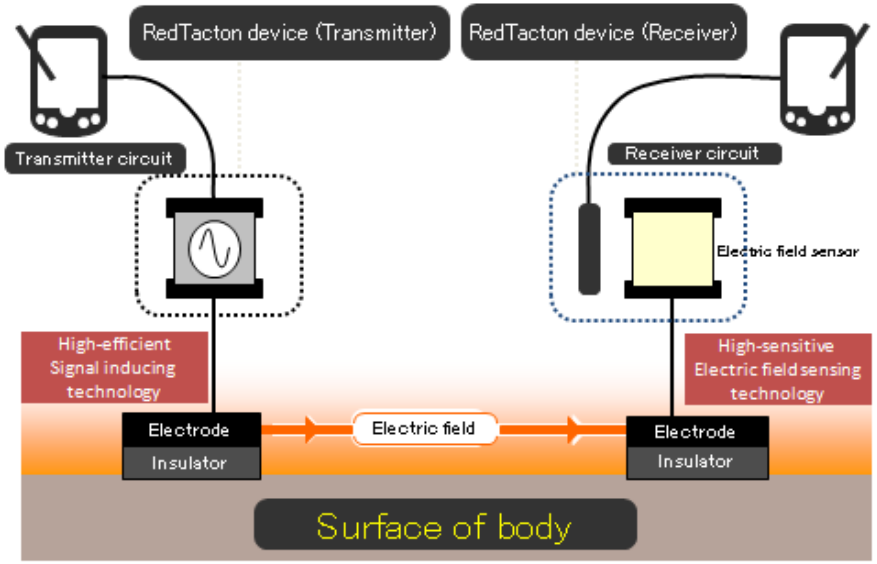


Networking-by-Touch: Using Human Network as Medium for Transferring Messages (Touchlets) Through Tactile or Electronic Interface
(with MAJ Rideout and LCDR Strickland)

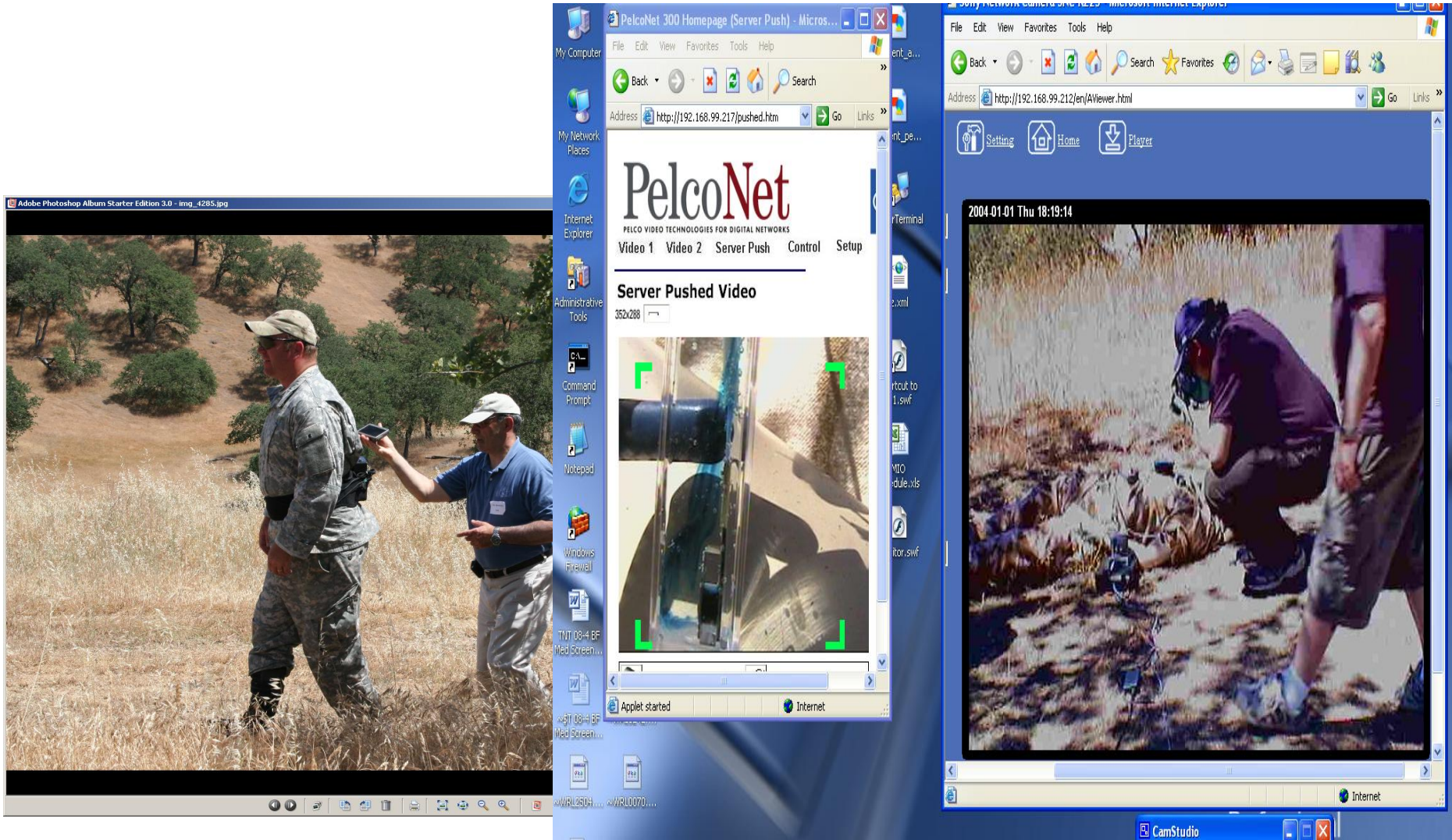


N-by-T Space and Time Covert File Transfer: Sony Transfer Jet and Nippon Red Tacton





Networking-by-Touch in Battlefield Medical Experiments: Tactile Vest (Medic), Nano Drug Delivery Device




NPS
PRAESTANTIA PER SCIENTIAM


CENTER
FOR NETWORK
CENETIX
INNOVATION AND
EXPERIMENTATION

Questions?