

Undersea Warfare Weapons, Vehicles, and Defensive Systems Department

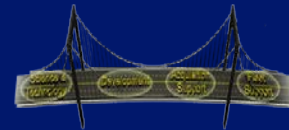


Presented to

NCMA RI Chapter Industry DAY

14 June 2016





- **Department Overview**

- ✓ Mission / Products
- ✓ Major Responsibilities
- ✓ Organization / Department Overview
- ✓ Division Descriptions
- ✓ Major Customers / Projects / Roles
- ✓ Department Resources
- ✓ Unique Facilities / Capabilities
- ✓ Acquisition Strategy Highlights

- **Contracting**

- ✓ Current Major Contractors ~ Summary
- ✓ Projected Contracts FY16 - FY17
- ✓ Summary

~ Talent May Win Games, but Teamwork Wins Championships ~

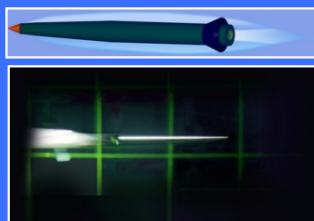
Department Mission / Vision



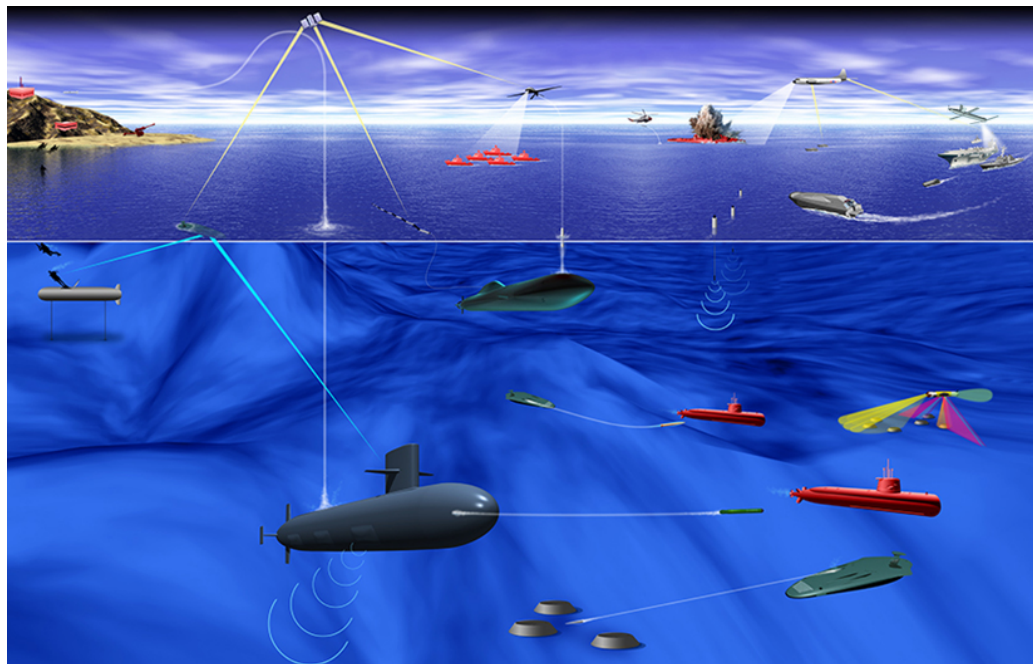
USW Weapons



UxVs



Platform Defense



Mission

“Provide integrated full spectrum undersea Weapon, Autonomous, and Defensive System solutions to the warfighter through technical expertise, cooperative innovation, engineering and life cycle stewardship.”

Vision

“Undersea Dominance through superior Autonomous and Defensive Systems”

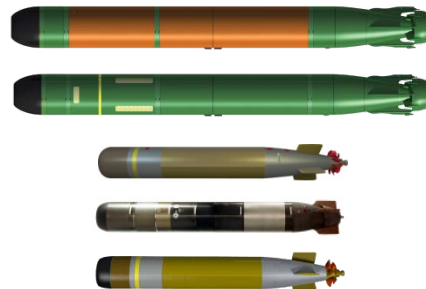
Philosophy

“Operate with Excellence; Commit to Success”

Department Products



- **Science and Technology for:**
 - ✓ Torpedoes / Targets
 - ✓ Autonomous Undersea Vehicles (AUVs)
 - ✓ Countermeasures/Counterweapons
- **System Development, Integration & Test**
 - ✓ AUVs
 - ✓ Mobile ASW Targets and Torpedoes
 - ✓ Undersea Defensive Systems
 - ✓ T&E, assessments, and M&S
- **Acquisition, Fleet Support, & In-Service Engineering**
 - ✓ HW and LW Torpedoes
 - ✓ AUVs
 - ✓ Mobile ASW Targets
 - ✓ Undersea Defensive Systems



Torpedoes

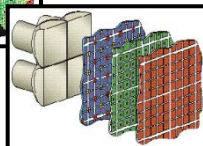
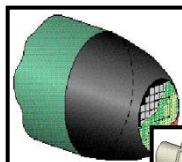


AUVs & Mobile Targets

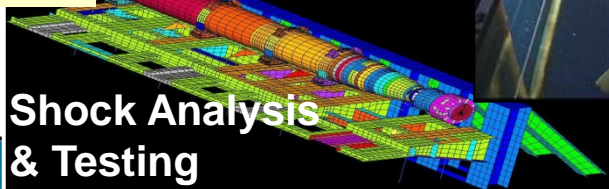


Undersea Defensive Systems

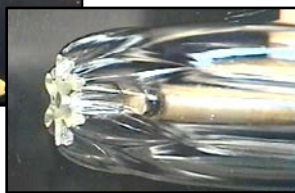
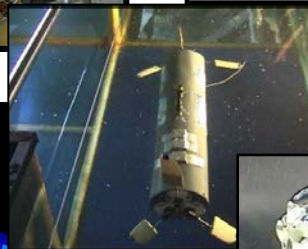
Electric Torpedoes



S & T



Shock Analysis & Testing



RAPID PROTOTYPING



CNO

ADM John
Richardson



*"It is possible...to come up with kind of an **HOV lane**, if you will, that can fast track some really mature [examples of] the right types of technologies,"*

"Then once you see that happening — and this has to be done with full transparency, right? — then more and more people can sort of start to gradually move over to this streamlined way of acquiring."

Assistant Secretary the Navy (RDA)

The Honorable Sean J.
Stackley



*"Using **prototypes** of weapons and conducting more experimentation are key to acquisition reform"*

*"We are at **prototyping** and experimentation in a big way today," "What we're doing, though, is fairly episodic. It is being driven by a compelling threat that gets top leadership's attention. We make mountains move to address the threat. What we need to do is take that model and incorporate it into the way we do business every day."*

Under Secretary of Defense for Acquisition, Technology and Logistics

The Honorable Frank
Kendall



*"Directing R&D money in order to build at least a few **prototypes** of systems the Pentagon knows it can't afford to buy in big quantities ... moves us forward technically. It keeps our industrial base healthy from a design perspective and it keeps our design teams together."*

Director, Unmanned Warfare Systems (OPNAV N99)

RADM Robert P. Girrier



*"...There is a 'very natural' fit for unmanned systems within the Navy, particularly in the ability to **rapidly prototype** and try to fill needs and capability gaps that have been flagged by fleet commanders, outside of the typically long, 'routinized' acquisition process..."*

"It's OK to fail as long as we fail fast,"

"I think what prototyping allows us to do is to better understand the art of the possible because you don't always know it until you see it, and the other thing I think it allows us to do is get immediate feedback from the soldier..."

