



# Non-Lethal Weapons Program



## Joint Non-Lethal Weapons Program (JNLWP)

# - Next-Generation Non-Lethal Directed Energy Weapons and Enabling Technology Portfolios

Present to: National Defense Industrial Association (NDIA)

2016 Armament Systems Forum

Fredericksburg Convention Exposition Center, Fredericksburg, Virginia

25-28 April 2016

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Joint Non-Lethal Weapons Directorate (JNLWD), Quantico, VA

<http://jnlwp.defense.gov>





# Purpose

- **Plenary presentation introduces this 2016 NDIA Armaments Forum's to the "Unconventional Emerging Technology Armaments (UEA) Forum" - "Non-Lethal Technology, Payloads, and Effects" Conference**
  - **NL conference is composed of several presentations/papers and a number of other non-lethal technology presentations/papers within other conferences at this UEA Forum**
    - **Conference covers: "Non-Lethal Technology, Payload, and Effects"**
    - **"Directed Energy" Conference in the UEA Forum**
    - **Other Non-Lethal Weapon Technology/Capabilities will be covered in the:**
      - **Small Arms Forum (USMC PM Infantry Weapon Panel**
      - **US Army PM Soldier Weapons Panel**
      - **Joint Service Small Arms. Synchronization Team (JSSAST) Panel**
      - **Guns, Ammunition, Rockets & Missiles (GARM) Forum**
  - **NL conference describes the JNLWP's S&T efforts to mature NL DEW technology readiness levels and demonstrate/transition next-generation NL DEWs and key peripheral DEW subsystems to programs of record**



# DoD Non-Lethal Weapons Program



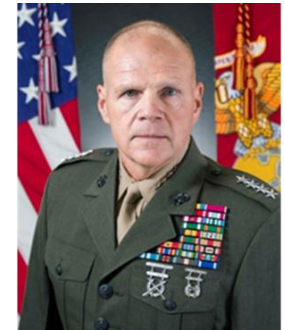
## DoD NLW Program Established 1996

- Operation United Shield (Somalia): General Anthony C. Zinni pioneered use of NLW
- FY96 National Defense Authorization Act directed DoD to centralize responsibility for NLW



## Program Highlights

- CMC designated Executive Agent
- Joint research and development funding
- Services responsible for NLW procurement



General Robert B. Neller  
Commandant of the  
U.S. Marine Corps  
★★★★★

## Vision

*“A fully integrated non-lethal competency within each Service, to complement lethal effects, enhance the Joint Force's adaptability, and support strategic objectives that include minimizing civilian casualties”*

## Non-Lethal Weapons

- Provide escalation-of-force options
- Minimize civilian casualties
- Reduce collateral damage



**Non-Lethal capabilities assist operating forces in minimizing civilian casualties and collateral damage**

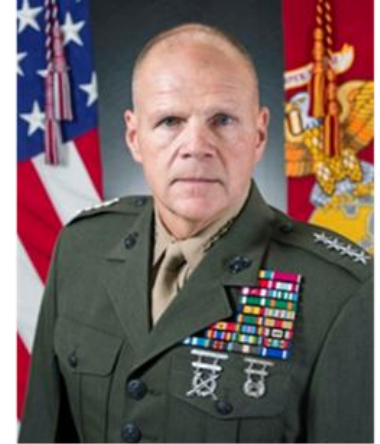


# DoD Non-Lethal Weapons (NLW) Program



## Mission Statement

“Through Executive Agent oversight and coordination, the DoD Non-Lethal Weapons Program --comprised of Joint and Service programs--will serve as the Department’s proponent to effectively identify, develop, test and evaluate, transition, field, and sustain integrated, relatively reversible and scalable effects technologies and capabilities, and develop associated policies, doctrine, concepts, and training in order to provide timely solutions to current and future requirements across the range of military operations, maximize mission effectiveness, and minimize risk to U.S. forces, coalition partners, civilians, and critical infrastructure.”



