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

Edward M. Carapezza
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The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

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)

DECISION SUPPORT/COMMAND, CONTROL, AND INTELLIGENCE I

- 7666 OM **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 ON **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)

DECISION SUPPORT/COMMAND, CONTROL, AND INTELLIGENCE II

- 7666 OR **A new framework of multistage parametric inference** [7666-26]
X. Chen, Southern Univ. (United States)
- 7666 OS **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 OT **A disaster evacuation planning tool (ADEPT)** [7666-28]
T. Feeley, J. Ferguson, R. Hosch, Rite-Solutions, Inc. (United States)
- 7666 OU **Bayesian performance metrics and small system integration in recent homeland security and defense applications** [7666-29]
T. Jansson, A. Koszrewski, E. Patton, R. Pradhan, M.-Y. Shih, K. Walter, G. Savant, R. Shie, T. Forrester, Physical Optics Corp. (United States)
- 7666 OV **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 OW **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 OX **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 OZ **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]
J. B. Delehanty, C. E. Bradburne, K. Boeneman, K. Susumu, B. C. Mei, U.S. Naval Research Lab. (United States); J. B. Blanco-Canosa, P. E. Dawson, The Scripps Research Institute (United States); H. Mattoussi, A. Huston, I. L. Medintz, U.S. Naval Research Lab. (United States)

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)

- 7666 1E **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)
- 7666 1H **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)
- 7666 1J **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)
- 7666 1L **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)

DECISION SUPPORT/COMMAND, CONTROL, AND INTELLIGENCE III

- 7666 1M **Behavioral analysis of loosely coupled systems** [7666-59]
N. F. Sandell, G. V. Cybenko, Dartmouth College (United States)
- 7666 1N **Considerations for developing technologies for an integrated person-borne IED countermeasure architecture** [7666-60]
N. J. Lombardo, C. K. Knudson, F. C. Rutz, K. J. Pattison, R. C. Stratton, J. C. Wiborg, Pacific Northwest National Lab. (United States)
- 7666 1O **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)

IMAGING SENSORS AND SURVEILLANCE SYSTEMS I

- 7666 1R **Novel wavelength diversity technique for high-speed atmospheric turbulence compensation** [7666-66]
W. W. Arrasmith, S. F. Sullivan, Florida Institute of Technology (United States)
- 7666 1S **A flat laser array aperture** [7666-67]
S. J. Papadakis, G. F. Ricciardi, M. C. Gross, J. A. Krill, The Johns Hopkins Univ. Applied Physics Lab. (United States)

IMAGING SENSORS AND SURVEILLANCE SYSTEMS II

- 7666 1V **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)
- 7666 1Y **Advances in IR thermal imaging for border defense** [7666-73]
D. P. Forrai, P. Smith, L-3 Communications Cincinnati Electronics (United States)
- 7666 20 **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)

GROUND SURVEILLANCE SYSTEMS: JOINT SESSION WITH CONFERENCE 7693

- 7666 21 **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)
- 7666 22 **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)
- 7666 23 **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)
- 7666 24 **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)
- 7666 25 **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)
- 7666 27 **Energy harvesting with low-power electronics** [7666-81]
T. Jansson, T. Forrester, K. Degrood, E. Gans, K. Lee, K. Nguyen, K. Walter, A. Kostrzewski, Physical Optics Corp. (United States)
- 7666 28 **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)
- 7666 29 **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)

- 7666 2A **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)

COUNTER SNIPER: JOINT SESSION WITH CONFERENCE 7693

- 7666 2B **Weapon identification across varying acoustic conditions using an exemplar embedding approach** [7666-85]
S. Khan, A. Divakaran, H. S. Sawhney, Sarnoff Corp. (United States)
- 7666 2C **Results of field testing with the FightSight infrared-based projectile tracking and weapon-fire characterization technology** [7666-86]
S. Snarski, A. Menozzi, T. Sherrill, C. Volpe, M. Wille, Applied Research Associates, Inc. (United States)
- 7666 2D **Minimizing the search space in sniper localization using sensor configuration** [7666-87]
T. Damarla, U.S. Army Research Lab. (United States)
- 7666 2E **Sniper detection using infrared camera: technical possibilities and limitations** [7666-88]
M. Kastek, R. Dulski, P. Trzaskawka, G. Bieszczad, Military Univ. of Technology (Poland)