~ Brig. Gen. John Charlton,

Undersea Autonomous Influence Convergence

MINE PROGRAMS

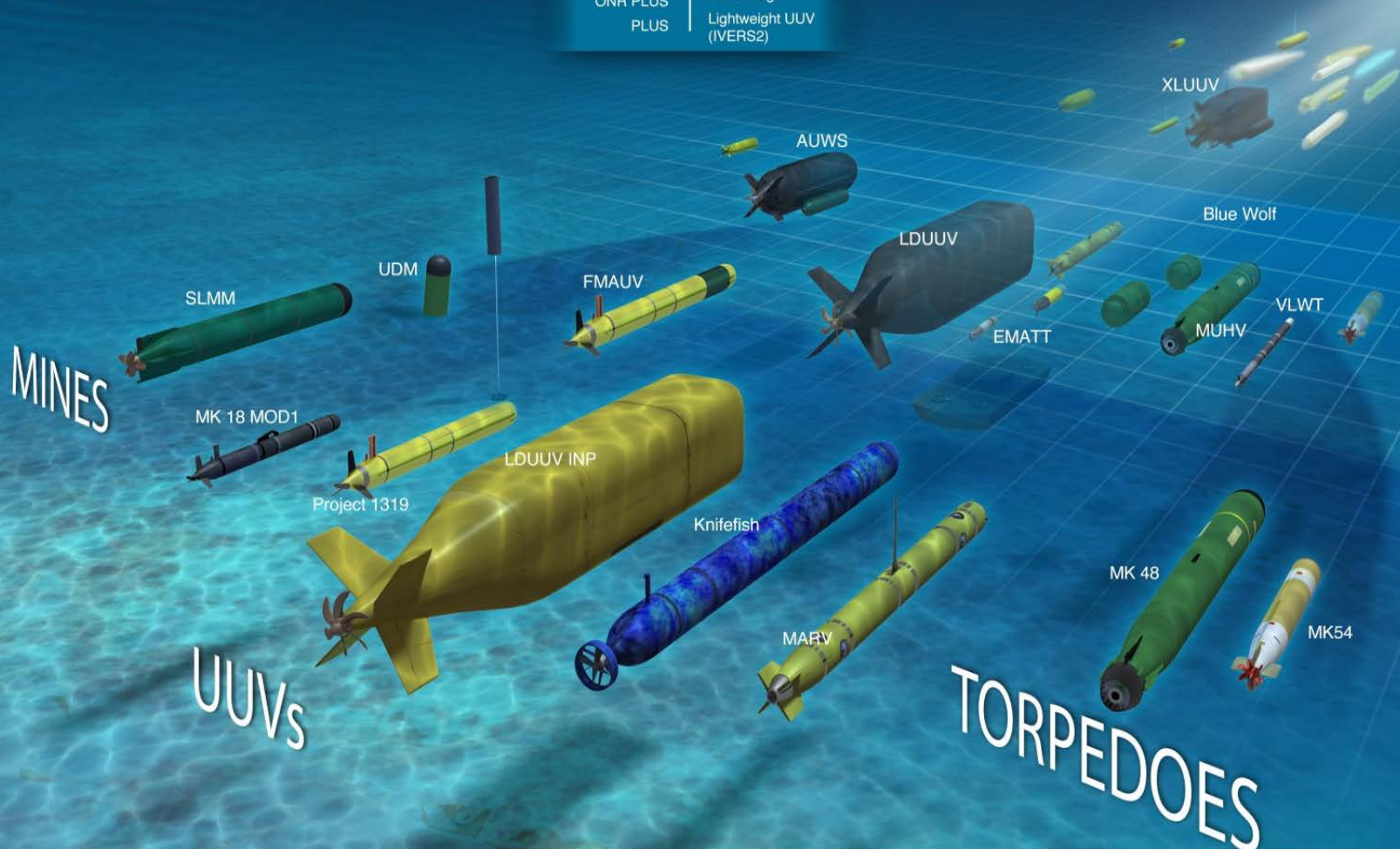
SLMM
CDM
AUWS

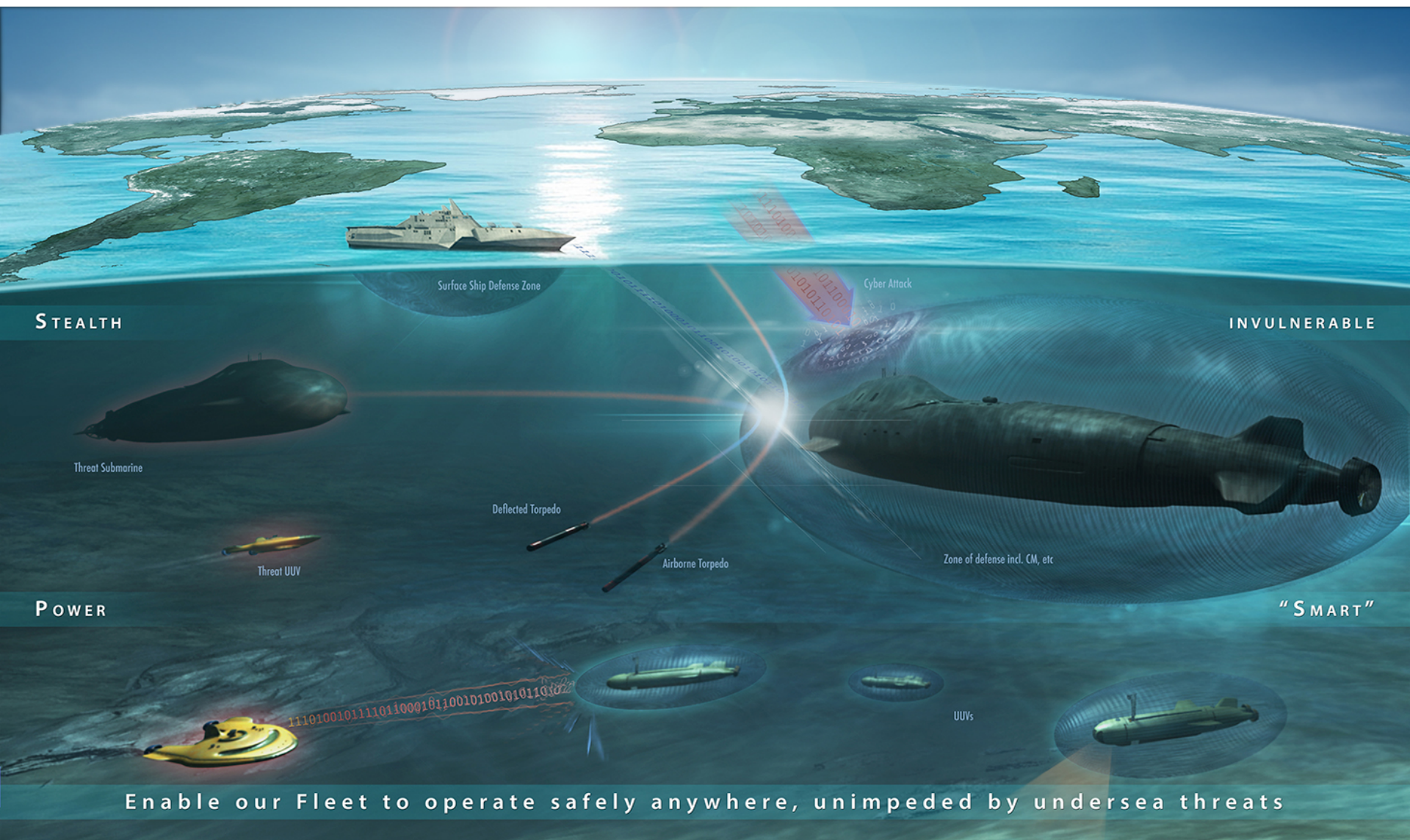
UUV PROGRAMS

MK18 MOD2
KNIFEFISH
ULRM
LDUUV INP
LDUUV
ONR PLUS
PLUS
EOD UUV
RAZOR Riverine
MK39 EMATT
SUBMATT
Mk30 MOD1
ASW Target
Lightweight UUV (IVERS2)