**General Robert B. Neller**  
**Commandant of the**  
**U.S. Marine Corps**

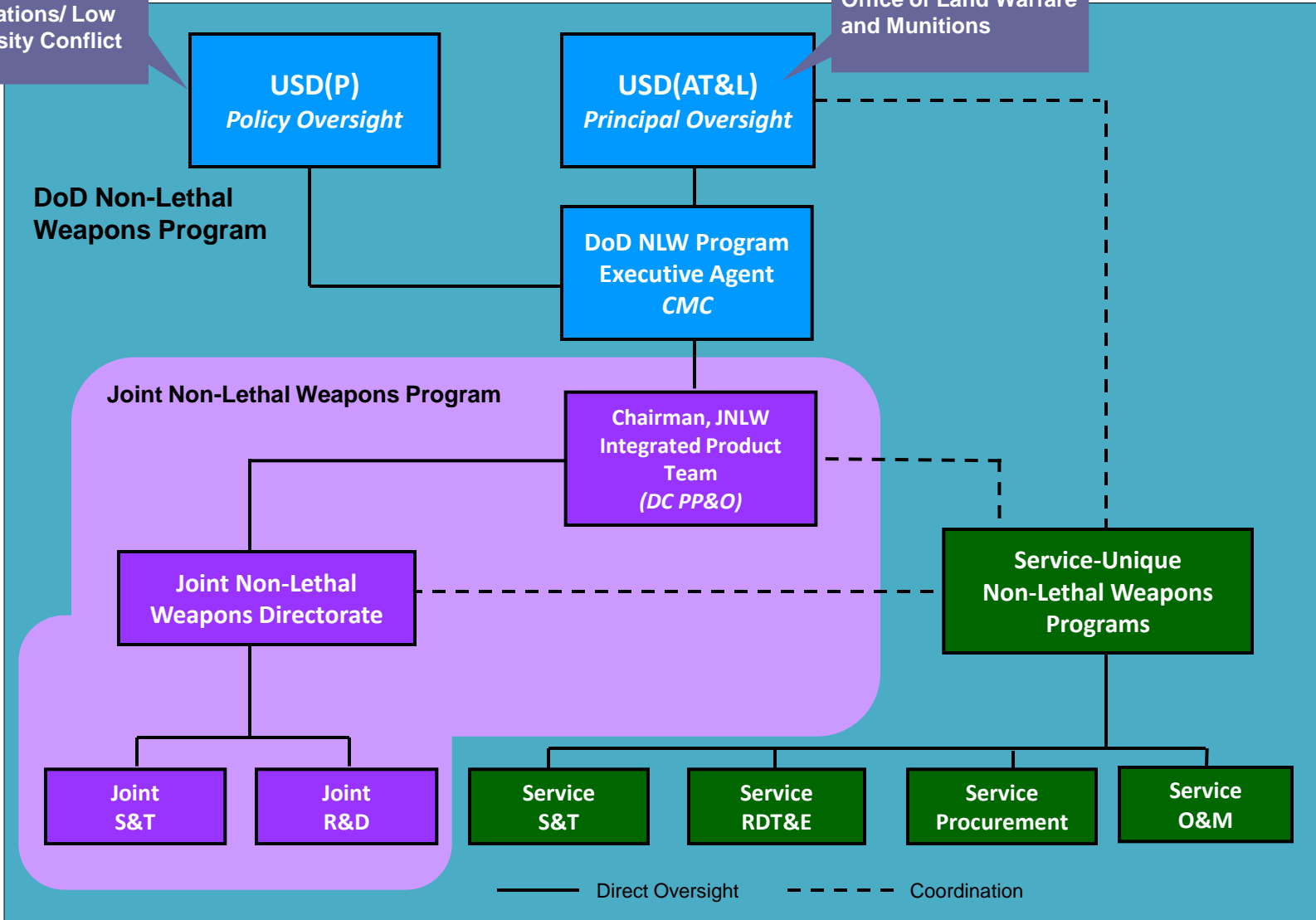




# DoD NLW Program Organization

Office of Special Operations/ Low Intensity Conflict

Office of Land Warfare and Munitions



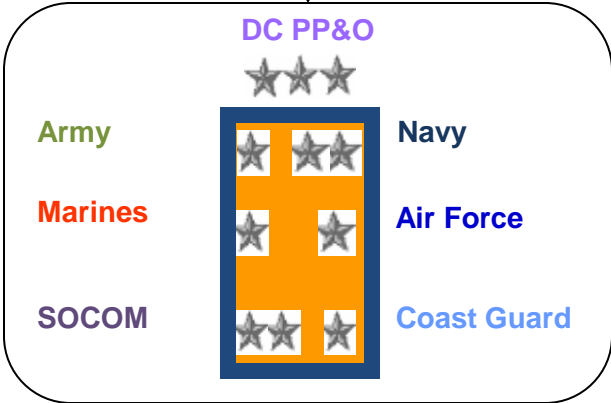


# JNLWP Management Structure



**Executive Agent  
Commandant, USMC**

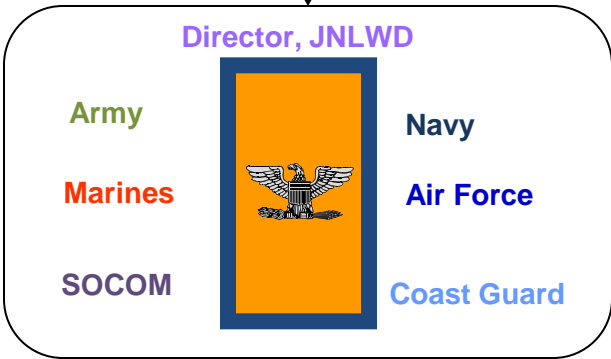
**Joint  
Integrated  
Product  
Team  
(JIPT)**



## Joint Integrated Product Team (JIPT)

- Approves JNLWP budget
- Approves resolution of program issues
- Reviews Joint & Service-unique programs

**Joint Coordination  
&  
Integration Group  
(JCIG)**



## Joint Coordination & Integration Group (JCIG)

- Recommends program priorities for development and funding
- Recommends lead-Service designations

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





# Joint Non-Lethal Effects (JNLE) Tasks

## Top Ten Tasks

- 1) *Stop Vehicle (small, confined, single)*
- 2) *Stop Vehicle (medium, confined, single)*
- 3) *Stop Vehicle (large, confined, single)*
- 4) *Stop Vessel (small, confined, single, [friendly anchored])*
- 5) *Suppress Individuals (confined, single/few)*
- 6) *Suppress Individuals (open, many)*
- 7) *Stop Vessel (small, open, single, [friendly underway])*
- 8) *Deny Access into/out of an area to individuals (confined, single/few/ many)*
- 9) *Deny Access into/out of an area to individuals (open, single/few/ many)*
- 10) *Move Individuals through an area (open, many)*

## JCIDS – Joint Non-Lethal Effects ICDs

- *Joint Capabilities Document signed February 2008*
