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Sensors, and Command, Control, Communications, and Intelligence (C3I) Technologies for Homeland Security and Homeland Defense IX

Edward M. Carapezza
Editor

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Contents

xi Conference Committee

xv Introduction

xvii The U.S. Department of Defense Joint Non-Lethal Weapons Program (Keynote Presentation)
D. Law, Joint Non-lethal Weapons Directorate (United States)

CYBER SECURITY

7666 03 Implementation of DoS attack and mitigation strategies in IEEE 802.11b/g WLAN [7666-02]
J. Deng, Intelligent Automation, Inc. (United States); K. Meng, Y. Xiao, The Univ. of Alabama
(United States); R. Xu, Intelligent Automation, Inc. (United States)

7666 04 Hypergame theory applied to cyber attack and defense [7666-03]
J. T. House, G. Cybenko, Dartmouth College (United States)

7666 05 Using principal component analysis for selecting network behavioral anomaly metrics
[7666-04]
I. Gregorio-de Souza, V. Berk, Dartmouth College (United States); A. Barsamian, ProQueSys,
LLC (United States)

7666 06 Dynamic social network analysis using conversational dynamics in social networking and
microblogging environments [7666-05]
G. Stocco, R. Savell, G. Cybenko, Dartmouth College (United States)

7666 07 Effectively identifying user profiles in network and host metrics [7666-06]
J. P. Murphy, V. H. Berk, I. Gregorio-de Souza, Dartmouth College (United States)

COMMUNICATION TECHNOLOGIES

7666 08 Comparison of experimental and mathematical models of attenuation and dispersion for
co-propagating helical channels of same wavelength in optical fibers [7666-07]
S. H. Murshid, A. Chakravarty, Florida Institute of Technology (United States)

7666 09 Effect of atmosphere on free-space optical communication networks for border patrol
[7666-08]
J. Zeller, T. Manzur, Naval Undersea Warfare Ctr. (United States)

7666 0A CAD simulated and experimental beam profile analysis of single-mode tapered fibers for
optical bandwidth enhancement applications [7666-09]
S. H. Murshid, R. Biswas, A. Chakravarty, Florida Institute of Technology (United States)
7666 0M  Structure mapping for improved situational awareness, missions planning, and operator tracking [7666-21]
J. Williams, M. Reese, W. Calcutt, J. Morrison, McQ, Inc. (United States); G. J. Roehrich, U.S. Army Armament Research, Development, and Engineering Ctr. (United States)

7666 0N  Increasing situation awareness of the CBRNE robot operators [7666-22]
P. Jasiobedzki, H.-K. Ng, M. Bondy, MacDonald, Dettwiler, and Associates Ltd. (Canada); C. H. McDiarmid, Royal Canadian Mounted Police (Canada)

7666 0R  A new framework of multistage parametric inference [7666-26]
X. Chen, Southern Univ. (United States)

7666 0S  First responder tracking and visualization for command and control toolkit [7666-27]
R. Woodley, P. Petrov, R. Meisinger, 21st Century Systems, Inc. (United States)

7666 0T  A disaster evacuation planning tool (ADEPT) [7666-28]
T. Feeley, J. Ferguson, R. Hosch, Rite-Solutions, Inc. (United States)

7666 0U  Bayesian performance metrics and small system integration in recent homeland security and defense applications [7666-29]
T. Jannson, A. Kostrzewski, E. Patton, R. Pradhan, M.-Y. Shih, K. Walter, G. Savant, R. Shie, T. Forrester, Physical Optics Corp. (United States)

7666 0V  A Bayesian belief network of threat anticipation and terrorist motivations [7666-30]
M. M. Olama, G. O. Allgood, Oak Ridge National Lab. (United States); K. M. Davenport, Southwestern Univ. (United States); J. C. Schryver, Oak Ridge National Lab. (United States)

7666 0W  Detection of deception in structured interviews using sensors and algorithms [7666-32]
M. G. Cunha, The Charles Stark Draper Lab., Inc. (United States); A. C. Clarke, J. Z. Martin, J. R. Beauregard, MRAC, LLC (United States); A. K. Webb, A. A. Hensley, N. Q. Keshava, The Charles Stark Draper Lab., Inc. (United States); D. J. Martin, MRAC, LLC (United States)

7666 0X  Sensing systems efficiency evaluation and comparison for homeland security and homeland defense [7666-33]
A. A. Pakhomov, Security and Defense Research, LLC (United States)

