

# UNCLASSIFIED

FY 2008/2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET  
Exhibit R-2

DATE: February 2007

BUDGET ACTIVITY: 02  
PROGRAM ELEMENT: 0602747N  
PROGRAM ELEMENT TITLE: UNDERSEA WARFARE APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2006 Actual	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
UNDERSEA WARFARE APPLIED RESEARCH	82,170	93,224	68,455	65,254	68,693	68,354	71,597	73,780

**A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:** All Navy applied research in undersea target detection, classification, localization, tracking, and neutralization is funded through this Program Element (PE). Technologies being developed within this PE are aimed at enabling Sea Shield, one of the core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new anti-submarine warfare (ASW) operational concepts that promise to improve wide-area surveillance, detection, localization, tracking, and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship, and air ASW assets.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

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**B. PROGRAM CHANGE SUMMARY:**

	<u>FY 2006</u>	<u>FY 2007</u>	<u>FY 2008</u>	<u>FY 2009</u>
FY 2007 President's Budget Submission	84,482	83,435	70,646	69,167
Congressional Action	0	10,150	0	0
Congressional Undistributed Reductions/Rescissions	-149	-361	0	0
Execution Adjustments	-541	0	0	0
Non-Pay Inflation Adjustments	0	0	-154	152
Program Adjustments	0	0	813	-5,465
Program Realignment	0	0	-2,908	1,275
Rate Adjustments	0	0	58	125
SBIR Assessment	-1,622	0	0	0
FY 2008/FY 2009 President's Budget Submission	82,170	93,224	68,455	65,254

**PROGRAM CHANGE SUMMARY EXPLANATION:**

Technical: Not applicable.  
Schedule: Not applicable.

**C. OTHER PROGRAM FUNDING SUMMARY:**

Not applicable.

**D. ACQUISITION STRATEGY:**

Not applicable.

**E. PERFORMANCE METRICS:**

The overall metrics of applied research in undersea warfare are to develop technologies aimed at improving target detection, classification, localization, tracking, increasing attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments, countering enemy torpedoes, providing the ability to conduct long-range engagements, increasing weapons load-out, providing multi-platform connectivity, increasing endurance/survivability, and reducing size and power requirements.

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**B. ACCOMPLISHMENTS/PLANNED PROGRAM:**

	FY 2006	FY 2007	FY 2008	FY 2009
<b>WIDE AREA ANTI-SUBMARINE WARFARE (ASW) SURVEILLANCE</b>	27,706	42,673	30,717	28,915

Wide Area ASW Surveillance is focused on dramatically improving the capability to sanitize large areas relative to the capabilities of legacy ASW sensors. Efforts include the development of affordable off-board systems with associated processing and robust, high bandwidth communications links. The cornerstone of Wide Area Surveillance is the ability to rapidly distribute acoustic and non-acoustic sensors from air, surface, and sub-surface platforms as well as to develop long-endurance sensors and unmanned ASW vehicles. This activity represents a shift from traditional fixed surveillance systems to autonomous, networked-components, multi-static operation, and supported by passive/active signal processing all with the objective of increased detection capabilities.

The increases from FY 2006 to FY 2007 reflects realignments of Future Naval Capabilities (FNC) program investments into this activity and a realignment of funds associated with the Innovative Naval Prototype

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(INP)- Persistent Littoral Undersea Surveillance (PLUS).

The FY 2007-2008 decrease is associated with the transition of INP PLUS to P.E. 0603747N.

## **FY 2006 Accomplishments:**

- Continued development of Telesonar technologies to enable deployable system acoustic communications.
- Continued development of signal processing algorithms aimed at reducing clutter-generated false alerts.
- Continued development/improvement of multi-static signal processing techniques for systems employing coherent sound sources.
- Continued development of "intelligent" algorithms aimed at optimizing distributed multistatic sources/receivers.
- Continued development of an advanced node design for survivable sensors.
- Continued development of a non-traditional tracking system for deployment on undersea vehicles.
- Continued development of multistatic signal processing algorithms with controllable transmit waveform type and ping schedule to enable improved detection and tracking of threat submarines.
- Continued integration of a prototype system for undersea persistent surveillance.
- Continued investigation of undersea persistent surveillance system performance through simulation and subsystem tests.
- Continued development and testing of components of a prototype system for undersea persistent surveillance.
- Continued analysis and modeling of high frequency underwater acoustic communications techniques between Unmanned Undersea Vehicles (UUVs) and demonstrate its capability. (NRL)
- Continued efforts to develop an underwater intruder defense system, including comprehensive active and passive signatures from swimmers, harbor environment noise characteristics, and fiber optic array technology. (NRL)
- Continued testing of a non-traditional tracking system.
- Continued efforts to measure, quantify, and model reverberation and clutter from biologics and the seafloor and provide a prediction tool for multistatic active sonars. (NRL)
- Initiated planning for testing of advanced node designs and associated technologies.
- Initiated development of alternative active optical sources and sensor devices for Non-Acoustic ASW systems.
- Initiated development of tracking and classification algorithms for broadband Doppler sensitive waveforms for wide area surveillance.
- Initiated development of a prototype system for PLUS.
- Initiated an effort to extend the technology base for blue laser sources for Undersea Warfare applications including underwater communications.