- *CP & CM Initial Capability Documents signed April 2009*
- *Joint Non-Lethal Effects Tasks re-validated in 2013*

## Counter-Personnel Tasks

- *Deny*
- *Move*
- *Disable*
- *Suppress*

## Counter-Materiel Tasks

- *Stop Vehicle*
- *Disable Vehicle*
- *Stop Vessel*
- *Disable Vessel*
- *Stop Aircraft on Ground*
- *Disable Aircraft on Ground*
- *Divert Aircraft in Air*
- *Deny Access to Facility*

## Capabilities Based Assessment Membership

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



# Non-Lethal Weapons in Use



12 Gauge / 40 mm Point, Area and Warning Munitions



FN303



Washable Paint



Permanent Paint



Training



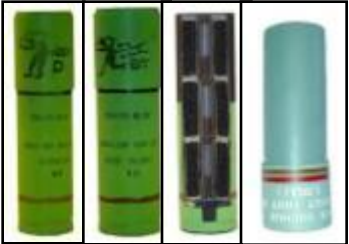
Optical Interrupters



X-26 TASER



Modular Crowd Control Munitions



66 mm Vehicle Launched NL Grenades



Flash-Bang Grenades



Portable Vehicle Arresting Barrier



Vehicle Lightweight Arresting Device M2 Net



Stingball Grenades & Launch Cups



Pen Flares



Acoustic Hailing Devices

**Close-in, Kinetic/Non-Kinetic Effects**



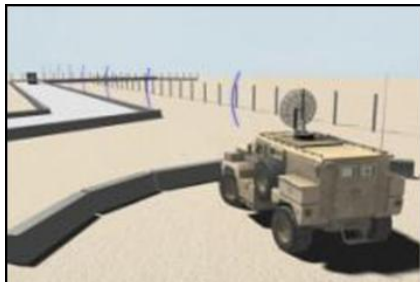


# JNLWP Non-Lethal Directed Energy Investment - Why



## Strengths

- Range
- Speed of delivery
- Volume of fire
- Duration of effect
- Precision engagement
- Controlled effects (scalable effects)
- Shoot on the move capability
- Electronic magazine
- Escalation of Force capable
- Logistics



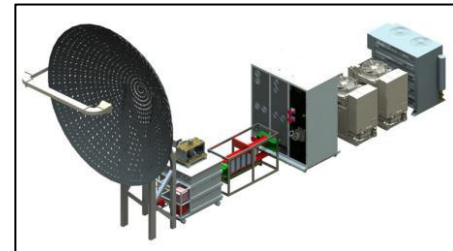
## Opportunity

- World's Directed Energy lead
- Game changer
- Revolutionary capability (beyond evolutionary)
- Addresses multiple missions/applications