7666 0Z  Optical receiver for high-speed communication [7666-110]
P. A. Mitchell, V. J. Grib, Photonis USA, Inc. (United States)
PERSPECTIVES ON GLOBAL HEALTH

7666 10  Extreme health sensing: the challenges, technologies, and strategies for active health sustainment of military personnel during training and combat missions (Keynote Paper) [7666-34]
M. Buller, U.S. Army Research Institute of Environmental Medicine (United States) and Brown Univ. (United States); A. Welles, U.S. Army Research Institute of Environmental Medicine (United States); O. Chadwicke Jenkins, Brown Univ. (United States); R. Hoyt, U.S. Army Research Institute of Environmental Medicine (United States)

7666 13  The emerging role of global situational awareness 2.0 resources in disaster response (Invited Paper) [7666-37]
C. Taylor, Univ. of South Alabama (United States)

BIOMARKERS

7666 17  Hepcidin: an emerging biomarker for iron disorders, inflammatory diseases, and infections [7666-43]
M. E. Westerman, G. Olbina, V. E. Ostland, E. Nemeth, T. Ganz, Intrinsic LifeSciences LLC (United States)

NANOMATERIALS: BIOMEDICAL APPLICATIONS AND HEALTH EFFECTS

7666 18  Environmental, health, and safety effects of engineered nanomaterials: challenges and research needs [7666-44]
H. Fairbrother, The Johns Hopkins Univ. (United States)

7666 19  Quantum dots in life sciences: applications, benefits, and safety issues [7666-45]

BIOSENSORS AND MOLECULAR DIAGNOSTICS

7666 1B  Epidemiological monitoring for emerging infectious diseases [7666-47]
M. Greene, Science Applications International Corp. (United States)

7666 1D  Resequencing Pathogen Microarray (RPM) for prospective detection and identification of emergent pathogen strains and variants [7666-49]
C. Tibbetts, A. M. Lichanska, L. A. Borsuk, B. Weslowski, L. M. Morris, M. C. Lorence, K. O. Schafer, TessArae, LLC (United States); J. Campos, M. Sene, Children's National Medical Ctr. (United States); C. A. Myers, D. Faix, P. J. Blair, J. Brown, D. Metzgar, Naval Health Research Ctr. (United States)
Analysis of dust samples from the Middle East using high-density resequencing micro-array RPM-TEI [7666-50]
T. A. Leski, U.S. Naval Research Lab. (United States); M. J. Gregory, U.S. Naval Research Lab. (United States) and U.S. Navy (United States); A. P. Malanoski, J. P. Smith, U.S. Naval Research Lab. (United States); R. H. Glaven, U.S. Naval Research Lab. (United States) and Nova Research Inc. (United States); Z. Wang, D. A. Stenger, B. Lin, U.S. Naval Research Lab. (United States)

Development of a microfluidic system for measuring HIV-1 viral load [7666-53]
S. Wang, A. Ip, F. Xu, Brigham and Women’s Hospital (United States); F. F. Giguel, Massachusetts General Hospital (United States); S. Moon, A. Akay, D. R. Kuritzkes, Brigham and Women’s Hospital (United States); U. Demirci, Brigham and Women’s Hospital (United States) and Harvard-MIT Division of Health Sciences and Technology (United States)

The toolbox of fluorescence standards: flexible calibration tools for the standardization of fluorescence-based measurements [7666-55]
U. Resch-Genger, K. Hoffmann, C. Würth, T. Behnke, A. Hoffmann, D. Pfeifer, BAM Federal Institute for Materials Research and Testing (Germany); A. Engel, Schott AG (Germany)

Laser- and UV-LED-induced fluorescence detection of dissolved organic compounds in water [7666-58]
A. V. Sharikova, D. K. Killinger, Univ. of South Florida (United States)

Behavioral analysis of loosely coupled systems [7666-59]
N. F. Sandell, G. V. Cybenko, Dartmouth College (United States)

Considerations for developing technologies for an integrated person-borne IED countermeasure architecture [7666-60]

Homeland security application of the Army Soft Target Exploitation and Fusion (STEF) system [7666-62]
R. T. Antony, SAIC (United States); J. A. Karakowski, U.S. Army Research, Development, and Engineering Command (United States)

Novel wavelength diversity technique for high-speed atmospheric turbulence compensation [7666-66]
W. W. Arrasmith, S. F. Sullivan, Florida Institute of Technology (United States)