TORPEDO PROGRAMS

MK 48 MOD 7
FNCs
MK54 MOD1
VLWT/ULWT





Major Code 85 Responsibilities



DARPA
PMS 404
ONR
ILIR/IAR

PMS 404, 403/406, 415
SUBFOR
International Sales
PMS 415

PMS 401,404, 403/406, 415
International Sales
PMS EOD
PMW 120

PMS 404, 406, 415
International Sales
Fleet
PMS EOD

Science & Technology

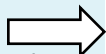
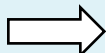
Development

Acquisition Support

Fleet Support

Working Together to Deliver the Best Solutions Quickly

- Submarine Track and Trail
- Biometrics
- Advanced Energy
- Non-Acoustic Technology
- Underwater Express
- AHSUM
- Supercavitation Technology
- Advanced Sensor Technology
- Next Generation CM/CCM
- G&C Technology
- Multi-band Sonar
- Propulsion, Silencing & Hydrodynamics
- New Fuzing
- BB
- Fiber Optics



- LDUUV / ATADS / AN/SLQ-25
- Torpedo Modular Upgrade Prog.
- System Requirements
- Performance M&S
- System Integration / Safety / T&E
- OP SW Development
- Contract Technical Direction
- Next Generation CM
- UUV Technology
- Multi-band Sonar
- Advanced Navigation
- Autonomy
- MK18 Mod 2
- Bluewolf



- ATADS / AN/SLQ-25
- MK30 Mod 1/2
- Signal Analysis System
- Risk Reduction
- HWT Sonar Tech Insertion
- Multi-band Sonar
- OP SW
- Knifefish
- ADC MK5
- MK 39 EMATT
- Production Eng'ing Support
- Fleet Introduction Planning
- Acceptance Testing Support
- Contractor Performance Ass'mt
- LBS (UUV-S)

- AN/SLQ-25A
- Countermeasures ADC 2/3/4
- Signal Analysis System
- MK30 Mod 1/2
- MK 39 EMATT
- Weapon performance assessment
- Fleet T&E support
- Fleet Failure Analysis / CA
- Reliability Management
- SCC training
- SW Downloads
- Fleet Procedures
- IMA Certifications
- ORDAIT Development



Transitioned Programs



Transitioning Programs

Our Main Thing: Working with industry, academia and Navy labs to deliver solutions to the warfighter where and when they are needed.

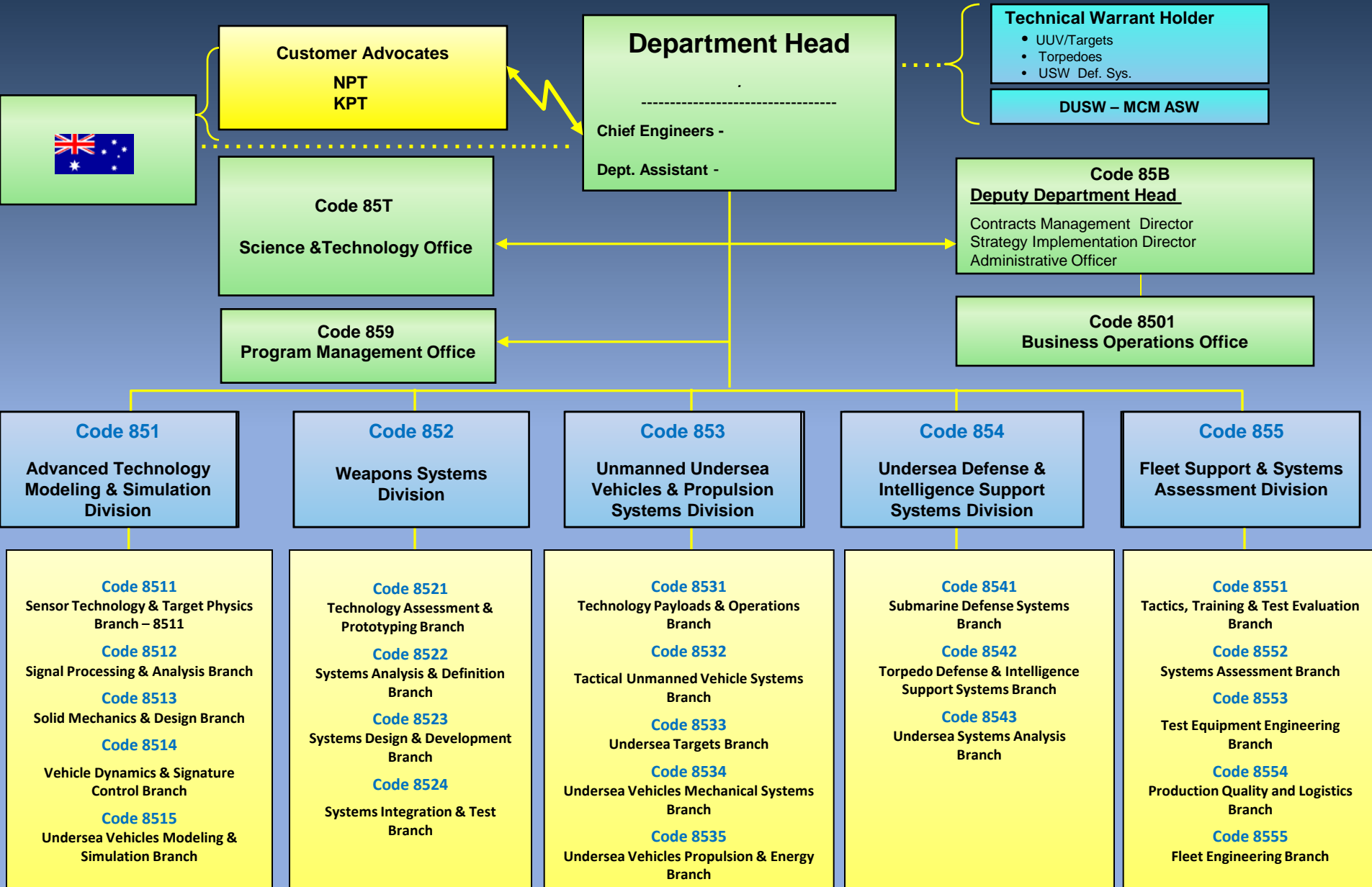
TOTAL: 16%

TOTAL: 27%

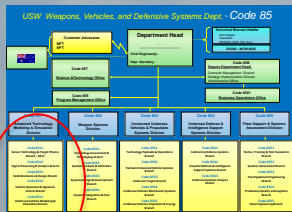
TOTAL: 29%

TOTAL: 28%

USW Weapons, Vehicles, and Defensive Systems Dept. ~ Code 85



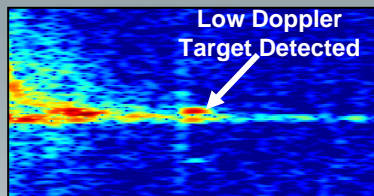
Code 851 ~ Advanced Technology Modeling & Simulation Division