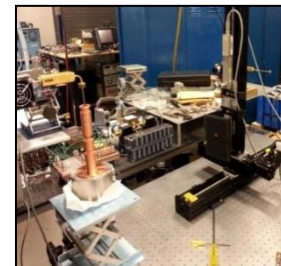
## Weaknesses

- Size and weight
- High cost
- Source technology
  - Limited power out
  - Lack of waveform diversity
  - Requires human effects characterization
- High power consumption requirements
- Ability to ruggedize
- Platform integration issues
- Specialized training requirements



## Programmatic Threats

- Requirements
  - # of DEWs included in current CBAs
  - Kinetic vs non-kinetic trade-offs
- DEW misperceptions
  - Public acceptability
- Initial prototype costs
- Limited industrial base
- New battlefield effects
- Battlefield damage assessment
- Policy support

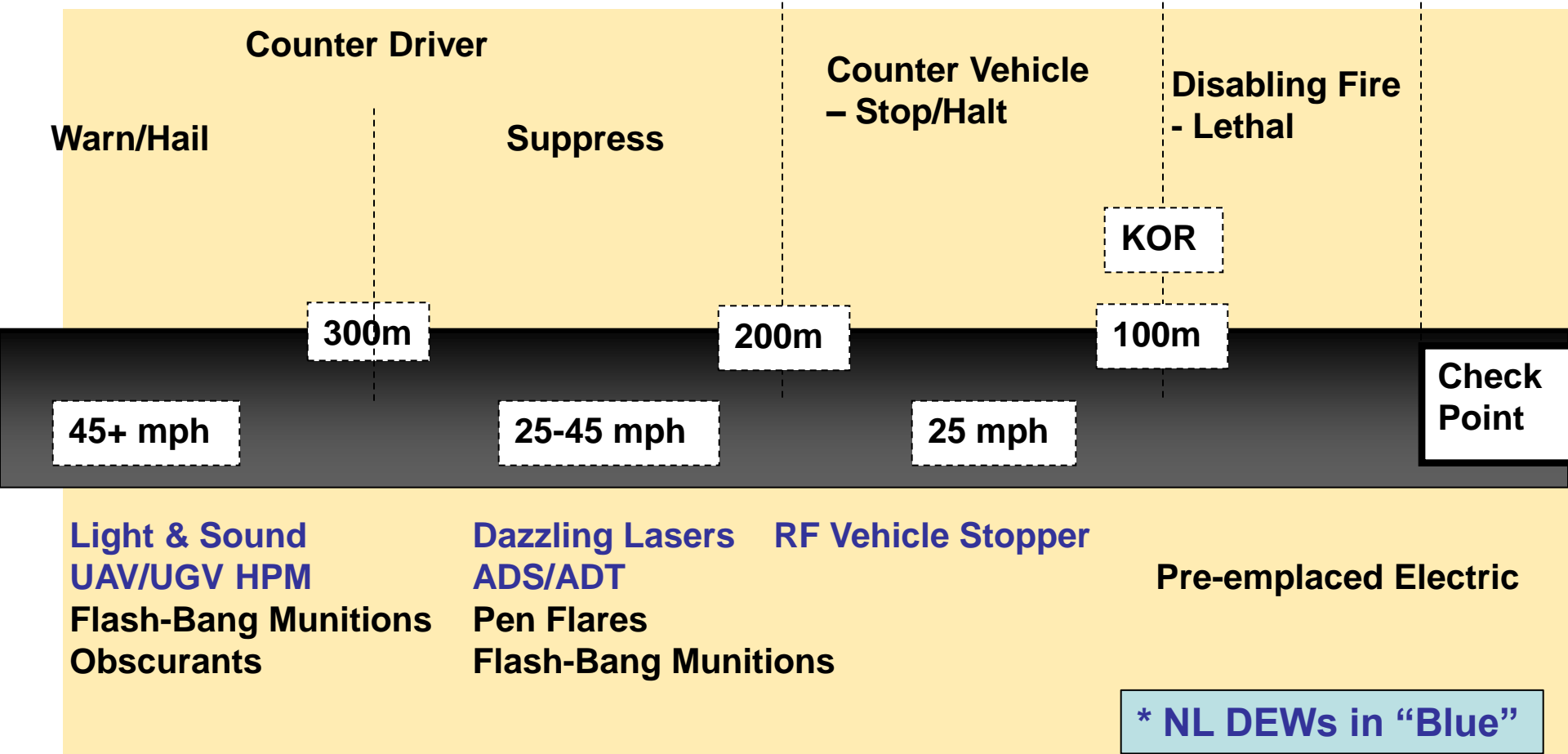


**Non-Lethal DEW capabilities assist operating forces in minimizing civilian casualties and collateral damage**

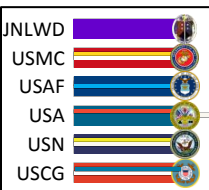


# Notional Escalation-of-Force & how NL DEWs help a Vehicle Stopping layered defense mission

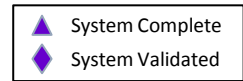
## No one silver bullet; System of Systems approach