A flat laser array aperture [7666-67]
A multispectral automatic target recognition application for maritime surveillance, search, and rescue [7666-70]
J. Schoonmaker, Advanced Coherent Technologies LLC (United States); S. Reed, SeeByte Ltd. (United Kingdom); Y. Podobna, Advanced Coherent Technologies LLC (United States); J. Vazquez, SeeByte Ltd. (United Kingdom); C. Boucher, Advanced Coherent Technologies LLC (United States)

Advances in IR thermal imaging for border defense [7666-73]
D. P. Forrai, P. Smith, L-3 Communications Cincinnati Electronics (United States)

Characterization of an InGaN-based photo-emissive device [7666-108]
J. W. Glesener, L-3 Electro-Optical Systems (United States); A. M. Dabiran, SVT Associates, Inc. (United States); J. P. Estrera, L-3 Electro-Optical Systems (United States)

Solar powered wireless sensor systems for border security [7666-75]
H. Zhang, M. Fallahi, S. Pau, R. A. Norwood, N. Peyghambarian, College of Optical Sciences, The Univ. of Arizona (United States)

Passive tracking of targets using electric field sensors [7666-76]
S. Beardsmore-Rust, P. B. Stiffell, H. Prance, R. J. Prance, P. Watson, Univ. of Sussex (United Kingdom)

Smart sensing surveillance system [7666-77]
C. Hsu, Trident Systems Inc. (United States); K.-D. Chu, U.S. Dept. of Homeland Security (United States); J. O’Looney, M. Blake, C. Rutar, Trident Systems Inc. (United States)

Autonomous energy harvesting embedded sensors for border security applications [7666-78]
A. Hande, P. Shah, Texas MicroPower, Inc. (United States); J. N. Falasco, D. Weiner, Crane Wireless Monitoring Solutions (United States)

Robust site security using smart seismic array technology and multi-sensor data fusion [7666-79]
D. Hellickson, Honeywell Aerospace (United States); P. Richards, Z. Reynolds, Quantum Technology Sciences, Inc. (United States); J. Keener, Air Force Research Lab. (United States)

Energy harvesting with low-power electronics [7666-81]

Multiple-input multiple-output (MIMO) analog-to-feature converter chipsets for sub-wavelength acoustic source localization and bearing estimation [7666-82]
S. Chakrabartty, Michigan State Univ. (United States)

Low-frequency signals detection and identification as a key point of software for surveillance and security applications [7666-83]
A. A. Pakhomov, Security and Defense Research, LLC (United States)
Validation of a BOTDR-based system for the detection of smuggling tunnels [7666-84]
I. Elkayam, A. Klar, R. Linker, Technion-Israel Institute of Technology (Israel); A. M. Marshall, Univ. of Nottingham (United Kingdom)

Weapon identification across varying acoustic conditions using an exemplar embedding approach [7666-85]
S. Khan, A. Divakaran, H. S. Sawhney, Sarnoff Corp. (United States)

Results of field testing with the FightSight infrared-based projectile tracking and weapon-fire characterization technology [7666-86]

Minimizing the search space in sniper localization using sensor configuration [7666-87]
T. Damarla, U.S. Army Research Lab. (United States)

Sniper detection using infrared camera: technical possibilities and limitations [7666-88]
M. Kastek, R. Dulski, P. Trzaskawka, G. Biesczad, Military Univ. of Technology (Poland)

A smart ROV solution for ship hull and harbor inspection [7666-94]
S. Reed, J. Wood, J. Vazquez, P.-Y. Mignotte, B. Privat, SeeByte Ltd. (United Kingdom)

Wide area active collaborative tracking of waterborne vessels [7666-90]
A. Tamrakar, S.-H. Jung, C. Broadus, A. Divakaran, H. Sawhney, Sarnoff Corp. (United States)

Task-specific sensor settings for electro-optical systems in a marine environment [7666-91]
P. B. W. Schwering, S. P. van den Broek, R. A. W. Kemp, H. A. Lensen, TNO Defence, Security and Safety (Netherlands)

A demonstration of a low cost approach to security at shipping facilities and ports [7666-92]
R. C. Huck, M. K. Al Akkoumi, R. W. Herath, J. J. Sluss, Jr., S. Radhakrishnan, T. L. Landers, Univ. of Oklahoma (United States)