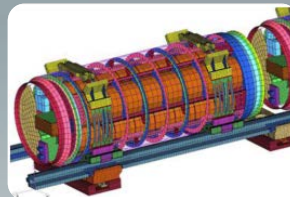
Autonomy Profilers



*Broadband
Torpedo Sonar*



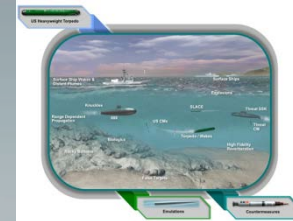
*Structural & Shock
FEA*



*Electric Propulsion /
Quiet Motor Design*



*EC WAF /
Land Based DT/OT*



*Sensor
Technology &
Target Physics*



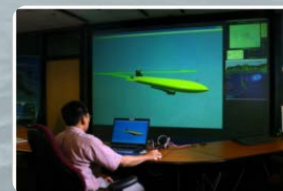
*Signal Processing
& Analysis*



*Solid Mechanics
& Design*



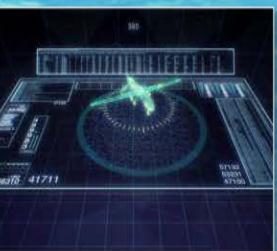
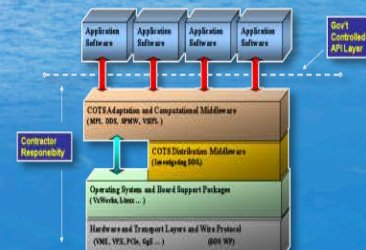
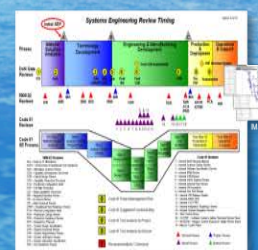
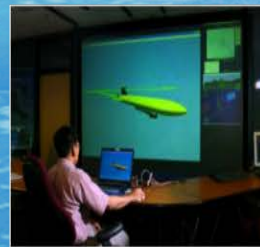
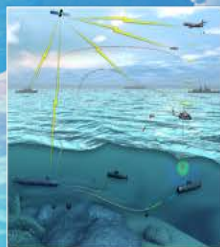
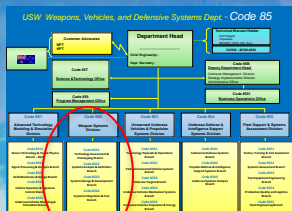
*Vehicle Dynamics
& Signature
Control*



*Undersea Vehicles
Modeling &
Simulation*

" Provide full-spectrum Science and Technology (S&T) and M&S solutions for diverse Undersea Weapons, Vehicles, and Defensive Systems"

Code 852 ~ Weapon Systems Division



Technology Assessment Prototypes

Requirements - HW/SW

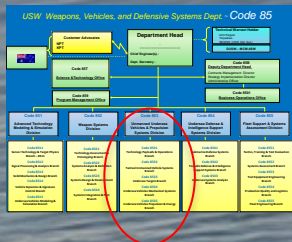
Systems - Definition, Design & Development

Systems Engineering Process

Integration & Test

"Provide the Navy with well integrated undersea weapons systems solutions that address today's challenges and tomorrow's vision... Also provides systems support to undersea vehicles and defensive systems"

Code 853 ~ Unmanned Undersea Vehicles & Propulsion Systems Division



**Undersea Vehicles
Mechanical Systems**



**ASW Mobile targets,
In-Fleet operations**



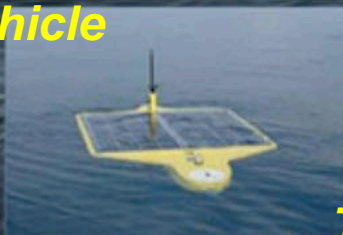
**Government testbed developed
Vehicles and operations,
Integration & Operations with
Commercial systems.**

**Undersea Vehicles
Propulsion & Energy**



Undersea Targets

**Tactical
Unmanned Vehicle
Systems**

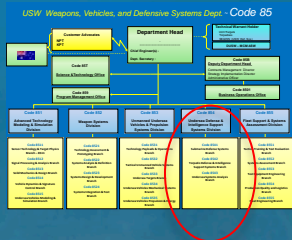


**Technology Payloads &
Operations**



“ Provide technical expertise and core competencies for UUV's, targets, undersea propulsion/energy, and technology payloads/operations as well as provide for associated technology development, evaluation & integration, acquisition, and life cycle management”

Code 854 ~ Undersea Defense & Intelligence Support Systems Division



Submarine Defense Systems

Undersea Systems Analysis



Torpedo Defense & Intelligence Support Systems

“ Develop and deliver innovative undersea warfare defense systems, including sensors, detection subsystems, soft and hard-kill devices, signal processing, and related deployment systems which provide effective torpedo self-defense for surface ships and submarines. Provide computer modeling, engineering evaluation, in water testing and submarine installations in support of intelligence programs.”

Code 855 ~ Fleet Support & Systems Assessment Division



**Quality, Production, &
Logistics**

**Test Equipment
Engineering & LCSF**

**Fleet
Engineering**

**Tactics, Training,
T&E**

**Systems
Assessment**



“Assure maximum Fleet readiness through superior engineering and technical support across undersea weapons, vehicles, and defensive systems’ life cycles; including development, acquisition, in-service operation , operations assessment, performance analysis, tactics development, training, and communication....”



Customer	Program	
DARPA, ONR, ONI	Concept Development, Maturation, and Insertion (RDT&E)	Propulsion <ul style="list-style-type: none"> • Certified Electro Chemical <ul style="list-style-type: none"> ✓ Cheap, Long Endurance, High /Low Rechargeable
		Navigation <ul style="list-style-type: none"> • Retard Undersea Navigational Errors Growth <ul style="list-style-type: none"> ✓ Over the Horizon Applications ✓ Third Party Link...RF, etc.
		Autonomy / Software <ul style="list-style-type: none"> • Autonomous Object Recognition <ul style="list-style-type: none"> ✓ Obstacle Avoidance ✓ Precision Targeting ✓ Energy Management
		Communications (COMMS) <ul style="list-style-type: none"> • Fiber Optics • 3rd Party Targeting
		Sensors <ul style="list-style-type: none"> • Sonar / Sensing <ul style="list-style-type: none"> ✓ Non-Traditional Sensing
		Payloads <ul style="list-style-type: none"> • Components / Module Level Technology