MARITIME AND PORT SURVEILLANCE: JOINT SESSION WITH CONFERENCE 7693

- 7666 2G **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)
- 7666 2H **Wide area active collaborative tracking of waterborne vessels** [7666-90]
A. Tamrakar, S.-H. Jung, C. Broaddus, A. Divakaran, H. Sawhney, Sarnoff Corp. (United States)
- 7666 2I **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)
- 7666 2J **A demonstration of a low cost approach to security at shipping facilities and ports** [7666-92]
R. C. Huck, M. K. Al Akkoui, R. W. Herath, J. J. Sluss, Jr., S. Radhakrishnan, T. L. Landers, Univ. of Oklahoma (United States)
- 7666 2L **Detecting underwater improvised explosive threats (DUIET)** [7666-95]
T. Feeley, Rite-Solutions, Inc. (United States)
- 7666 2M **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)
- 7666 2N **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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Nino Srour, Army Research Laboratory (United States)
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- 1 Cyber Security
Daniel Lehrfeld, Blue Marble Group, LLC (United States)
Edward M. Carapezza, University of Connecticut (United States) and
Defense Advanced Research Projects Agency (United States)
- 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
- 5) **“Emergency Responder Location Tracking Program: Technologies and Challenges”** by Jalal Mapar from the U.S. Dept. of Homeland Security
- 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. Blich**, 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; **Baochuan 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 Srou**, 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



The U.S. Department of Defense Joint Non-Lethal Weapons Program

SPIE Defense, Security, and Sensing Conference
5-9 April 2010
Orlando, FL

Session: Non-Lethal Weapons (NLW) Technologies and Systems

Presenter: David Law, Technology Division Chief, Joint Non-Lethal Weapons Directorate

Date: 5 April 2010

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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)

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Joint Non-Lethal Weapons Directorate

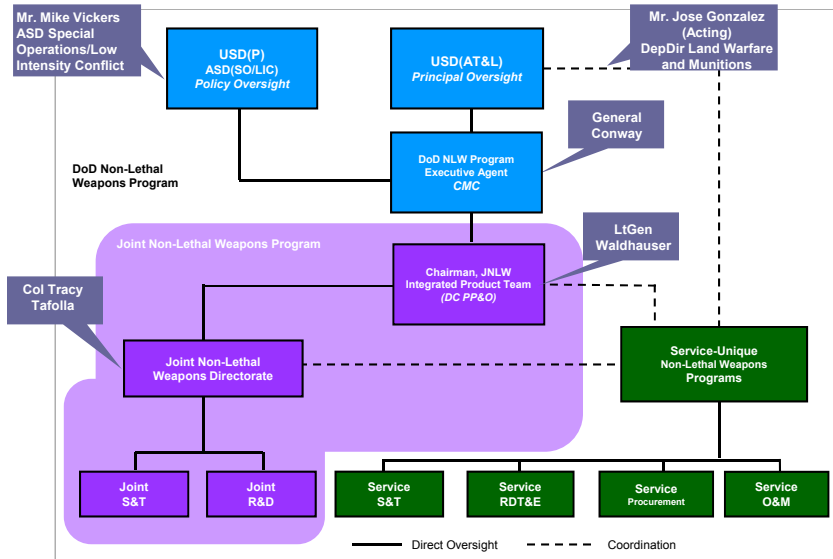


- *Established* as a Jointly Manned Activity in 1996/97
 - All Services plus US Coast Guard
- *Serves* as the focal point for DoD NLW Program
 - All four Services, SOCOM, and US Coast Guard
- *Manages* the day-to-day operations of the DoD Program for the Executive Agent
- *Provides* S&T and R&D funding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