Detecting underwater improvised explosive threats (DUET) [7666-95]
T. Feeley, Rite-Solutions, Inc. (United States)

Benthic microbial fuel cells: long-term power sources for wireless marine sensor networks [7666-96]
J. J. Guzman, K. G. Cooke, M. O. Gay, S. E. Radachowsky, Trophos Energy, Inc. (United States); P. R. Girguis, Harvard Univ. (United States); M. A. Chiu, Trophos Energy, Inc. (United States)

Rule-based expert system for maritime anomaly detection [7666-97]
J. Roy, Defence Research and Development Canada (Canada)
### AIR TRANSPORTATION SECURITY: COUNTER MANPAD SYSTEMS

**7666 2T**  
**Capacity utilization study for aviation security cargo inspection queuing system** [7666-103]  
G. O. Allgood, M. M. Olama, J. E. Lake, Oak Ridge National Lab. (United States);  
D. Brumback, CVG Delta Cargo Facility (United States)

### MATERIAL AND CONCEALED OBJECT INSPECTION

**7666 2U**  
**Multi-channel millimeter wave image registration and segmentation for concealed object detection** [7666-104]  
D.-S. Lee, S. Yeom, J.-Y. Son, S.-H. Kim, Daegu Univ. (Korea, Republic of)

**7666 2V**  
**The use of triangle diagram in the detection of explosive and illicit drugs** [7666-106]  
D. Sudac, M. Baricevic, J. Obhodas, Institut Ruđer Bošković (Croatia); A. Franulovic, Croatian Customs (Croatia); V. Valkovic, A.C.T.d.o.o. (Croatia)

**7666 2W**  
**A distributed sensor system for detection of toxic and hazardous gases** [7666-107]  
S. A. Eliza, R. Olah, A. K. Dutta, Banpil Photonics, Inc. (United States)

**Author Index**
Conference Committee

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2 Communication Technologies
Edward M. Carapezza, University of Connecticut (United States) and Defense Advanced Research Projects Agency (United States)

3 Non-Lethal Weapon (NLW) Technologies and Systems
David B. Law, Joint Non-Lethal Weapons Directorate (United States)

4 Decision Support/Command, Control, and Intelligence I
Tariq Manzur, Naval Undersea Warfare Center (United States)

5 Decision Support/Command, Control, and Intelligence II
Tariq Manzur, Naval Undersea Warfare Center (United States)

6 Perspectives on Global Health
Šárka O. Southern, Gaia Medical Institute (United States)
Kevin N. Montgomery, U. S. Army Telemedicine and Advanced Technology Research Center (United States)

7 Biomarkers
Šárka O. Southern, Gaia Medical Institute (United States)
Mark E. Westerman, Intrinsic LifeScience (United States)

8 Nanomaterials: Biomedical Applications and Health Effects
Šárka O. Southern, Gaia Medical Institute (United States)
Howard Fairbrother, The Johns Hopkins University (United States)

9 Biosensors and Molecular Diagnostics
Šárka O. Southern, Gaia Medical Institute (United States)
Konrad Faulstich, Embedded System Engineering GmbH (Germany)
10 Decision Support/Command, Control, and Intelligence III  
Jon Schoonmaker, Advanced Coherent Technologies LLC (United States)  
Daniel Lehrfeld, Blue Marble Group, LLC (United States)  

11 Imaging Sensors and Surveillance Systems I  
Jon Schoonmaker, Advanced Coherent Technologies LLC (United States)  
Tariq Manzur, Naval Undersea Warfare Center (United States)  
Daniel Lehrfeld, Blue Marble Group, LLC (United States)  

12 Imaging Sensors and Surveillance Systems II  
Jon Schoonmaker, Advanced Coherent Technologies LLC (United States)  
Tariq Manzur, Naval Undersea Warfare Center (United States)  
Daniel Lehrfeld, Blue Marble Group, LLC (United States)  

13 Ground Surveillance Systems: Joint Session with Conference 7693  
Daniel Lehrfeld, Blue Marble Group, LLC (United States)  
Tariq Manzur, Naval Undersea Warfare Center (United States)  

14 Counter Sniper: Joint Session with Conference 7693  
Myron E. Hohil, U.S. Army RDECOM (United States)  
Sachi V. Desai, U.S. Army Armament Research, Development and Engineering Center (United States)  