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- Initiated an effort to extend the technology base for high performance electro-optic detectors suitable for Undersea Warfare applications including underwater communications.
- Initiated an effort to extend the technology base for high performance electro-optic filters suitable for Undersea Warfare applications including underwater communications.
- Initiated an effort to develop consistent and comprehensive modeling and simulation tools for photonic Undersea Warfare and underwater communications components and systems.
- Initiated an effort to develop optical signal processing technology appropriate for Undersea Warfare and underwater communications systems.
- Initiated and completed third geomagnetic noise coherence investigation from cooperating airborne measurement platforms.
- Initiated magnetic mapping and localization study and component development for small-diameter Autonomous Undersea Vehicles.
- Initiated development of a Helium-3 scalar magnetometer for stationary magnetic arrays.
- Initiated Next Generation Autonomous Sensor (NGAS) Joint Research Project (JRP) collaboration and related Overhauser scalar magnetometer investigations.

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Completed at-sea testing of the multistatic system components. This effort transitions to PE 0603747N.
- Completed concept feasibility study and initial design concepts for a non-acoustic surveillance system (Palantir).
- Initiated/Completed design and development of Palantir sensor and data collection system and conducted a FY 2006 data collection exercise.
- Initiated experimental test planning for Palantir sensor.
- Initiated Deployable Autonomous Distributed System study of component feasibility to enable effective deployment, survival, and cost options. This effort transitions to PE 0603747N in FY 2007.

## **FY 2007 Plans:**

- Continue all FY 2006 efforts less those noted as completed above.
- Complete development of Telesonar technologies to enable deployable system acoustic communications.
- Complete testing of advanced node design and associated technologies.
- Complete development of multistatic signal processing algorithms with controllable transmit waveform type and ping schedule to enable improved detection and tracking of threat submarines.

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- Complete integration of a prototype system for undersea persistent surveillance.
- Complete investigation of undersea persistent surveillance system performance through simulation and subsystem tests.
- Complete development and testing of components of a prototype system for undersea persistent surveillance.
- Complete evaluation of undersea persistent surveillance system performance and trade-offs.
- Complete demonstration of a prototype system for undersea persistent surveillance.
- Complete development of a prototype system for PLUS. PLUS transitions to PE 0603747N (Undersea Warfare Advanced Technology) for advanced technology development beginning in FY 2008.
- Complete efforts to develop an underwater intruder defense system, including comprehensive active and passive signatures from swimmers, harbor environment noise characteristics, and fiber optic array technology. (NRL)
- Complete analysis and modeling of high frequency underwater acoustic communications techniques between UUVs and demonstrate its capability. (NRL)
- Complete development of a Helium-3 scalar magnetometer for stationary magnetic arrays.
- Complete NGAS JRP collaboration and related Overhauser scalar magnetometer investigations.
- Complete efforts to measure, quantify, and model reverberation and clutter from biologics and the seafloor and provide a prediction tool for multistatic active sonars. (NRL)
- Initiate the development of technologies for a low source-level, light-weight ship-protection system against underwater intruders, including vessels with explosives. (NRL)
- Initiate development of signal processing algorithms for operational and pipeline ASW active sonar systems by extending NRL's broadband, beam-based theory for the Time Reversal Operator. (NRL)

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Continue all FY 2006 efforts less those noted as completed above.
- Continue Submarine Track and Trail applied research efforts for UUV technology in the areas of advanced undersea sensors, communications, and autonomy. This effort transferred from PE 0602114N due to Enabling Capability (EC) realignments.
- Initiate an applied research effort to improve distributed system processing techniques and capabilities.
- Initiate development of automatic signal processing algorithms for use with a Deep Water Active Deployable System (DWADS) for surveillance of deep ocean submarine threats.
- Initiate development of a transmit/receive array for use with a DWADS for surveillance of deep ocean submarine threats.