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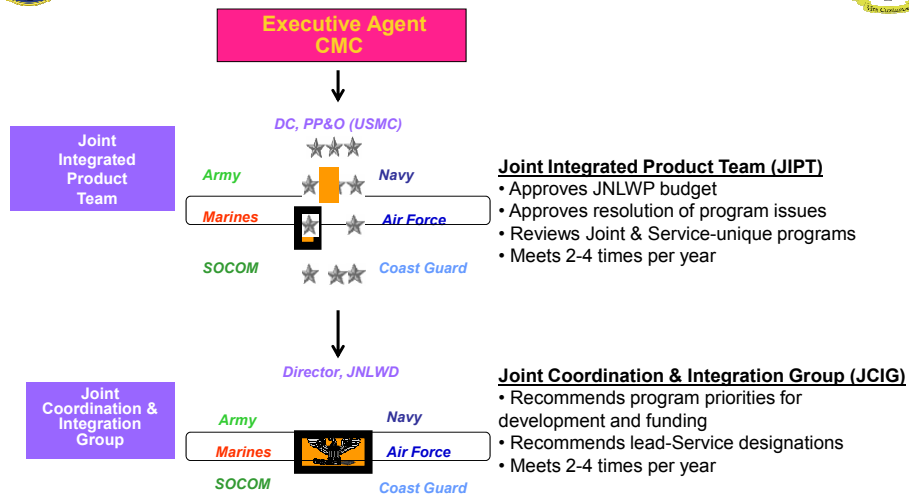
DoD Non-Lethal Weapons Program Management Structure



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JNLWP Management Structure

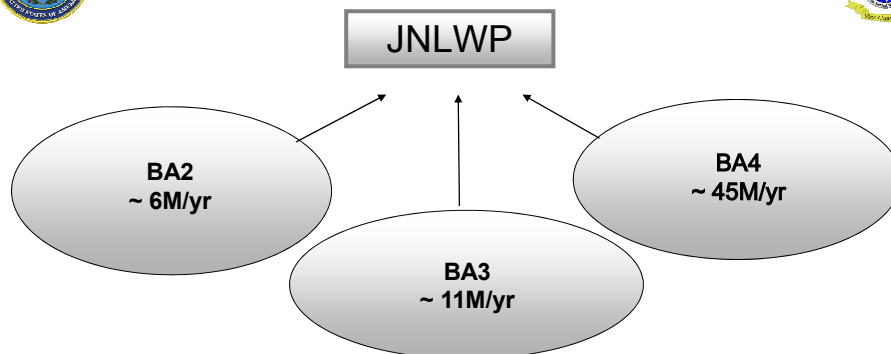


Non-Voting Members - OSD, DOS, DOJ, DOE, DHS, NGB, Border Patrol, Combatant Commanders and Joint Staff have representation on the IPT and JCIG

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JNLWP Budget



BA-2: 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)

BA-3: 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)

BA-4: 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)

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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

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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 Arcft on Ground
- Disable Arcft on Ground
- Divert Arcft 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	
<ul style="list-style-type: none"> • Stop Vehicle (small/medium/large, confined, single) • Stop Vehicle (medium, confined, single) • Stop Vehicle (large, confined, single) 	<ul style="list-style-type: none"> • Stop Vessel (small, confined, single, [friendly anchored]) • Stop Vessel (small, open, single, [friendly underway])

Counter-Personnel	
<ul style="list-style-type: none"> • Suppress Individuals (confined, single/few) • Suppress Individuals (open, many) 	<ul style="list-style-type: none"> • Move Individuals through an area (open, many)
<ul style="list-style-type: none"> • Deny Access into/out of an area to individuals (confined, single/few/ many) • Deny Access into/out of an area to individuals (open, single/few/ many) 	

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Spectrum of Response



“NLWs Provide Operating Forces Needed Capabilities”

“Increasing RANGE increases OPTIONS”