Customer	Program	Role
PMW 120 - PMS406 - LDUUV PMS406 - Knifefish PMS418 - Mk 18 Mod 2 UUV DARPA, ONR, PMS406, PMS408	Unmanned Maritime Systems	<p>LBS (UUV-S): Littoral Battlespace Sensing (Unmanned Underwater Vehicle – Submarine)</p> <p>LDUUV: <i>Lead Technical & Systems Engineering Agent for acquisition of the LDUUV. We help establish and articulate requirements and define Technical specifications & requirements; provide acquisition planning support & systems engineering from source selection thru IOC; and coordinate technical efforts of other Technical activities to meet Program acquisition needs. NUWC Npt will be the Contracting Agency/PCO for LDUUV ACAT II Program.</i></p> <p>Knifefish: <i>Provide Systems Engineering expertise as part of the Gov't Team in support of development, acquisition, and fielding of the Knifefish Surface Mine Countermeasure UUV Program. NUWC provides specific expertise as Gov't technical leads in the areas of Undersea Vehicle systems engineering, Acquisition Software, Systems Safety, and Cyber Security/Info Assurance. (ACAT III)</i></p> <p>Mk 18 Mod 2 UUV (Payload integrator/Advanced Technology support): <i>Payload integration and demonstration for potential P3I product upgrades to the Mk18 Mod 2 UUV. We support the Program Office and Lead Technical Agents (SPAWAR SSC and NSWC-PCD) with risk mitigation systems engineering and payload integration for future Block Upgrades. We contract to several commercial partners for hardware and technical services. (ACAT-IV)</i></p> <p>AUS: <i>Advanced UUV systems technology based development, integration, test, and transition</i> UUV Payload Develop / Prototypes:</p>
PMS404, USFF N7, CPF N7, OPNAV N98, OPNAV N43, Various Navy TYCOMs	ASW Targets Mk30 EMATT	<p><i>Manage DIVNPT ASW Target efforts and Identify the technical requirements needed now and in the future to provide the USN with the best targets at the lowest overall cost.</i></p> <p>Mk30 Mod 1: <i>Responsible for the integrity, technical design, and Fleet support for the HWT mobile ASW Training Target MK30 Mod 1 and support equipment.</i></p> <p>EMATT: <i>Manage/implement all aspects of the Expendable Mobile ASW Training Target program. Execute procurement contract.</i></p>

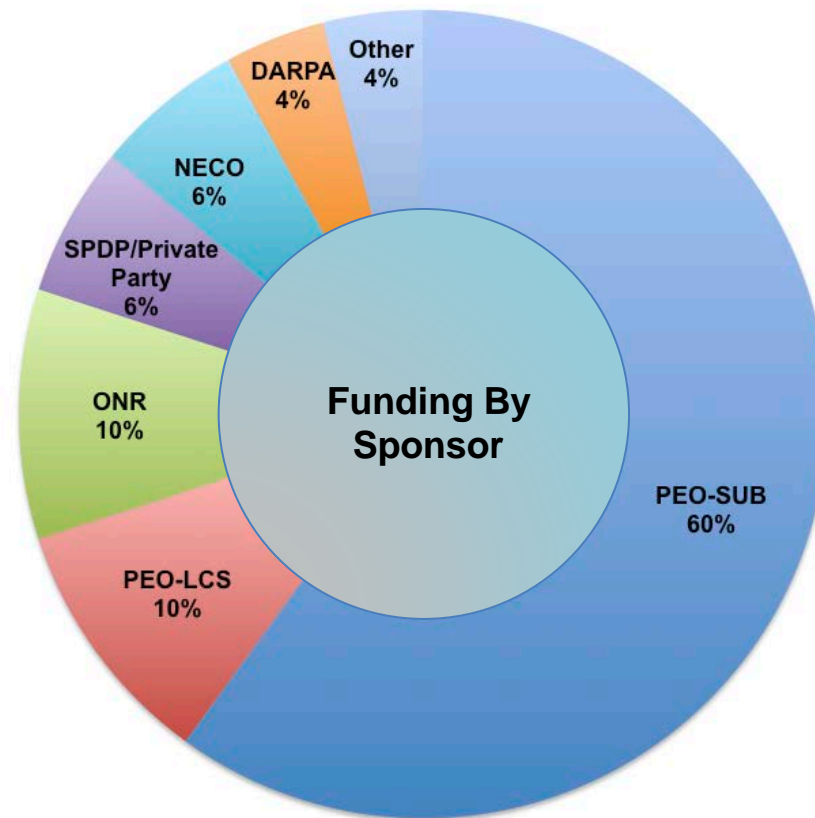
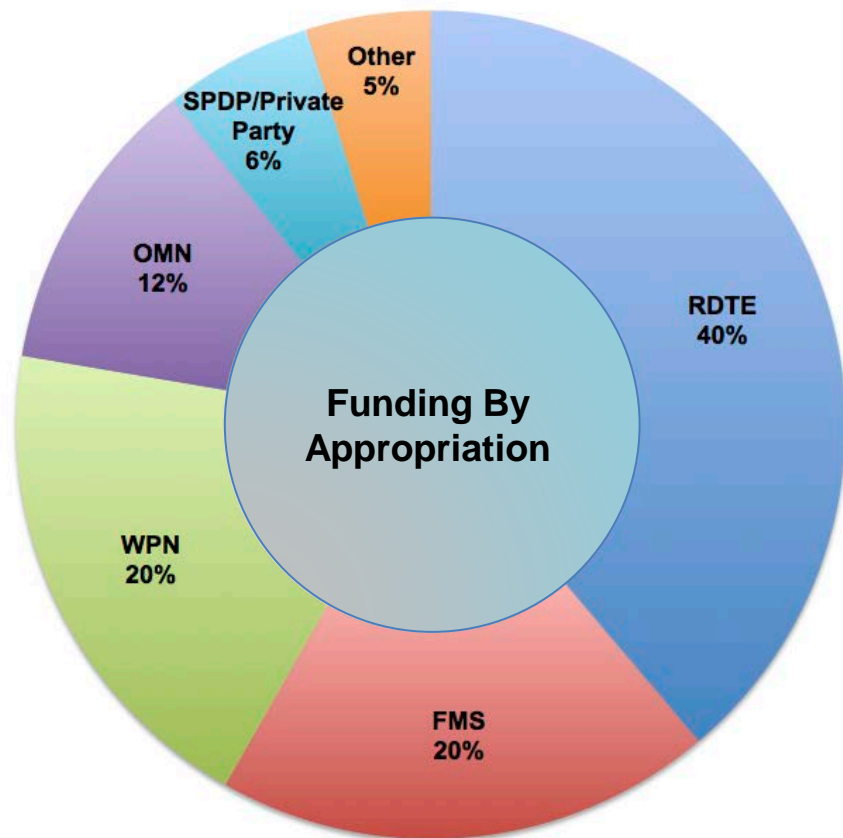


Customer	Program	Role
PMS415 - AN/SLQ-25 (NIXIE) PMS415 - Countermeasure Anti-Torpedo (CAT) PMS415 - Torpedo Warning System ONI - Intelligence support ONR (FNC) PMS420 - LIGHTWEIGHT TOW PMS415 - Sub Countermeasures PMS415 - Next Generation CM (NGCM) PMS415 - Special Projects	Defensive Systems	<p>AN/SLQ-25 (NIXIE): Manage systems engineering, acquisition, in-service engineering, Logistics Support, and Fleet Support tasking essential to deliver/maintain AN/SLQ-25 for the USN and FMS customers.</p> <p>Countermeasure Anti-Torpedo (CAT): System level technical performance certification authority as well as monitor design progress of the CAT program.</p> <p>Torpedo Warning System (TWS): Perform system engineering functions to develop and verify compliance with the TWS performance specification; work directly with the program office to perform acquisition planning and establish program concepts as well as develop program documentation.</p> <p>Manage and maintain carry-on\carry-off systems. This includes developing SW builds to integrate SW system changes, provide technical support wherever the platform requires support and procure components and services to support the program. Contractors provide a majority (80%) of the program support.</p> <p>LIGHTWEIGHT TOW: Manage Surface Ship Torpedo Defense Advanced Development for the Lightweight Tow acquisition program.</p> <p>Submarine Countermeasures: Manages all aspects of NUWCDIVNPT acoustic countermeasure responsibilities. Oversees production of acoustic countermeasures to verify conformance; perform research toward device-level improvement; and participates in program office (NAVSEA) technical tasking.</p> <p>NGCM: Provide technical direction regarding all countermeasure development programs, and perform contract monitoring, risk assessment, and systems engineering for the NGCM Program.</p> <p>Various</p>