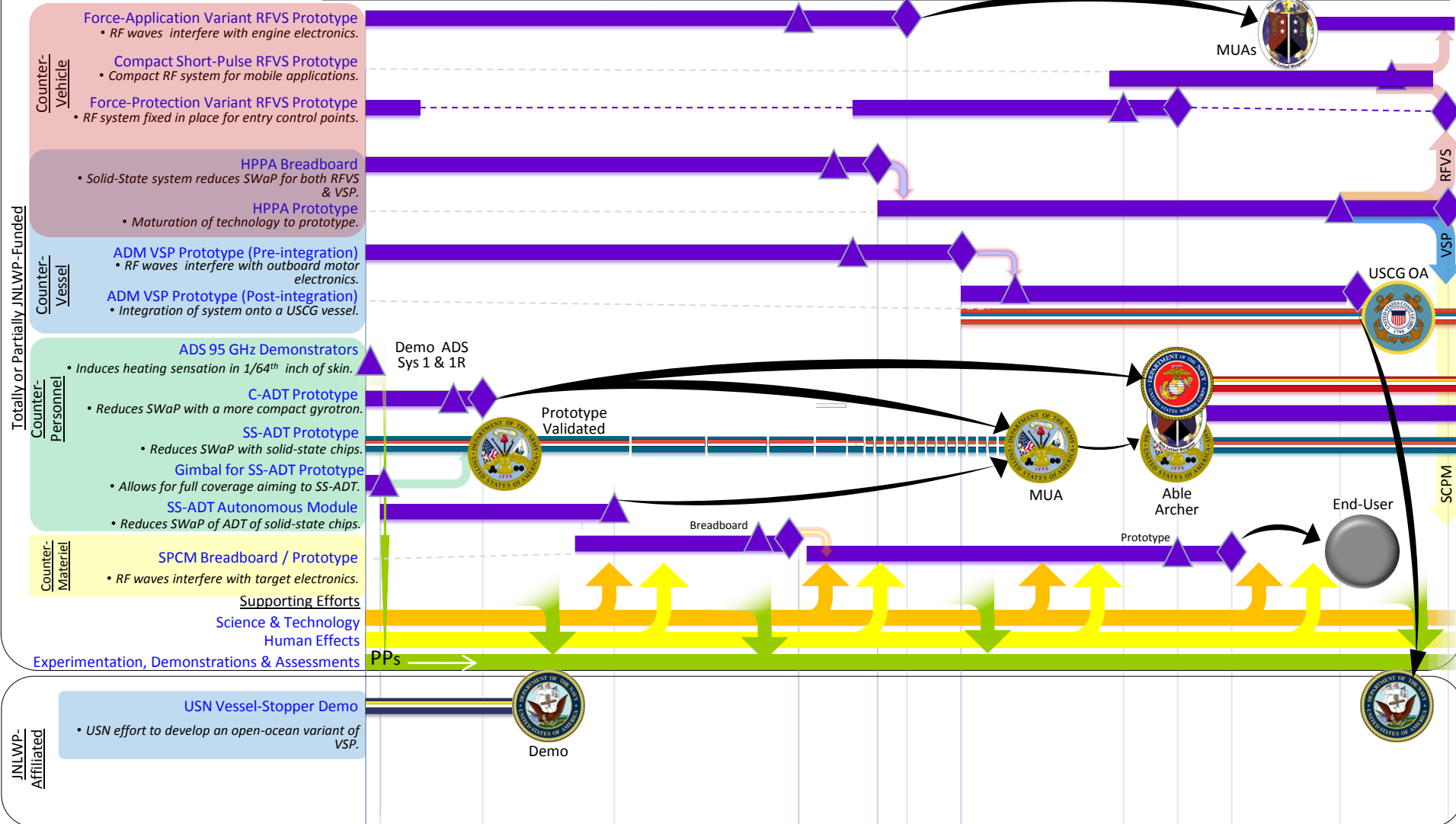
**@ 45 mph close from 300 m to 100 m in ~10 seconds**