Target selected individuals

Clear personnel

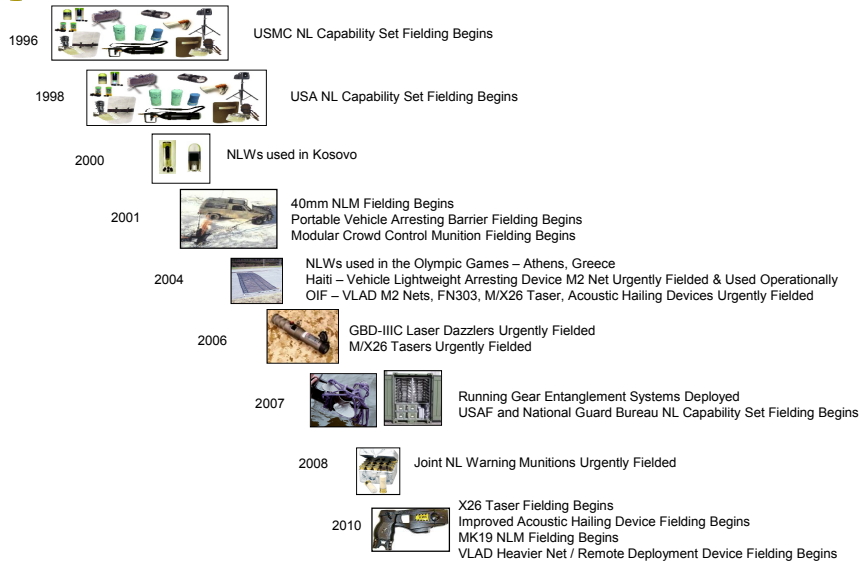
Control group movements

Secure without Destroying

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DoD NLW Deployment Timeline



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Near-Term Technology Solutions



Counter-Personnel Capabilities Suppress, Move, & Deny Individuals



Optical Distractors & Acoustics



Commercial Off-the-Shelf Human Electro-muscular 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

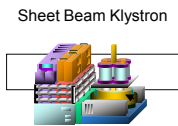


Counter-Personnel Capabilities

Suppress, Move, Deny & Disable Individuals



Long Range Human Electro-Muscular Incapacitation

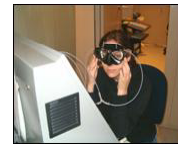


Sheet Beam Klystron

Active Denial Technologies



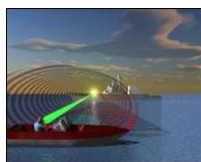
Counter-Swimmer Human Effects



Malodorants

Counter-Materiel Capabilities

Stop/Disable Vehicles, Stop/Disable Vessels, Stop/Disable/Divert Aircraft



Directed Energy Vehicle / Vessel Stoppers

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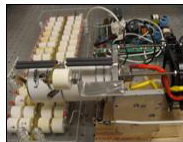


Far-Term Technology Solutions

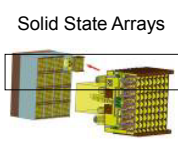


Counter-Personnel Capabilities

Suppress, Move, Deny & Disable Individuals



Nanosecond Electrical Pulses for LR HEMI



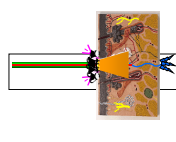
Solid State Arrays

Active Denial Technologies

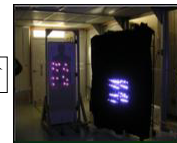


NLW Suite T&E

Synergistic NL Effects Weapons



Ultra Short Pulse Lasers - Neuro-effects



Ultra Short Pulse Lasers - Flash, Acoustics, and Thermal Effects

Counter-Materiel Capabilities

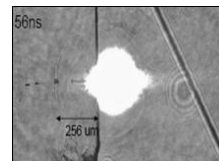
Stop/Disable Vehicles, Stop/Disable Vessels, Stop/Disable/Divert Aircraft