15 Maritime and Port Surveillance: Joint Session with Conference 7693  
Tariq Manzur, Naval Undersea Warfare Center (United States)  
Han Q. Le, University of Houston (United States)  

16 Air Transportation Security: Counter Manpad Systems  
Daniel Lehrfeld, Blue Marble Group, LLC (United States)  
Tariq Manzur, Naval Undersea Warfare Center (United States)  

17 Material and Concealed Object Inspection  
Daniel Lehrfeld, Blue Marble Group, LLC (United States)  
Tariq Manzur, Naval Undersea Warfare Center (United States)
Introduction

The interest in sensors and command, control, communications, and intelligence technologies for homeland security and homeland defense and applications has dramatically increased over the past several years. Systems are being developed in support of homeland security, intelligence, and law enforcement applications around the world. Government agencies are making significant investments to develop improved sensors, sensor networks, communication systems, and command, control, and decision-making technologies. This SPIE conference series is devoted to papers on recent technological advancements in related technologies and applications.

The conference included 90 talks, with 6 keynote and 84 technical paper presentations, organized into 15 session topics covering recent advances in cyber security, communication technologies, non-lethal weapon technologies and systems, decision support/command, control, and intelligence, perspectives on global health, biomarkers, nanomaterials: biomedical applications and health effects, biosensors and molecular diagnostics, imaging sensors and surveillance systems, ground surveillance systems, counter sniper, maritime and port surveillance, air transportation security; counter manpad systems, and material and concealed object inspection.

Additionally there was an all day series of joint technical sessions with the Unattended Ground, Sea, and Air Sensor Technologies and Applications conference 7693 on counter sniper, ground surveillance systems, and maritime and port surveillance systems. The following six keynote talks were given and we sincerely thank all of these speakers for very stimulating and relevant presentations:

1) “Enhanced Cyber Security with CyLab Technologies” by Jonathan McCune from Carnegie Mellon University

2) “Next Generation Non-Lethal Weapons (NLW) versus Current Joint Non-Lethal Weapons Capability Gaps” by David Law from the Joint Non-Lethal Weapons Directorate

3) “Command and Control in Homeland Security” by David G. Boyd from the U.S. Dept. of Homeland Security

4) “Extreme Health Sensing: the Challenges, Technologies, and Strategies for Active Health Sustainment of Military Personnel during Training and Combat Missions” by Mark J. Buller from the U.S. Army Research Institute of Environmental Medicine


6) “DHS Counter-MANPADS Program: Scope and Results” by Kerry D. Wilson from the U.S. Dept. of Homeland Security
Thanks to those who prepared and presented the technical papers and for their contribution to a very successful meeting. The success of this conference is attributed to the participation of the commercial, university, and government research-and-development community, as well as the organizing efforts of the diverse and talented program committee.

Thanks to our program committee members for their dedication, time and assistance in conference planning and organizing and especially to those members who were able to participate as session chairs including: Zoraida P. Aguilar, Ocean Nanotech, LLC; John G. Bittch, ARACAR: Alliance for Robot Assisted Crisis Assessment and Response; George V. Cybenko, Dartmouth College; Michael J. DeWeert, BAE Systems; Mildred A. Donlon, Defense Advanced Research Projects Agency; John S. Eicke, Army Research Lab.; Konrad Faulstich, Embedded System Engineering GmbH (Germany); Jeffrey R. Heberley, U.S. Army Armament Research, Development and Engineering Ctr.; Todd M. Hintz, Space and Naval Warfare Systems Command; Myron E. Hohil, U.S. Army Research, Development and Engineering Command; Ivan Kadar, Interlink Systems Sciences, Inc.; Pradeep K. Khosla, Carnegie Mellon Univ.; Peter Kiesel, Palo Alto Research Ctr., Inc.; Han Q. Le, Univ. of Houston; Daniel Lehrfeld, Blue Marble Group, LLC; Baocchuan Lin, U.S. Naval Research Lab.; Tariq Manzur, Naval Undersea Warfare Ctr.; Igor L. Medintz, U.S. Naval Research Lab.; Paul F. Morgan, U.S. Special Operations Command; Richard M. Ozanich, Pacific Northwest National Lab.; Dennis J. Reimer, National Memorial Institute for the Prevention of Terrorism; Steven A. Ripp, The Univ. of Tennessee; Kim E. Sapsford, U.S. Food and Drug Administration; Glenn T. Shwaery, Univ. of New Hampshire; Šárka O. Southern, Gaia Medical Institute; Nino Srour, Army Research Lab.; Aurel Ymeti, Ostendum R&D BV (Netherlands)

Very special thanks to 5 program committee members who worked especially hard to help organize this challenging conference: Todd M. Hintz, Myron E. Hohil, Tariq Manzur, Daniel Lehrfeld, and Šárka Southern. Dr Šárka Southern deserves special thanks for organizing four new Global Health related sessions. She hopes to stimulate more interest in this important technical area and to hopefully develop these sessions into a stand-alone homeland security related conference in future years. We could not have had so successful a technical conference without the excellent help and dedication of these five people.