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## **FY 2008 Plans:**

- Continue all FY 2007 efforts less those noted as completed above.
- Complete development of tracking and classification algorithms for broadband Doppler sensitive waveforms for wide area surveillance.
- Complete magnetic mapping and localization study and component development for small-diameter Autonomous Undersea Vehicles
- Initiate design of a "Sea Star" undersea local area network to link peripheral sensors to a centralized node through high-bandwidth, short-haul acoustic communications.
- Initiate development of spin-dependent tunneling and coupled magnetostictive/piezoelctric passive magnetometer device technologies.

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Complete experimental test planning for Palantir sensor.
- Complete Palantir work in this PE; transition remaining work to PE 0603747N.
- Initiate incorporation and enhancement of technology from real-time data fusion technologies into Distributed System Processing (DSP).
- Initiate and complete an FY 2008 Palantir data collection exercise.
- Initiate development of algorithms to optimize the placement of uncontrolled drifting systems.
- Initiate development of a simulator for placement of uncontrolled drifting systems.
- Initiate development of technologies to provide rapid localization of threat submarines for On-Demand Detection, Classification and Localization (On-Demand DCL).

## **FY 2009 Plans:**

- Continue all FY 2008 efforts less those noted as completed above.
- Complete development of technologies for a low source-level, light-weight ship-protection system against underwater intruders, including vessels with explosives. (NRL)
- Complete development of signal processing algorithms for operational and pipeline ASW active sonar systems by extending NRL's broadband, beam-based theory for the Time Reversal Operator. (NRL)

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

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- Continue all FY 2008 efforts less those noted as completed.
- Complete incorporation and enhancement of technology from real-time data fusion technologies into Distributed System Processing (DSP).
- Complete development of a simulator for placement of uncontrolled drifting systems.
- Complete development of automatic signal processing algorithms for use with a DWADS for surveillance of deep ocean submarine threats.
- Complete development of a transmit/receive array for use with DWADS for surveillance of deep ocean submarine threats.
- Initiate algorithm testing of uncontrolled drifting systems using a simulator.
- Develop and apply advanced technologies that support delivery of Technology Oversight Group approved FNC ECs structured to close operational capability gaps in undersea warfare.
- Package emerging undersea warfare technologies into deliverable FNC products and ECs that can be integrated into acquisition programs within a five year period.
- Mature undersea warfare technologies that support naval requirements identified within the Sea shield naval capability.

	FY 2006	FY 2007	FY 2008	FY 2009
<b>BATTLEGROUP ANTI-SUBMARINE WARFARE (ASW) DEFENSE</b>	22,466	15,875	15,370	14,820

Battlegroup ASW Defense technology focuses on the development of platform-based sources and receivers aimed at denying submarines the ability to target grey ships. This technology area is primarily concerned with detections inside 10 nm. Battlegroup ASW Defense integrates next-generation technologies, automatic target recognition, sensors that adjust to complex acoustic environments, and environmentally adaptive processing techniques. Battlegroup ASW Defense will enable smaller, lighter, and cheaper acoustic/non-acoustic arrays, large multi-line arrays, and submarine flank arrays (all with environmental adaptation capabilities).

The decrease from FY 2006 to FY 2007 reflect the completion and transition of efforts to budget activity 3 PEs as well as the realignment of FNC program investments into ECs. As a result of FNC reorganization, funding for each EC has been aligned to a budget activity 2 and budget activity 3 PE as appropriate. The FY 2007 funding level reflects the alignment of investments for the Sea Shield EC.

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## **FY 2006 Accomplishments:**

- Continued development of signal processing improvements for coherent tactical active sonar systems aimed at improving Detection, Classification, and Localization of small, slow moving submarines in shallow water.
- Continued investigation of synthetic aperture sonar techniques for improving target versus clutter classification performance.
- Continued development of Acoustic Flux Sensor for affordable improvement of sonar signal-to-noise.
- Continued development and completed testing of line arrays with piezocrystal vector sensors for improved signal-to-noise and bandwidth.
- Continued design and development of underwater projectors using structural magnetostrictive materials.
- Continued development of improved techniques to distinguish submarine echoes from those produced by ocean bottom features.
- Continued development of an acoustic/magnetic hybrid sensor.
- Continued development of low cost, compact, combined acoustic sensor.
- Continued development of advanced sonar signal processing algorithms that integrate target classification and tracking into a combined system for autonomous deployable sensor processing.
- Completed development of baffled ring transducer technology.
- Initiated electroactive polymer smart sensor development.
- Initiated dipole projector array design and development.