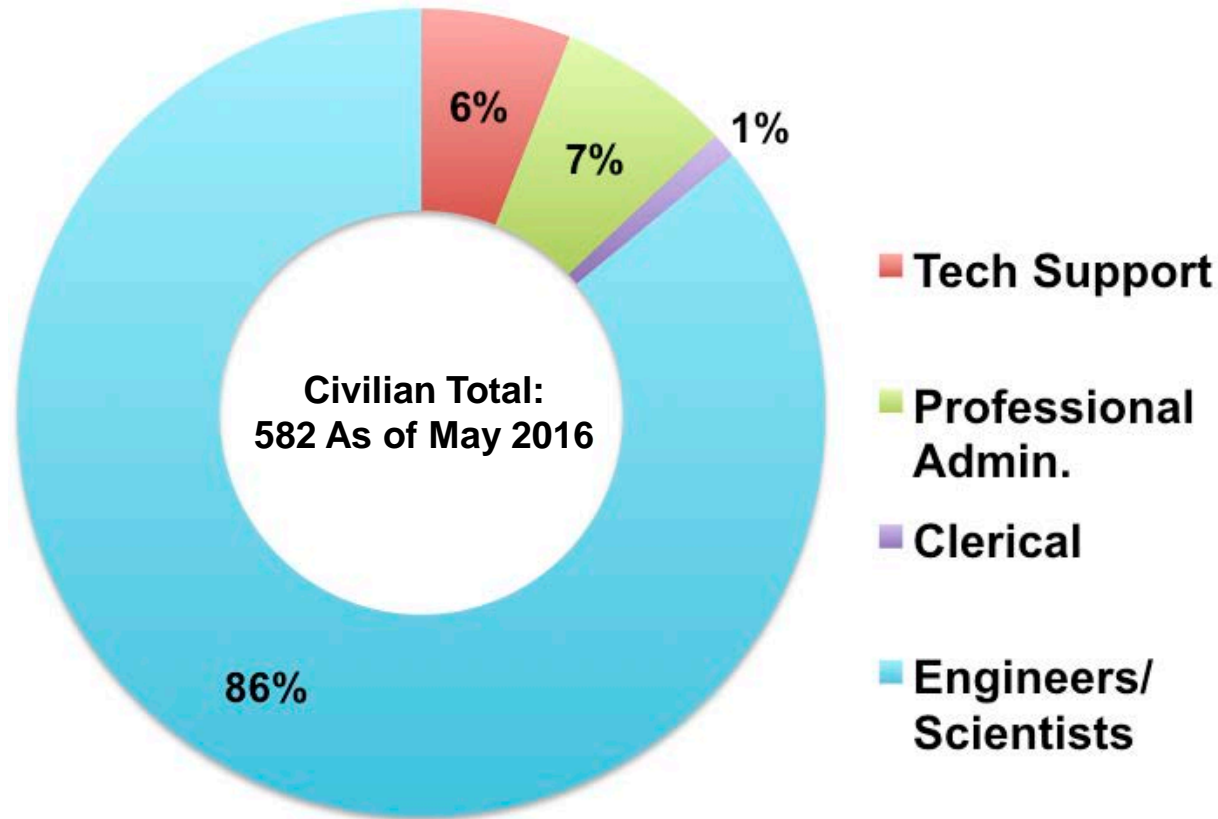
Customer	Program	Role
PMS404 - HWT / LWT <ul style="list-style-type: none"> • APB • BUG/Weapon Concepts • Production Support • Production Restart • Fleet Support • In Service Eng'ing • Block Upgrade • Mk48 Mods 6/7 AT • International Programs • Mk710 Torpedo Systems Test Set 	Torpedoes Mk 48 Mk 54	<p>Development of: Mk48 Mod7 APB5 & APB6/TI-1</p> <p>Production Support: <i>Support overall HWT and LWT Torpedo production including reestablishing a production capability for all MK 48 Mod 7 CBASS torpedo parts (except warhead material).</i></p> <p>Manage in-service engineering, Logistics Support, and Fleet Support <i>tasking essential to deliver/maintain reliable, available, and effective Fleet torpedoes.</i></p> <p>Mk48 Mods 6/7 AT: <i>Provide for design, development, and evaluation of an upgrade package which will convert FMS Mk 48 Mod 4 torpedoes to a Mk 48 Mod 6/7 capability.</i></p> <p>Mk 54 Mods 0 and 1</p> <p>FMS: <i>Manage extensive USN / FMS partnerships and collaborative efforts.</i></p> <p>Mk710: <i>Field/maintain an automated All Up Round MK 48 Torpedo System Test Set for use by the Intermediate Maintenance Activities in the preparation and test of MK 48 torpedoes for the USN and RAN.</i></p>
PMS397, PMS415, PMS450	Signal Analysis Systems (SAS)	<i>Support all aspects of the SAS program including development, production and lifecycle support.</i>

USW Weapons, Vehicles, and Defensive Systems Department



FY 16 LRE Projections are \$190M

Our People FY16

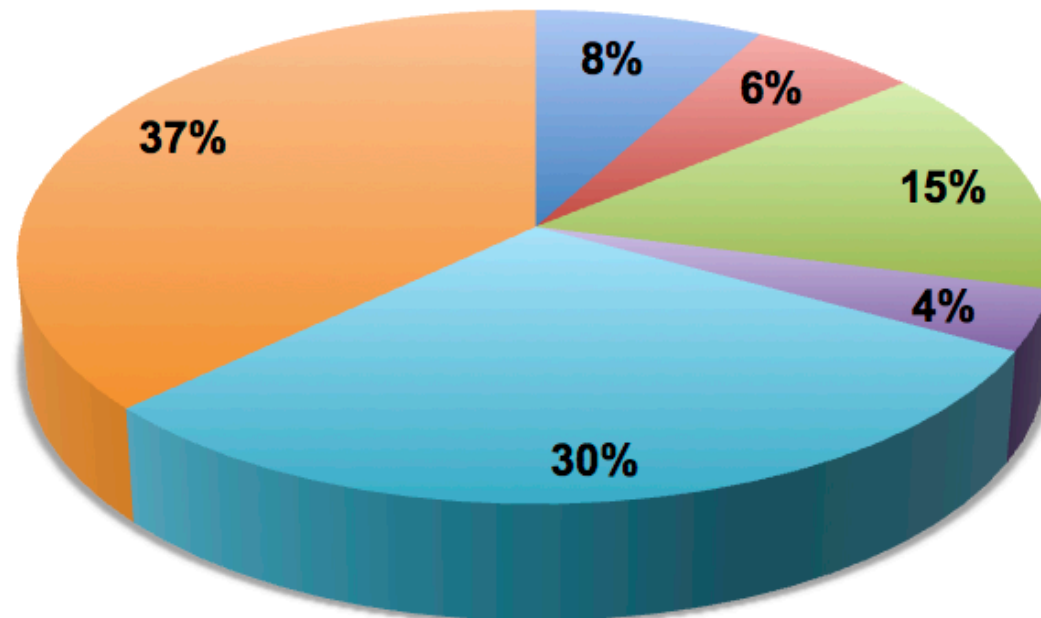


***~44% of our Engineers and Scientists have Advanced Degrees
& ~8% have PhDs***

Code 85 Outsourced WYs By Skill – FY16 Total WYs - 150



- Business/Finance
- Clerical
- Admin/Mgt. Support
- Logistician
- Technicians
- Scientists & Engineers