Finally, an extra special thanks to all of the conference attendees this year for your interest and enthusiasm. The conference was well attended, with a great deal of interest in all the sessions. We hope the interest in this technology continues to grow, and that this conference will expand with even greater technical content and significance in future years.

Edward M. Carapezza
Purpose

- Identify DoD’s high priority NLW needs through: (1) a recently completed Capabilities-Based Assessment (JCIDS) and (2) Service/COCOM’s current urgent needs
- Set the stage for those JNLWP projects which will come next after this brief
  - Show how these technology development efforts mitigate and address these known joint capability-gaps
- **Goals:** (1) Forge new coordination and collaboration opportunities for NLW technology research within the DoD and all other government agencies and organizations and (2) increase and facilitate fielding of NLWs by the Services to meet today’s warfare (irregular, traditional, catastrophic, and disruptive)
Joint Non-Lethal Weapons Directorate

- Established as a Jointly Manned Activity in 1996/97
  - All Services plus US Coast Guard
- Serves as the focal point for DoD NLW Program
  - All four Services, SOCOM, and US Coast Guard
- Manages the day-to-day operations of the DoD Program for the Executive Agent
- Provides S&T and R&D funding to Milestone B/C
- Chairs NATO NLW Sub-committee

DoD Non-Lethal Weapons Program Management Structure
JNLWP Management Structure

Joint Integrated Product Team (JIPT)
- Approves JNLWP budget
- Approves resolution of program issues
- Reviews Joint & Service-unique programs
- Meets 2-4 times per year

Joint Coordination & Integration Group (JCIG)
- Recommends program priorities for development and funding
- Recommends lead-Service designations
- Meets 2-4 times per year

Non-Voting Members - OSD, DOS, DOJ, DOE, DHS, NGB, Border Patrol, Combatant Commanders and Joint Staff have representation on the IPT and JCIG

JNLWP Budget

BA2: Applied Research (USN ONR/OSD Oversight)
- NL studies and analysis to augment and support current JNLWP areas of interest as well as explore new NLW technology opportunities: Includes experimentation and model development. (TRL 2&3)

BA3: Advanced Technology Development (USN ONR/OSD Oversight)
- Next generation NLW concepts and advanced prototype development to support challenging mission needs: Includes laboratory and field testing and model verification and validation. (TRL 4&5)

BA4: Advanced Component Development and Prototypes (ACD&P) (DC PP&O Oversight)
- Primary source of funds. Supports research and development of JNLWP efforts. Includes efforts necessary to evaluate integrated technologies, prototype systems and to expedite technology transition from laboratory to operational use. (TRL 6&7)
DoD NLW Definition

"Weapons, devices and munitions that are explicitly designed and primarily employed to incapacitate targeted personnel or materiel immediately, while minimizing fatalities, permanent injury to personnel, and undesired damage to property in the target area or environment. Non-lethal weapons are intended to have reversible effects on personnel and materiel."

Non-Lethal Weapons Core Capabilities:

Counter-Personnel (CP)
- Suppress
- Move
- Deny
- Disable

Counter-Materiel (CM)
- Stop
- Disable
- Divert
- Deny Access

Key Attributes: Incapacitation and Reversibility

Joint Non-Lethal Effects ICDs

JCID-JNLE ICDs
- Joint Capabilities Document signed February 2008
- CP & CM Initial Capability Documents signed April 2009

CP TASKS
- Deny
- Move
- Disable
- Suppress

CM TASKS
- Stop Vehicle
- Disable Vehicle
- Stop Vessel
- Disable Vessel
- Stop Arctf on Ground
- Disable Arctf on Ground
- Divert Arctf in Air
- Deny Access to Facility