# JNLWP-Funded and JNLWP-Affiliated DE Primary Projects Path Forward



RFVS	Radio-Frequency Vehicle Stopper	OA	Operational Assessment	ADT	Active Denial Technology	PPs	Pilot Program (s)
MUA	Military Utility Assessment	VSP	Vessel-Stopping Prototypes	ADS	Active Denial System	SS-ADT	Solid State Active Denial Technology
HPPA	High-Power Phased Array	ADM	Advanced Demonstrator Model	SPCM	Short-Pulse Counter-Materiel	C-ADT	Compact Active Denial Technology



FY16 | FY17 | FY18 | FY19 | FY20



# Current FY16 Non-Lethal Directed Energy Weapon Demonstrators



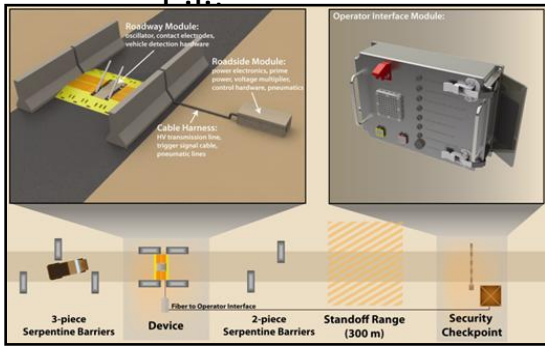
## Distributed Sound and Light Array (DSLA)

- Phased acoustical array and optical interrupting device
- Provides hailing and warning and optical suppression capabilities
- Combined effects of two integrated sensory stimulators for unambiguous long range (600m+) hail and warn



## Active Denial System (ADS) 1R and System 2 & the JNLWD/US Army 6.4 kW Solid State (GaN) Active Denial Technology (SS-ADT) Skid-Plate Demonstrator

- ADS provides ability to repel/suppress personnel and vehicle/vessel operators up to 1,000m
- ADS and SS-ADT employs 95 GHz “millimeter waves” not microwaves”
- SS-ADT Skid-Plate demonstrator provides a 100 meter “push-back”



## Pre-Emplaced Electrical Vehicle Stopper (PEVS)

- Pre-emplaced, electric, direct injection “speed-bump” system
- Selectively stops single or multiple threat vehicles and reduces risk to personnel from vehicle-borne IEDs
- Low cost per shot and has a long lifetime (> 3000 shots)



**Non-Lethal DEW capabilities assist operating forces in minimizing civilian casualties and collateral damage**





# Future: Non-Lethal Counter-Personnel Directed Energy Weapons

## Active Denial System – Legacy Systems

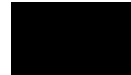
- Advanced Concept Technology Demonstrator
- Proven Effects – 95 GHz effects
- Effective at long-ranges

**90-kW CW Demonstrator**



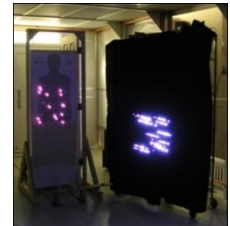
## Compact Active Denial Technology (ADT)

- Demonstrate the same effectiveness in an operationally suitable configuration
- Develop a compact, lightweight second harmonic 95 GHz Gyrotron with a room temperature electropermanet



## Solid State (SS) ADT

- Develop a compact, self-contained, NL SS-ADT demonstrator
- Significant reduction in size and weight
- Cost sharing effort between Army Research and Development Center and JNLWP



## Sound & Light Portfolio

- Distributed Sound and Light Array – technology development/improvement efforts
- USMC's Optical Interruption (OI) - OI system is a weapons mounted dazzling laser employed to visually warn and/or suppress targeted personnel at ranges from 10 to 500 meters.

## NL Counter-Personnel Lasers

- High repetition rate flash-bang effects, thermal discomfort, and long range intelligible acoustic hailing capabilities via laser induced plasmas

## Other Key Peripheral NL DEW Sub-Systems

- USMC SBIRs: Advanced Thermal Management; Compact Prime Power; Compact RF Antennas; Human Test Target Surrogate

**DoD Non-Lethal Directed Energy Investment**



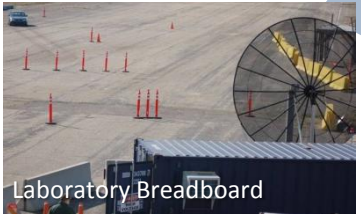


# Future: Non-Lethal Counter-Materiel Directed Energy Weapons



- High Power Microwave (HPM) Portfolio & Counter-Electronics Systems
- Directed Energy: Radio Frequency (HPM) Vehicle and Vessel Stopper