Significant NUWC Investment in Unique Facilities/Capabilities



Undersea Warfare Development Complex



Weapon Analysis Facility
Super Computers



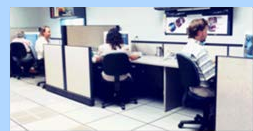
Weapon Analysis Facility
H-W-I-L



Torpedo Analysis
Facility



Weapon Analysis
Facility-User Area



Simulation Based
Design Laboratory

Specialized Laboratories



Materials
Laboratory



Chemistry
Laboratory



Motor
Laboratory



Small Tow Tank



Research Water
Tunnel



Battery
Laboratory



Anechoic Chamber



Acoustic Wind
Tunnel

Undersea Tactical Vehicles Complex



Life Cycle Support Facility



Shapes Laboratory



Acoustic Test Facilities



Torpedo Electronics Lab

Torpedo Industrial Complex



Undersea Weapons Collaboration Center



Reconfigurable Design



Collaborative Development

Land Based Propulsion Test Facility Complex



Electric Propulsion
Test Facility



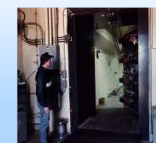
Deep Depth Test Facility



Propulsion Noise
Test Facility



Torpedo Component
Test Facility



High Energy
Chamber

In-Water Test Facilities



Portable Ranges



Littoral Undersea Test Facilities



AUTEC Range Complex

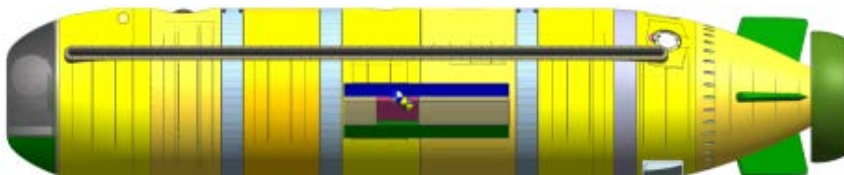


Nanoose, Canada USW Range
& Control Facility



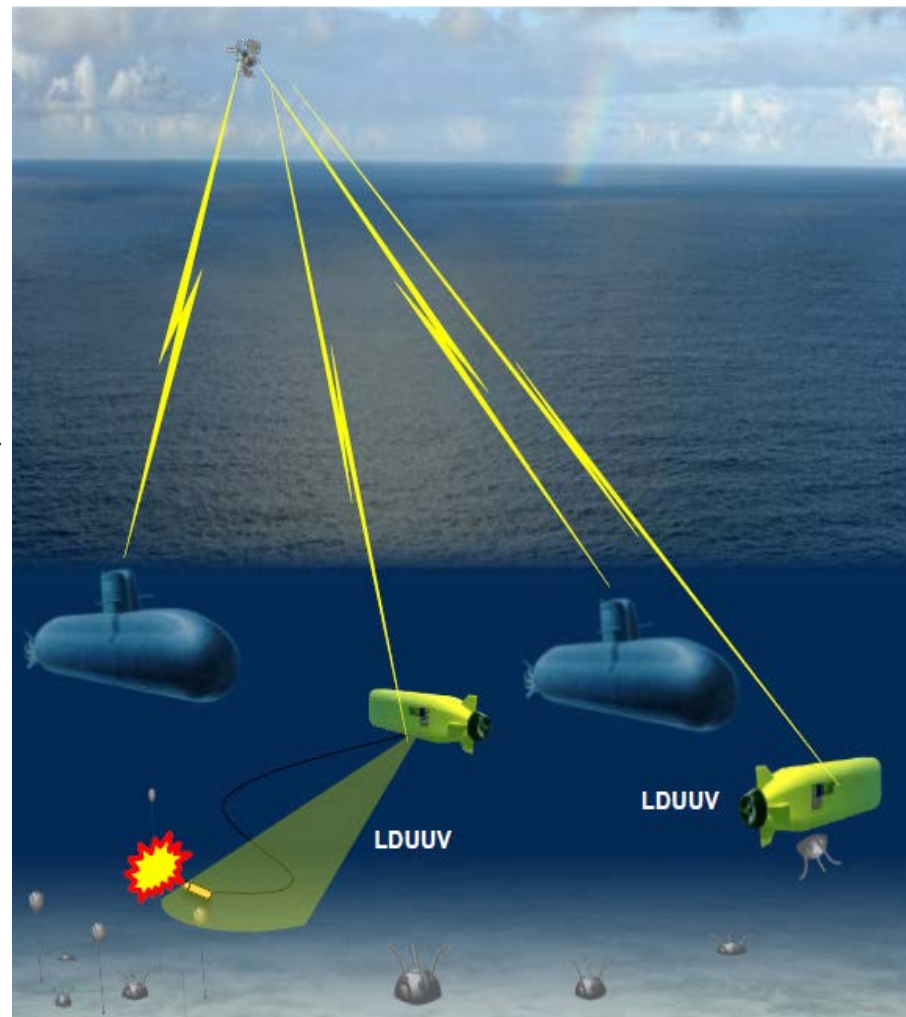
Dabob Bay USW Range

Prototyping for Large Displacement Unmanned Undersea Vehicle (LDUUV)



LDUUV Concept Design ~17,000 lbs Displacement

- **Current Navy LDUUV Program**
 - Use Government Lead System Integrator Approach (NUWC Newport leads the NR&DE, UARC, and Industry Team)
- **Define Capability We Buy**
 - Use Set-Based Design principles
 - Increased early Prototyping & Experimentation
- **Establish a Reliable Modular “Truck”**
 - Use Incremental approach for delivering Operational Capability