CBA Membership

J2/J3/J8 JFCOM EUCOM PACOM CENTCOM STRATCOM NORTHCOM USA USCG USMC USN USAF JNLWD OSD AT&L *HECOE

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## JNLWP Priority Focus Areas

### Counter-Materiel

<table>
<thead>
<tr>
<th>Action</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop Vehicle</td>
<td>small/medium/large, confined, single</td>
</tr>
<tr>
<td>Stop Vehicle</td>
<td>medium, confined, single</td>
</tr>
<tr>
<td>Stop Vehicle</td>
<td>large, confined, single</td>
</tr>
<tr>
<td>Stop Vessel</td>
<td>small, confined, single, [friendly anchored]</td>
</tr>
<tr>
<td>Stop Vessel</td>
<td>small, open, single, [friendly underway]</td>
</tr>
</tbody>
</table>

### Counter-Personnel

<table>
<thead>
<tr>
<th>Action</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suppress Individuals</td>
<td>confined, single/few</td>
</tr>
<tr>
<td>Suppress Individuals</td>
<td>open, many</td>
</tr>
<tr>
<td>Move Individuals</td>
<td>through an area, open, many</td>
</tr>
<tr>
<td>Deny Access into/out of an area</td>
<td>to individuals, confined, single/few/many</td>
</tr>
<tr>
<td>Deny Access into/out of an area</td>
<td>to individuals, open, single/few/many</td>
</tr>
</tbody>
</table>

## Spectrum of Response

“NLWs Provide Operating Forces Needed Capabilities”

“Increasing RANGE increases OPTIONS”

### Spectrum Diagram

- **Military Presence**
- **Non-Lethal Weapons**
- **Lethal Force**

- Target selected individuals
- Clear personnel
- Control group movements
- Secure without Destroying
DoD NLW Deployment Timeline

1996
USMC NL Capability Set Fielding Begins

1998
US Army NL Capability Set Fielding Begins

2000
NLWs used in Kosovo

2001
40mm NLM Fielding Begins
Portable Vehicle Arresting Barrier Fielding Begins
Modular Crowd Control Munition Fielding Begins

2004
NLWs used in the Olympic Games – Athens, Greece
Haiti – Vehicle Lightweight Arresting Device M2 Net Urgently Fielded & Used Operationally
OIF – VLAD M2 Nets, FN303, M/X26 Taser, Acoustic Hailing Devices Urgently Fielded

2006
GBD-IIIC Laser Dazzlers Urgently Fielded
M/X26 Tasers Urgently Fielded

2007
Running Gear Entanglement Systems Deployed
USAF and National Guard Bureau NL Capability Set Fielding Begins

2008
Joint NL Warning Munitions Urgently Fielded

2010
X26 Taser Fielding Begins
Improved Acoustic Hailing Device Fielding Begins
MK19 NLM Fielding Begins
VLAD Heavier Net / Remote Deployment Device Fielding Begins

Near-Term Technology Solutions

**Counter-Personnel Capabilities**

*Suppress, Move, & Deny Individuals*

- Optical Distractors & Acoustics
- Commercial Off-the-Shelf Human Electromuscular Incapacitation Devices
- Advanced Materials for Non-lethal Projectiles

**Counter-Materiel Capabilities**

*Stop Vehicles, Stop Vessels, & Deny Access to a Facility*

- Electrical Vehicle Stopping
- Entanglement Devices

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Mid-Term Technology Solutions

Counter-Personnel Capabilities
Suppress, Move, Deny & Disable Individuals
- Sheet Beam Klystron
- Long Range Human Electro-Muscular Incapacitation
- Active Denial Technologies
- Counter-Swimmer Human Effects
- Malodorants

Counter-Materiel Capabilities
Stop/Disable Vehicles, Stop/Disable Vessels, Stop/Disable/Divert Aircraft
- Directed Energy Vehicle / Vessel Stoppers
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Far-Term Technology Solutions

Counter-Personnel Capabilities
Suppress, Move, Deny & Disable Individuals
- Solid State Arrays
- Nanosecond Electrical Pulses for LR HEMI
- Active Denial Technologies
- Synergistic NL Effects Weapons
- Ultra Short Pulse Lasers – Neuro-effects
- Ultra Short Pulse Lasers – Flash, Acoustics, and Thermal Effects

