ONR Initiatives
Unmanned Surface Vehicles and Power & Energy

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The Office of Naval Research
The S&T Provider for the Navy and Marine Corps

- 4,000+ People
- 23 Locations
- $2.1B / year
- >1,000 Partners

Discover ➔ Develop ➔ Deliver ➔ Technological Advantage

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Warfighting Capabilities Enabled by S&T Investments

CNR’s S&T Investment
- Directed Energy/Electric Weaponry
- Cyber
- Electromagnetic Maneuver Warfare
- UxS Maneuver Warfare
- Synthetic Biology/Bio-Inspired Technologies

Portfolio is balanced across near, mid and long term S&T investments.
Naval S&T Strategy
Focus Areas

- Autonomy & Unmanned Systems
- Assure Access to Maritime Battlespace
- Expeditionary & Irregular Warfare
- EM Maneuver Warfare
- Platform Design & Survivability
- Info Dominance & Cyber
- Power Projection & Integrated Defense
- Power & Energy
- Warfighter Performance

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Autonomous Unmanned Surface Vehicles

**USV Swarm**: S&T program to develop Unmanned Surface Vehicles capable of perceiving their environment, as well as sensing and responding effectively in a dynamic situation without human intervention.

**MDUSV**: S&T program to build and demonstrate an unmanned sea surface vehicle with ocean-spanning range, months of endurance, and substantial payload capacity.

**USV Swarm**
- Demonstrated Aug 2014 (Swarm I) & Sept 2016 (Swarm II)

**Medium Displacement Unmanned Surface Vehicle (MDUSV)**

**CARACaS**
*(Autonomous Control for USVs)*
Control Architecture for Robotic Agent Command & Sensing

- Perception
- Data Fusion
- Route Planning
- Actuators
USV Platforms

- USV Swarm I and II utilize 7 and 11 meter platforms
- CARACaS cooperative autonomy can be implemented on much larger platforms:

Medium Displacement USV

A wide range of platform size and capability is possible for USV Swarm
EMILY—short for Emergency Integrated Lifesaving Lanyard—was recently tested on the Thames River in London, England.

EMILY is the successful collaboration of inventor Tony Mulligan, ONR and the Navy’s SBIR/STTR program.

(Photos provided by ONR Global)
Efficient Power and Energy Systems

- Increased efficiency and power density on platforms and reduced weight for personal power through advanced materials, devices and architectures
- Efficient power conversion, switching, distribution, control and thermal management
- Efficient power generation equipment including engines, generators, motors and actuators
- Electrochemical, thermal, dielectric and kinetic energy storage
- Energy harvesting
- Power for distributed sensors

Energy Security

- Alternative and renewable energy sources for naval operations
- Issues associated with the logistics and compatibility of future alternative fuels
- Resilient power networks and systems for platforms and shore based infrastructure

High Energy and Pulsed Power

- Energy storage, switching and control systems
- Pulsed power architectures
- Thermal management
Power and Energy demands have steadily increased and are projected to increase at a higher rate in the future.
Directed energy weapons and their intended platforms are areas where the DoD must perform its own Energy & Power R&D.
Challenge of High Power Systems

Today’s Fleet and tomorrow’s Fleet cannot support future high power systems without an integrated power and energy solution.

Gain an understanding of how the combined pulsating loads strain a power system through:
- Architecture Topologies
- Interface Characterization
- Modeling
- Hardware Methodology
- Testing & Validation

Goal: Support dynamic demand from steady generation (efficiency)
**Multifunction Energy Storage for Navy-USMC Applications**

Develop & demonstrate multi-function, reconfigurable energy storage modules with advanced control methodologies for fuel efficient plant configuration, power quality stabilization and surge demand capability. Integrated system demonstration FY19

**High Power Solid State Circuit Protection**

Develop components and methods to quickly detect and clear electrical faults, replacing slow-acting circuit breakers and protective relays. Integrated system demonstration FY 18

**Efficient and Power Dense Electric Architecture and Components**

Increase shipboard electrical system power density 2X while also meeting energy storage volumetric and gravimetric energy density goals.

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**Accomplishments**

- Modeling and simulation capability that has been used by industry and the Navy in the design of new equipment and systems.
- Prototype development and testing capability that have contributed to the Navy's decision to fund at least three major development programs with industry.
- Technology and Software that is being adopted by industry for integration into the fleet.
- Workshops on modeling and simulation, reconfiguration, and power train technology that brought leaders of industry, government, and academe to discuss and stimulate technical advances in this area.
- More than 300 papers were presented to the technical community helping to establish U.S. leadership in this area.
- More than 50 students have received advanced degrees for research conducted in support of future electric ships.