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Continued development of signal processing and system control algorithms for the AN/WSQ-11 "Tripwire" torpedo protection system.
- Continued development of an AN/WSQ-11 "Tripwire" testbed for the testing of algorithms.
- Continued hardware component integration, testing; initiated further development to improve array functionality of the acoustic test bed in support of future passive sonar system designs.
- Continued collection of data at sea from torpedoes fired in salvos of two and four for purposes of developing advanced automatic detectors and false alarm reduction techniques. Counter Torpedo Detection, Classification, and Localization (CTDCL) transitions to PE 0603123N (Force Protection Advanced Technology) in FY 2007.
- Completed Adaptive Beamforming processing development.

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## **FY 2007 Plans:**

- Continue all FY 2006 efforts less those noted as completed above.
- Complete investigation of synthetic aperture sonar techniques for improving target versus clutter classification performance.
- Complete development of Acoustic Flux Sensor for affordable improvement of sonar signal-to-noise.
- Complete development of line arrays with piezocrystal vector sensors for improved signal-to-noise and bandwidth.
- Initiate compact low frequency projector developments.

The following efforts contribute to the Littoral Anti-Submarine Warfare FNC:

- Continue all FY 2006 efforts less those noted as completed above.
- Complete hardware component integration, testing and installation of the acoustic array test bed.
- Initiate a focused research study to evaluate sonar performance using the acoustic array testbed.

## **FY 2008 Plans:**

- Continue all FY 2007 efforts less those noted as completed above.
- Complete development of advanced sonar signal processing algorithms that integrate target classification and tracking into a combined system for autonomous deployable sensor processing.
- Complete a focused research study to evaluate sonar performance using the acoustic array testbed.
- Initiate development of target classification algorithms that adapt to local shipping noise conditions, thereby reducing false alarm probability.
- Initiate development of environmentally adaptive target detection and classification algorithms for deep water operating environments.

## **FY 2009 Plans:**

- Continue all FY 2008 efforts less those noted as completed above.
- Initiate single crystal and hybrid projector design and development.

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	FY 2006	FY 2007	FY 2008	FY 2009
COOPERATIVE ASW	696	763	0	0

Cooperative ASW technology developments enable ASW platforms to work together effectively to detect, classify, and localize very quiet undersea targets. Many of the tools required to achieve this objective were being developed as components of the Littoral Anti-Submarine Warfare FNC under the heading of Integrated Anti-Submarine Warfare (IASW) in PEs 0602235N and 0603235N. The focus of this effort is to leverage those concepts and technologies previously investigated under IASW in order to develop technologies that enable the exchange and fusion of ASW sensor data among the technologies developed under Battlegroup ASW Defense, Wide Area ASW Surveillance, and Neutralization program areas.

The funding profile from FY 2007 to FY 2008 reflects the completion of the real-time data fusion effort.

#### **FY 2006 Accomplishments:**

- Continued the incorporation of estimates of environmental uncertainty into the fusion of sensor information.
- Completed development of technologies to automatically fuse tactical ASW sensor information to enhance the ASW portion of the Common Tactical Undersea Picture.
- Initiated planning for an at-sea demonstration of real-time data fusion technologies.

#### **FY 2007 Plans:**

- Complete the incorporation of estimates of environmental uncertainty into the fusion of sensor information.
- Complete planning for and conduct at-sea technology demonstration of real-time data fusion technologies and analyze results. Real-time data fusion technologies transition to the Distributed System Processing effort described under the Wide Area ASW Surveillance activity in this Program Element.

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	FY 2006	FY 2007	FY 2008	FY 2009
<b>NEUTRALIZATION</b>	17,648	23,801	22,368	21,519

Neutralization focuses on the development of enabling technologies for undersea weapons to counter threat submarines and surface vessels by increasing Probability of Kill and platform survivability. Weapon technology focus areas include: Explosives and Warheads, Guidance and Control (G&C), Multidisciplinary Systems Design & Optimization (MSDO) (comprising Simulation Based Design, Silencing, and Propulsion), Power Sources, Supercavitation, and Torpedo Defense (TD).