Long Range DEW Vehicle / Vessel Stoppers



Counter Aircraft Capabilities

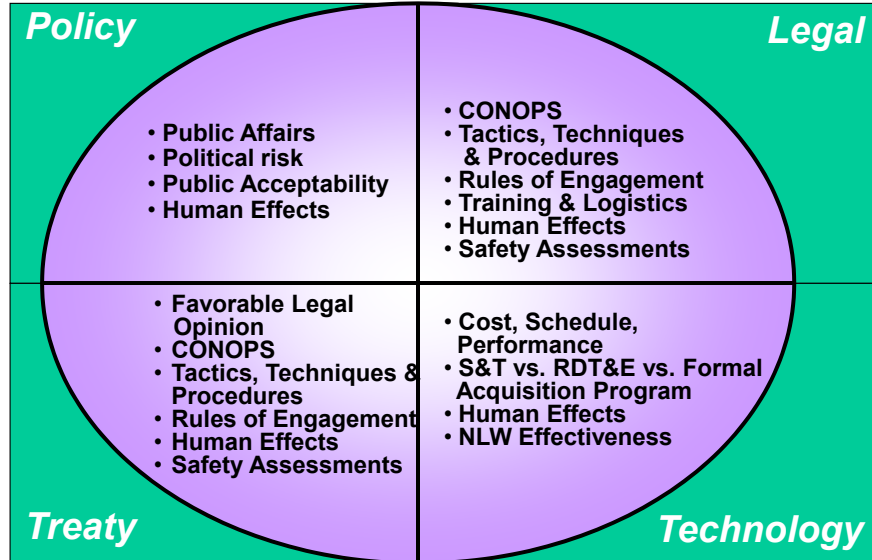


Ultra Short Pulse Lasers - Counter-Sensor

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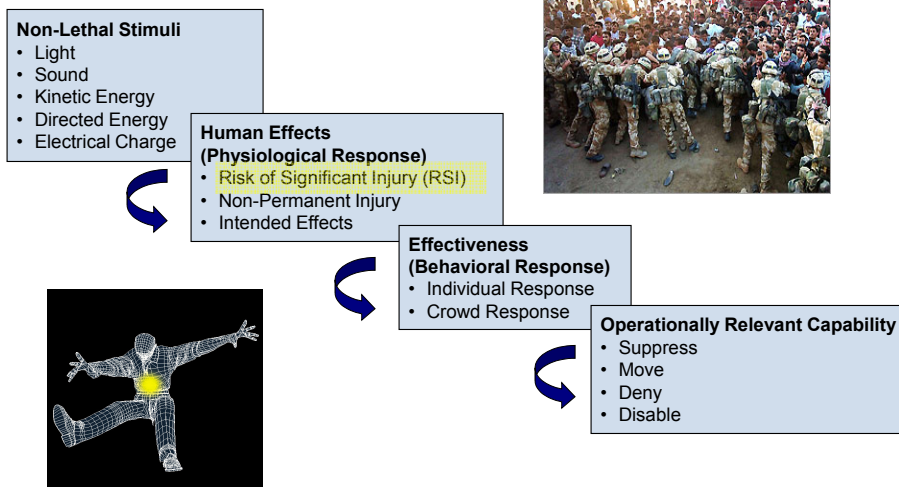
Non-Lethal Weapons Overall Challenges



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Human Effects & Effectiveness



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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 advanced today's non-lethal weapons capabilities

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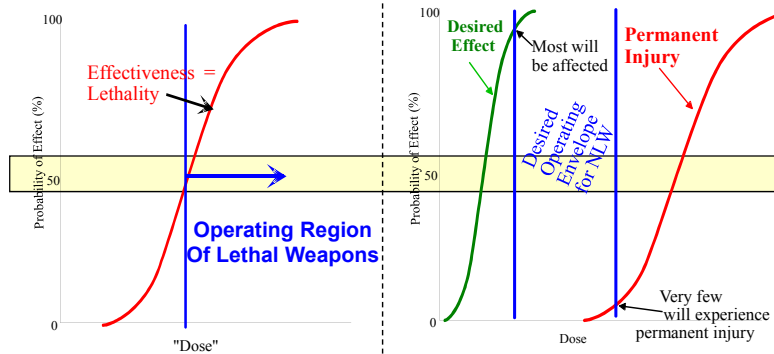


Backup Slides

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NLW Human Effects Characterization