Counter-Materiel Capabilities
Stop/Disable Vehicles, Stop/Disable Vessels, Stop/Disable/Divert Aircraft
- Long Range DEW Vehicle / Vessel Stoppers
- Counter Aircraft Capabilities
  UNCLASSIFIED - For Official Use Only
- Ultra Short Pulse Lasers – Counter-Sensor
Non-Lethal Weapons
Overall Challenges

Policy
- Public Affairs
- Political risk
- Public Acceptability
- Human Effects

Legal
- CONOPS
- Tactics, Techniques & Procedures
- Rules of Engagement
- Training & Logistics
- Human Effects
- Safety Assessments

Treaty
- Favorable Legal Opinion
- CONOPS
- Tactics, Techniques & Procedures
- Rules of Engagement
- Human Effects
- Safety Assessments

Technology
- Cost, Schedule, Performance
- S&T vs. RDT&E vs. Formal Acquisition Program
- Human Effects
- NLW Effectiveness

Human Effects & Effectiveness

Non-Lethal Stimuli
- Light
- Sound
- Kinetic Energy
- Directed Energy
- Electrical Charge

Human Effects (Physiological Response)
- Risk of Significant Injury (RSI)
- Non-Permanent Injury
- Intended Effects

Effectiveness (Behavioral Response)
- Individual Response
- Crowd Response

Operationally Relevant Capability
- Suppress
- Move
- Deny
- Disable
Summary

- NLWs provide warfighters with escalation-of-force options while minimizing casualties and collateral damage.
- The need for non-lethal weapons continues to be relevant in today’s national security environment, both domestically and abroad.
- For the last 13 years, the DoD NLW Executive Agent has been successful in coordinating the Department’s non-lethal weapons program.
- There are a number of promising technologies, particularly in directed energy, that have the potential to greatly advance today’s non-lethal weapons capabilities.

Questions

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Backup Slides

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NLW Human Effects Characterization

- Generally, the goal of lethal weapons has been to maximize a single effect
  - lethality, while meeting the constraints of LOAC, logistics, cost, etc
- For NLW, two competing objectives exist: cause a desired effect, while minimizing permanent injuries or fatalities
- Understanding human effects is critical for legal/treaty reviews, policy acceptability, and warfighter awareness
Effects Based Design

- Proposed Effect
  - Surrogate & Tissue Tests
  - Modeling & Simulation
  - Surrogate Tests
  - Human Tests

- Validation Studies
  - Response Models

NL Stimuli
- Directed Energy
  • Light
  • Sound
  • Radiofrequency
- Electrical Energy
- Kinetic Energy
- Advanced NL Materials

32 CFR 219
DoDD 3216.2
IRB Process
ANSI Stds
OSHA Stds
ACGIH Stds

DoDD 3216.1
IACUC
NIH Pub 86-23

Effects Effectiveness
Changed Behavior
Military Utility

Treaty
Legal
Policy
Fielded Weapon

JNLWP Human Effects
Processes

JNLWD – Human Effects Branch
• Provide HE Strategy
• Resource HE Research
• Coordinate HE Reviews

HERB
• Joint Service Board of Medical & Safety Officers
• Legal Treaty & Policy SME Representatives
• HE Safety, Training, Experimentation Guidance

TEAP
• Government & Non-government Board of NLW Effectiveness SMEs

HEAP
• Non-government Board of Bio-effects SMEs

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Current Cross Agency & JNLWP Collaborative Projects

- Department of Homeland Security (USCG is a voting JNLWP member)
  - Small Vessel Stopping (CM) (RF and Propeller Entanglement)
  - Science of Entanglement
  - RF Vehicle Stopping
  - Optical Interruption
  - HEMI H/W and HEMI Bio-Effects
- Department of Justice (NIJ, BoP, FBI)
  - Thermal Laser
  - HEMI Bio-Effects
  - ADT
  - Vehicle Stopping
- Department of State
  - ADT
- Department of Energy
  - Rigid Foam (CP and CM)
- National Guard Bureau
  - NL Blunt Impact munitions
  - NL Acoustics and Dazzlers
  - HEMI H/W
- Defense Threat Reduction Agency (DTRA)
  - ADS
  - Counter-Swimmer
  - Vehicle/Vessel Stopping
- Technical Support Working Group (TSWG)
  - Vehicle Stopping

Mutual Top-5 Capability-Gaps:

- Vehicle Stopping
- Vessel Stopping
- HEMI
- Active Denial Technologies (ADT)
- Optical Interruption & Acoustics

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DoD 5000 Framework & the JNLWP

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