Demonstration FNC projects included in the Neutralization effort (between FY 2005 and FY 2007) include: 1) the initiation of the Lightweight Torpedo Technology (LTT) project (initiated in FY 2005 and will begin transition to PE 0603747N in FY 2008), and 2) the initiation of the Compact Rapid Attack Weapon (CRAW) project (initiates in FY 2007).

The ultimate goal of the Neutralization effort is to develop modular and reduced sized undersea weapons based on common technology enablers (where possible), to provide revolutionary capabilities needed to fill Sea Shield Warfighter Capability Gaps, and enable new undersea weapon concepts of operations to rapidly transition to submarine neutralization/engagement in deep and shallow water under unique payload limitations posed by unmanned platforms, external stowage, and future Naval platforms.

The increase from FY 2006 to FY 2007 reflects the reorganization of FNC program investments into ECs. As a result of this reorganization, the funding for each EC has been aligned to a budget activity 2 and budget activity 3 PE as appropriate. This activity reflects the alignment of investments for the Sea Shield EC.

## **FY 2006 Accomplishments:**

- Continued development of improved threat models and torpedo system simulation capabilities under the Torpedo Enterprise Advanced Modeling and Simulation initiative.
- Continued development of technologies for terminal defense against close-in waterborne/underwater threats and high-speed weapons (examine experimentally, in water, the physics of interactions among multiple supercavitating projectiles in a projectile burst).
- Continued optimization of undersea weapons system design using MSDO with respect to constraints in cost and performance.
- Continued development of enhanced performance directed energy torpedo warhead technologies for Light Weight

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Torpedo Improvement and CRAW applications.

- Continued validation of computational models for torpedo lethality.
- Continued effort to conduct full ship validation effort for Explosion Response simulation code, using Dynamic System Mechanics Advanced Simulation (DYSMAS) Hydrocode (test plan developed, finite element ship model was completed, pretest simulations were conducted).
- Continued implementation of MSDO tools in hybrid propulsion and Weapons Silencing systems development.
- Continued development of high-speed supercavitating torpedo vehicle control and homing sensor. Continued to conduct experiments and tests on vehicle control concepts and homing sensors.
- Continued fourth quarter (of the fiscal year) explosive testing for warhead projects.
- Continued conduct of computer code refinements and investigation of supercavitating vehicle dynamics and instability.
- Completed transition of undersea weapons system design tools techniques for use in Lightweight Torpedo (LWT), Anti-Torpedo Torpedo (ATT), and Next Generation Countermeasure. Transition to PEs 0602747N (FNC) and 0602123N (FNC).
- Continued development of a supercavitating 6.75-inch (or full-scale) vehicle with vehicle control devices and homing sensors.
- Continued feasibility investigations (including acoustic element construction) to test the ability of single crystal to operate at high field, high drive, and high duty cycle for both torpedo Tonpiltz transducer and broadband cylindrical projector applications.
- Initiated fin and cavitator control, and integrate with controller for the supercavitating 6.75-inch vehicle.
- Initiated transition of Low Acoustic Motor Propulsor (LAMPrEy) technology to Defense Advanced Research Projects Agency (DARPA) Tango Bravo Program.
- Initiated torpedo design and optimization to support the external weapon stowage effort in DARPA Tango Bravo Program.
- Initiated data collection on a technology test-bed for surface ship close in torpedo defensive system using supercavitating projectiles.

The following efforts support the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area:

- Continued application of MSDO tools probabilistic methods and uncertainty analysis for LWT design.
- Terminated planning for a joint project agreement between the US and UK titled "Torpedo Guidance and Control (G&C): False Targets.
- Continued feasibility investigations under LTT to quantify adjunct sensor configurations and signal processing approaches to enable positive discrimination of artificial targets at standoff ranges. This

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feasibility investigation is expected to result in five (5) new patent applications. (Transitions to PE 0603747N in FY 2008)