- Provides several advantages over existing non-lethal capabilities with extended range, ability to hold vehicles immobilized until released, and safe and reversible effects
- New design will provide multi-mission capabilities and various concepts of employment
- Reduced size and weight will allow integration into multiple platforms



Laboratory Breadboard  
 FY08–FY11  
 SIZE: 1360 ft<sup>3</sup>  
 WEIGHT: 9,500 lbs



Long Range Demonstrator  
 FY12  
 SIZE: 895 ft<sup>3</sup>  
 WEIGHT: 9,500 lbs



Compact Modulator  
 FY 14  
 SIZE: 450 ft<sup>3</sup>  
 WEIGHT 4,500 lbs

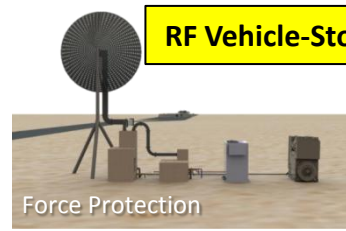
## RF Vessel Stoppers



Narrowband HPM

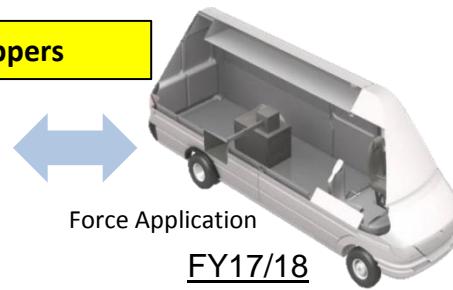


Wide-band HPM



## RF Vehicle-Stoppers

Force Protection  
 FY17/18  
 SIZE: < 100 ft<sup>3</sup>  
 WEIGHT: < 2000 lbs



Force Application  
 FY17/18  
 SIZE: < 50 ft<sup>3</sup>  
 WEIGHT: < 750 lbs

## Other Peripheral NL DEW Systems

- USMC SBIRs: Advanced Thermal Management; Compact Prime Power; Compact RF Antennas



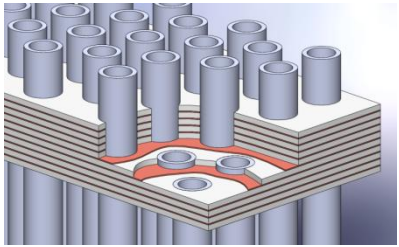
# DoD Non-Lethal Directed Energy Investment



# Key NL DEW Peripheral Technologies

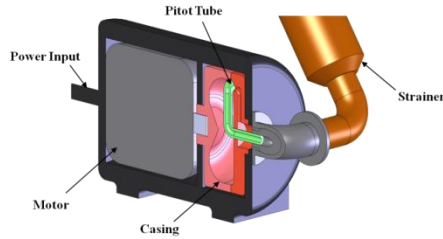
- All currently being developed under USMC SBIRs (Phase II) as led by the JNLWD and MARCORSSCOM

## Advanced Compact Thermal Management Systems (TMS)



Contract M67854-11-C-6508 with Mezzo Technologies

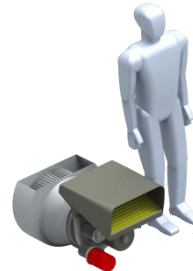
- Micro-tube based thermal cooling system that employs a phase change material that **reduces the current thermal management system by ~ 65% in both size and weight over conventional thermal coolers**



Contract M67854-11-C-6510 with Thermal Form & Function

- Developed pitot pump sizing tool/model to produce a compact low power Pitot Pump design for many existing Directed Energy Weapons **reducing their current TMSs by ~ 65% in weight and size.**
- Developed Pumped Liquid Multiphase Cooling (PLMC) & Vapor Compression Refrigeration system for sub ambient cooling on the 90 KW Compact ADT system.

## Compact NL DEW Prime Power



Contract M67854-14-C-6507 Candent Technologies Inc.

- Small gas turbine** powered, advanced power generation system capable of producing **250 kW of continuous power.**
- The complete system **weight** goal is < 500 pounds, with an overall **volume** goal of < 27 cubic feet, having a fuel consumption of 4.6 kW-hr/kg at 75% power, and 4.7 kW-hr/kg at 25% power.



Contract M67854-14-C-6510 -Toyon Inc.