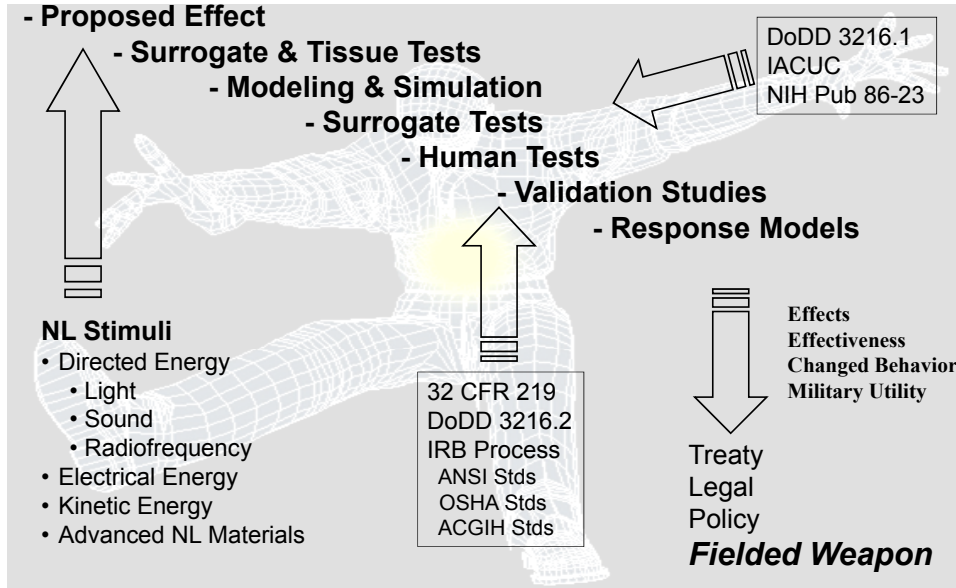


- Generally, the goal of lethal weapons has been to maximize a single effect
 - lethality, while meeting the constraints of LOAC, logistics, cost, etc
- For NLW, two competing objectives exist: cause a desired effect, while minimizing permanent injuries or fatalities
- Understanding human effects is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

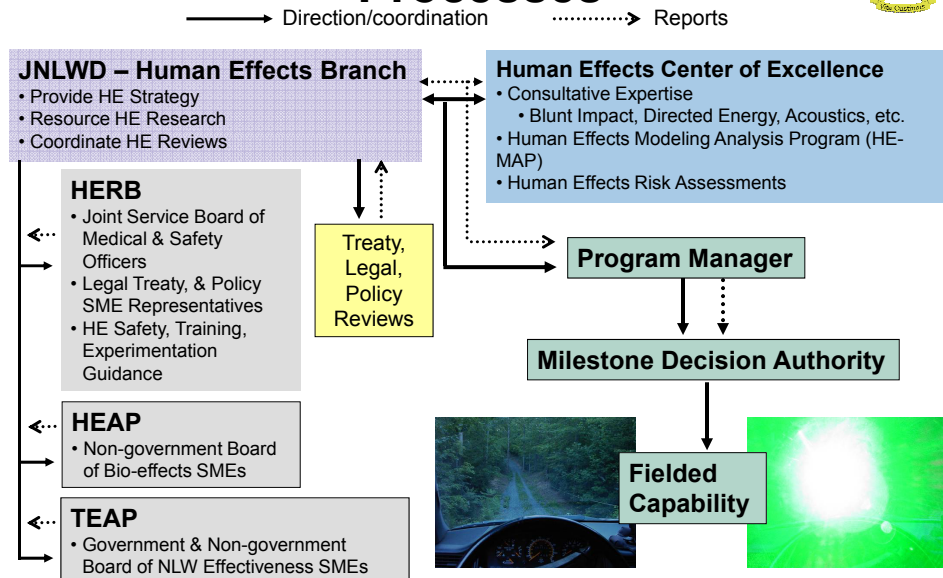
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Effects Based Design



JNLWP Human Effects Processes



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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

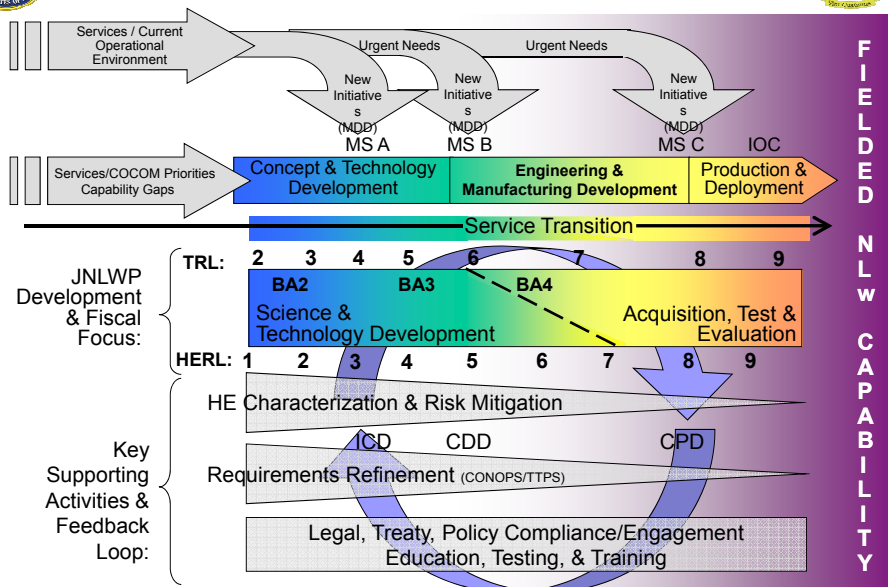
Mutual Top-5 Capability-Gaps:

- 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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