- Terminated (within the LTT project) sub-scale testing and scaling law determination of the directed blast warhead due to technical reasons.
- Continued LTT feasibility investigations to select the stealth and propulsion technologies for future integration as a low cost propulsion replacement for the Mk 54 LWT. (Transitions to PE 0603747N in FY 2008)
- Continued LTT feasibility investigations and selected geo-coordinate based navigation system technologies and connectivity methods (i.e. acoustic communications, fiber link) for future development of technologies for LWT demonstration). (Transitions to PE 0603747N in FY 2008)
- Continued data collection for LWT broadband and counter-countermeasures in the harsh shallow water environment of the Shore Bombardment Area site off the Southern California Off-Shore Range using an experimental test vehicle fitted with a broadband Mk 54 array. (Transitions to PE 0603747N in FY 2008)
- Initiated LTT sensor package development to achieve integrated coherent broadband sonar and novel adjunct sensors homing and classification capabilities for LWT. (Transitions to PE 0603747N in FY 2008)
- Initiated LTT development of an advanced LWT directed charge warhead, multi-mode fusing, and sub-scale detonation testing.
- Initiated LTT advanced counter-countermeasure algorithm and tactics development for LWT. (Transitions to PE 0603747N in FY 2008)
- Initiated feasibility assessment of LTT to best utilize precision targeting and distributed sensors for weapon employment from high altitude and standoff range. (Transitions to PE 0603747N in FY 2008)
- Initiated development and integration of adjunct sensors into a lightweight torpedo sensor and design signal processing and data fusion techniques to improve target classification in areas of high contact density. (Transitions to PE 0603747N in FY 2008)
- Initiated a high fidelity weapon frequency model development effort to parallel adjunct sensor developments and provide accurate synthetic data for algorithm design and measurement. (Transition to PE 0603747N in FY 2008)

## **FY 2007 Plans:**

- Continue all efforts of FY 2006 less those noted as completed above.
- Complete LAMPPrEy technology transition to DARPA Tango Bravo Program. Transition to DARPA PE 0603766E, Project NET-02.
- Complete development of improved threat models and torpedo system simulation capabilities under the Torpedo Enterprise Advanced Modeling and Simulation initiative.

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- Complete transition of appropriate supercavitating vehicle control technology and control devices to DARPA Underwater Express program.
- Initiate efforts in electric propulsion for the Next Generation Torpedo.
- Initiate signal processing and homing algorithms for supercavitating vehicle.
- Initiate efforts that enhance undersea weapons G&C capabilities in autonomy, sensors, sensor processing, communication and networking by leveraging current, or contribute to developing, technologies for UUVs.

The following efforts support the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area:

- Continue all efforts of FY 2006 less those noted as completed above.
- Initiate development of a reduced size/weight CRAW for air deployment. This effort will include sensor, guidance and control, warhead, propulsion, and air frame integration tasks.
- Initiate an iterative algorithm development to enable the CRAW to search, home, and terminally home against targets in deep and shallow water both without and with countermeasures.
- Initiate technology to enable a CRAW warhead to achieve required lethality against submarine targets.
- Initiate use of design techniques for LWT using undersea weapons system design tools transitioned from Discovery and Innovation to FNC.

## **FY 2008 Plans:**

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete validation of computational models for torpedo lethality and transition to PMS415.
- Initiate test and evaluation of signal processing and homing algorithms for supercavitating vehicle.
- Initiate integration of hydroreactive shaped charge technology into CRAW warhead development. Technology transitioning from PE 0602123N
- Initiate long pulse concept to exploit explosion bubble technology to enhance undersea warhead performance with smaller volumetric requirements.
- Initiate efforts to develop the concept for air and underwater delivered kinetic energy enhanced lethality warheads.
- Initiate hybrid propulsion for Heavyweight Torpedo.
- Complete weaponization study for unmanned undersea vehicle.

The following efforts support the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area:

- Continue all efforts of FY 2007 less those noted as completed above.
- Complete an iterative algorithm development to enable the CRAW to search, home, and terminally home against

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FY 2008/2009 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET  
Exhibit R-2a

DATE: February 2007

BUDGET ACTIVITY: 02

PROGRAM ELEMENT: 0602747N PROGRAM ELEMENT TITLE: UNDERSEA WARFARE APPLIED RESEARCH

PROJECT TITLE: UNDERSEA WARFARE APPLIED RESEARCH

targets in deep and shallow water both without and with countermeasures.

- Continue development of a shaped charge liner for CRAW warhead initiated in FY 2007.
- Initiate LTT development of an underwater acoustics communications capability to enable coordinated attack and net-centric connectivity.
- Initiate LTT development of salvo weapons tactics utilizing behavior-based control.

## **FY 2009 Plans:**

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete transition of appropriate supercavitating vehicle control technology and devices to DARPA Underwater Express Program.
- Complete efforts in electric propulsion for LWT.
- Complete signal processing and homing algorithms for supercavitating vehicle.