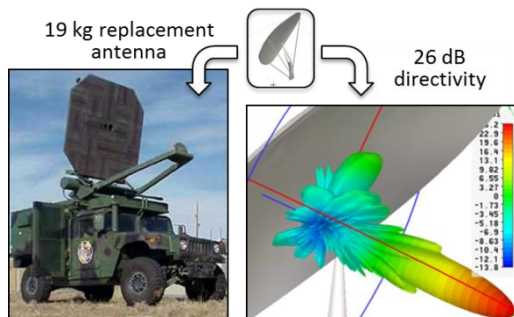
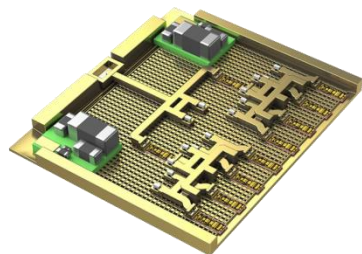
- A Lightweight 50-250 Watt Efficient Generator technology comprised of a heavy fuel, turbocharged, **rotary engine** employing a direct injection stratified charge combustion process in conjunction with a forced air cooled high power density (HPD) motor/generator with a total weight less than 500 lbs,<sub>15</sub>



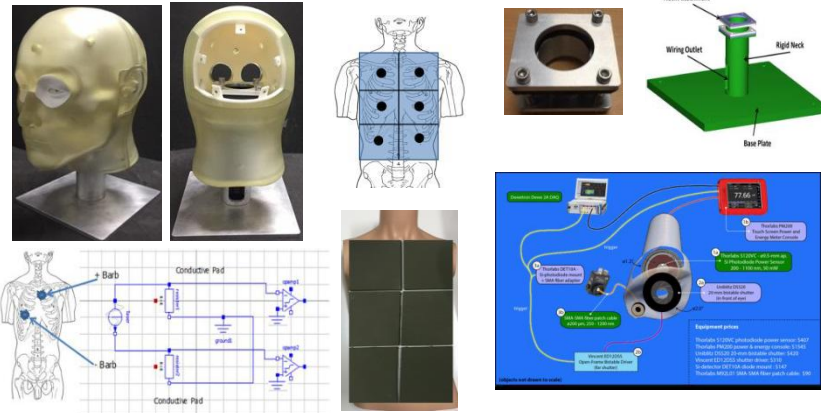
# Key NL DEW Peripheral Technologies

- All currently being developed under USMC SBIRs (Phase II) as led by the JNLWD and MARCORSYSCOM

## Compact RF Antennas



## Human Surrogate Test Target



### Contract M67854-11-C-6508 with Nuvotronics Inc.

- Use of novel micro-coax transmission lines and integrated antenna feed to improve efficiency of front-end antenna for the US Army's (Raytheon-developed) GaN – based 95 GHz **Solid State Active Denial Technology (SS ADT) Skid-Plate demonstrator**.
- Improves current Raytheon amplifier modules using Poly-Strata coax
- Reduces packaging cost by 5X** by using an integrated 94 GHz coax circuit, Improves reproducibility of RF modules, and enables electronic vertical direction scanning.

### Contract M67854-11-C-6508 with RadiaBeam Technologies, LLC.

- High Power Super-radiant Mobile Antenna Project
- Development of high gain and high directivity S-band antenna capable of handling 10s of MW peak power, which can be installed on a tactical vehicle with a more than **5-fold reduction in aperture size**.
- Achieves >25 dB directivity, > 50% efficiency, small footprint, high peak power (20 MW), and fast steerability.
- A parallel concept development effort at W-band

### Contract M67854-14-C-6501 with CFD Research Corp.

- The overall objective of this project (Phase I, II, and III) is to develop, fabricate and test a novel, modular **human test surrogate target**, consisting of a human head/neck/torso, that can be used to evaluate non-lethal weapons and validate software input for the JNLWP HEMAP software. The CFDRC and JHU/APL team measures blast overpressure, kinetic/blunt impact, **directed energy** (sound, light/laser, electromagnetic fields, radio frequencies, thermal energy), and chemical irritants. This will allow for precise validation and agreement between the physical and virtual models.





# Non-Lethal Directed Energy Weapons Summary



- Provide operating forces with escalation-of-force options while minimizing casualties and collateral damage
- Always have lethal force overwatch/back-up
- Help fill the gap between shouting and shooting
- Offer options across the full spectrum of conflict



**Non-Lethal directed energy weapons capabilities assist operating forces in providing scalable controlled effects, minimize civilian casualties and reduce collateral damage**



# Department of Defense Non-Lethal Weapons Program

## Questions?