The following efforts support the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area:

- Continue all efforts of FY 2008 less those noted as completed above.
- Complete the development of algorithms for CRAW to search, home and terminally home in deep water against targets both without and with countermeasures.
- Continue the development of a CRAW warhead offensive capability module initiated in FY 2007.
- Develop and apply advanced technologies that support delivery of Technology Oversight Group approved FNC enabling capabilities structured to close operational capability gaps in undersea warfare.
- Package emerging undersea warfare technologies into deliverable FNC products and ECs that can be integrated into acquisition programs within a five year period.
- Mature undersea warfare technologies that support naval requirements identified within the Sea shield naval capability.

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**CONGRESSIONAL PLUS-UPS:**

	FY 2006	FY 2007
ACOUSTIC LITTORAL GLIDER	3,738	4,782

FY 2006: Continued at-sea testing of a prototype acoustic glider and evaluated the capability to collect environmental data in harsh littoral ocean environments. Completed assembly of two (2) prototype littoral gliders.

FY 2007: Continue efforts of FY 2006 and initiate integration and operational testing of six (6) gliders with undersea warfare payloads.

	FY 2006	FY 2007
ADVANCED ACOUSTIC TRANSDUCER CONCEPTS	0	1,943

Support high power transducer research efforts using structural magnetostrictive materials. Support design and prototyping of Terfenol-D low frequency projectors.

	FY 2006	FY 2007
ATT (6.75-INCH DIAMETER) MULTI-MISSION WEAPON	1,638	1,444

FY 2006: Continued the research effort to support optimization of signal processing and 6.75" weapon tactics used in ATT for offensive applications. Continued collection of in-water data to evaluate proposed multi-mission guidance and control technologies.

FY 2007: Continue efforts of FY 2006 and initiate extending multi-mission ATT performance assessment software tools to address air dropped compact rapid attack weapon concept.

	FY 2006	FY 2007
HIGH POWER, HIGH DUTY TRANSDUCERS	2,203	0

Supported high power, high duty transducer research efforts using magnetostrictive materials such as Terfenol-D and Galfenol.

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	FY 2006	FY 2007
MICRO ELECTRO MECHANICAL SYSTEMS-INERTIAL MEASUREMENT UNITS	2,702	1,943

FY 2006: Continued the research and design of MEMS sensors for various applications including weapons safety and health monitoring. Continued development of advanced manufacturing processes for MEMS and demonstrated their reliability and application in system prototyping and low volume output for these applications.

FY 2007: Continue efforts of FY 2006 and initiate research into application of MEMS based projectile control devices.

	FY 2006	FY 2007
PROTOTYPE DEMONSTRATION OF POINT DEFENSE UNDERSEA WEAPON	2,408	0

Explored the feasibility to develop a prototype point defense undersea weapon adapting unique underwater gun using supercavitation technology for potential underwater applications.

	FY 2006	FY 2007
TOW CABLE SHAPE ESTIMATION	965	0

Validated cable shape models as a tool to improve the real-time estimation of towed array shape during submarine maneuvers to further mitigate the loss of towed array performance during such maneuvers.

**C. OTHER PROGRAM FUNDING SUMMARY:**

NAVY RELATED RDT&E:

- PE 0601153N (Defense Research Sciences)
- PE 0602114N (Power Projection Applied Research)
- PE 0602123N (Force Protection Applied Research)
- PE 0602435N (Ocean Warfighting Environment Applied Research)
- PE 0602782N (Mine and Expeditionary Warfare Applied Research)
- PE 0603114N (Power Projection Advanced Technology)
- PE 0603123N (Force Protection Advanced Technology)
- PE 0603506N (Surface Ship Torpedo Defense)

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PE 0603553N (Surface ASW)  
PE 0603561N (Advanced Submarine System Development)  
PE 0603747N (Undersea Warfare Advanced Technology)  
PE 0603758N (Navy Warfighting Experiments and Demonstrations)  
PE 0604221N (P-3 Modernization Program)  
PE 0604261N (Acoustic Search Sensors)  
PE 0604784N (Distributed Surveillance Systems)

NON-NAVY RELATED RDT&E:

PE 0603739E (Advanced Electronics Technologies)  
PE 0602702E (Tactical Technology)

**D. ACQUISITION STRATEGY:**

Not applicable.