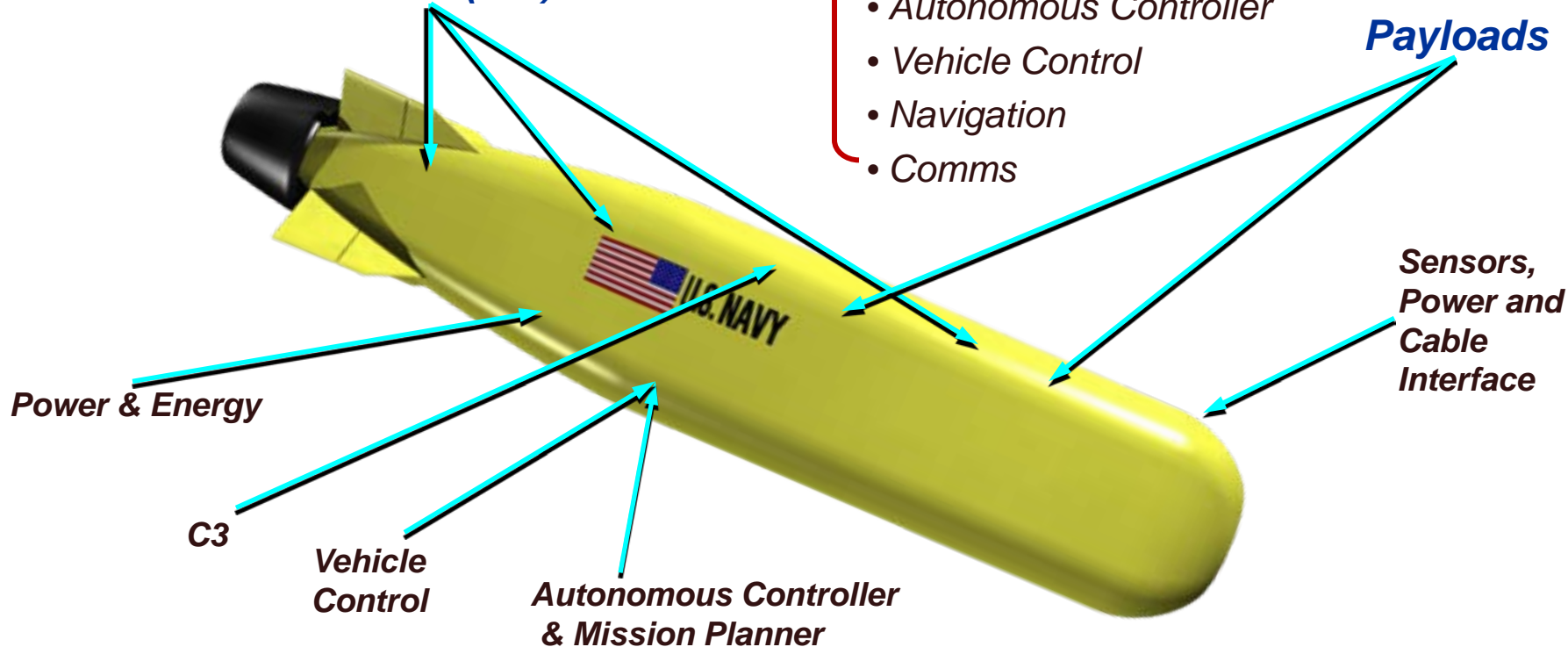
LDUUV Business Model



Government Controlled Open Architecture (OA) Interfaces

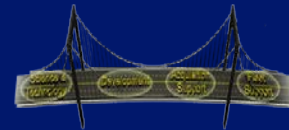
- Sensors / Payload Controller
- Autonomous Controller
- Vehicle Control
- Navigation
- Comms

Innovate via Payloads





- ***Request for Information (RFI) Issued by NUWCDIVNPT***
 - 3QFY16 (N66604-16-S-9999, www.fbo.gov)
 - *Seeking technical and manufacturing capabilities, knowledge, experience level, and qualifications to meet LDUUV requirements*
- ***UUV Industry Day – 4QFY16/1QFY17***
 - *Stay tuned for more information at www.fbo.gov*
- ***Watch for Future NUWCDIVNPT UUV Prototyping Contract Opportunities***



- **Department Overview**

- ✓ Mission / Products
- ✓ Major Responsibilities
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- ✓ Major Customers / Projects / Roles
- ✓ Department Resources
- ✓ Unique Facilities / Capabilities
- ✓ Acquisition Strategy Highlights

- Rapid Prototyping



Contracting

- ✓ Current Major Contractors ~ Summary
- ✓ Projected Contracts FY16 - FY17
- ✓ Summary

~ Talent May Win Games, but Teamwork Wins Championships ~

Current Code 85 Major Contractors



- **Adaptive Methods**
 - ✓ *Sensor Processing and Computing Architecture for Fish Net Avoidance*
- **Alion Science and Technology**
 - ✓ *SSTD*
- **Applied Physical Science**
 - ✓ *Sensor and Sonar Support*
- **Barber Nichols**
 - ✓ *Alternator/Regulator Production*
- **Boeing**
 - ✓ *Data Co-Processor*
- **DDL Omni**
 - ✓ *Intelligence Programs*
- **Draper Labs**
 - ✓ *Engineering Support*
- **General Dynamics Information Technology (GDIT)**
 - ✓ *Eng. and Tech. Support to Surface Ship Torpedo Defense (SSTD)*
- **ICI**
 - ✓ *WAF Simops Support*
- **Lockheed Martin**
 - ✓ *MK 39 Expendable Mobile ASW Training Target (EMATT)*
 - ✓ *Torpedo Engineering Support*
- **McLaughlin Research Corp. (MRC)**
 - ✓ *Torpedo Engineering, Logistics, and Analysis Support ; UUV Engineering*

Current Code 85 Major Contractors



- **Ocean Acoustical Services and Instrumentation Systems (OASIS)**
 - ✓ Computational & Experimental Mechanics Lab (CEML) Facility
- **Progeny**
 - ✓ Torpedo Engineering Support
- **Purvis**
 - ✓ SAS / CM Support
- **Raytheon**
 - ✓ Engineering Support (torpedoes)
- **Science Applications International Corporation(SAIC)**
 - ✓ Financial, Service Cost Ctr. ; Prop. Test Facility; FMS Support; Engineering and Technical Support.
- **SeaCorp**
 - ✓ WAF Engineering Support
- **Syston Donner**
 - ✓ IMU Design Support
- **Veterans Assembled electronics (VAe)**
 - ✓ Torpedo Wire-link and Tuning Box Production Restart
- **Woods Hole Oceanographic Institute (WHOI)**
 - ✓ Engineering UUV Support
- **Yardney Technical (Products) Material**
 - ✓ Silver zinc batteries
- **Ultra 3 Phoenix, Inc.**
 - ✓ MK 710 Torpedo System Test Set (TSTS)

Projected Contracts



Contract Number	Title	Current Contract Value (w options)	Incumbent	Seaport	Follo w-On	Current Contract Type	Expected RFP Release	Strategy
4032 N405	Intelligence Program Support	\$5.5M	DDL Omni	Y	Y	CPFF	Nov 2016	SBSA
4066 N403	Surface Ship Torpedo Defense	\$44M	Alion	Y	Y	CPFF	April 2017	TBD Sources Sought
4119 N432	USW Weapons Engineering Services	\$10M	SAIC	Y	Y	CPFF	Feb 2017	TBD Sources Sought
4083 N455, N457 &N458	Fleet Engineering analysis and Logistics Support	\$26.5M \$27.8M \$4.5M	MRC MRC MRC	Y	Y (com bines 3)	CPFF CPFF CPFF	Dec 2016	TBD Sources Sought
4065 N404	WAF Operations Support	\$3.7M	ICI	Y	Y	CPFF	July 2016	SDVOSB
4095 N402	Computational and Experimental Mechanics Lab (CEML) Test Facilities	\$7.2M	OASIS	Y	Y	CPFF	Mar 2017	SBSA
4119 N425	Surface Ship Torpedo Defense	\$7.9M	SAIC	Y	Y	CPFF	Dec 2016	TBD Sources Sought

Projected Contracts (Con't)



Contract Number	Title	Current Contract Value (w options)	Incumbent	Seaport	Follo w-On	Current Contract Type	Expected RFP Release	Strategy
4119 N429 & N433	Technical Services for AUV EF	\$9M \$35M	SAIC SAIC	Y Y	Y (com bines 2)	CPFF CPFF	Mar 2017	TBD Sources Sought
4119 N426	Programmatic and Financial Support	\$7.4M	SAIC	Y	Y	CPFF	June 2017	TBD Sources Sought
4083 N453	Fleet Production Support	\$49M	MRC	Y	Y	CPFF	Jan 2017	TBD Sources Sought
4012 N440	Surface Ship Torpedo Defense	\$47M	GDIT	Y	Y	CPFF	Aug 2017	TBD
N66604-12-C-0393	Batteries	\$5M	Yardney	N	Y	CPFF	Mar 2017	TBD
NEW	UUV Procurement	N/A	N/A	N	N	CPFF	June 2017	TBD
NEW	Torpedo Electronics ASSY Production (EEA/TSOB)	N/A	N/A	N	N	CPFF	Dec 2016	TBD
NEW	Lightweight TOW LRIP	N/A	N/A	N	N	CPFF	April 2017	TBD

Summary

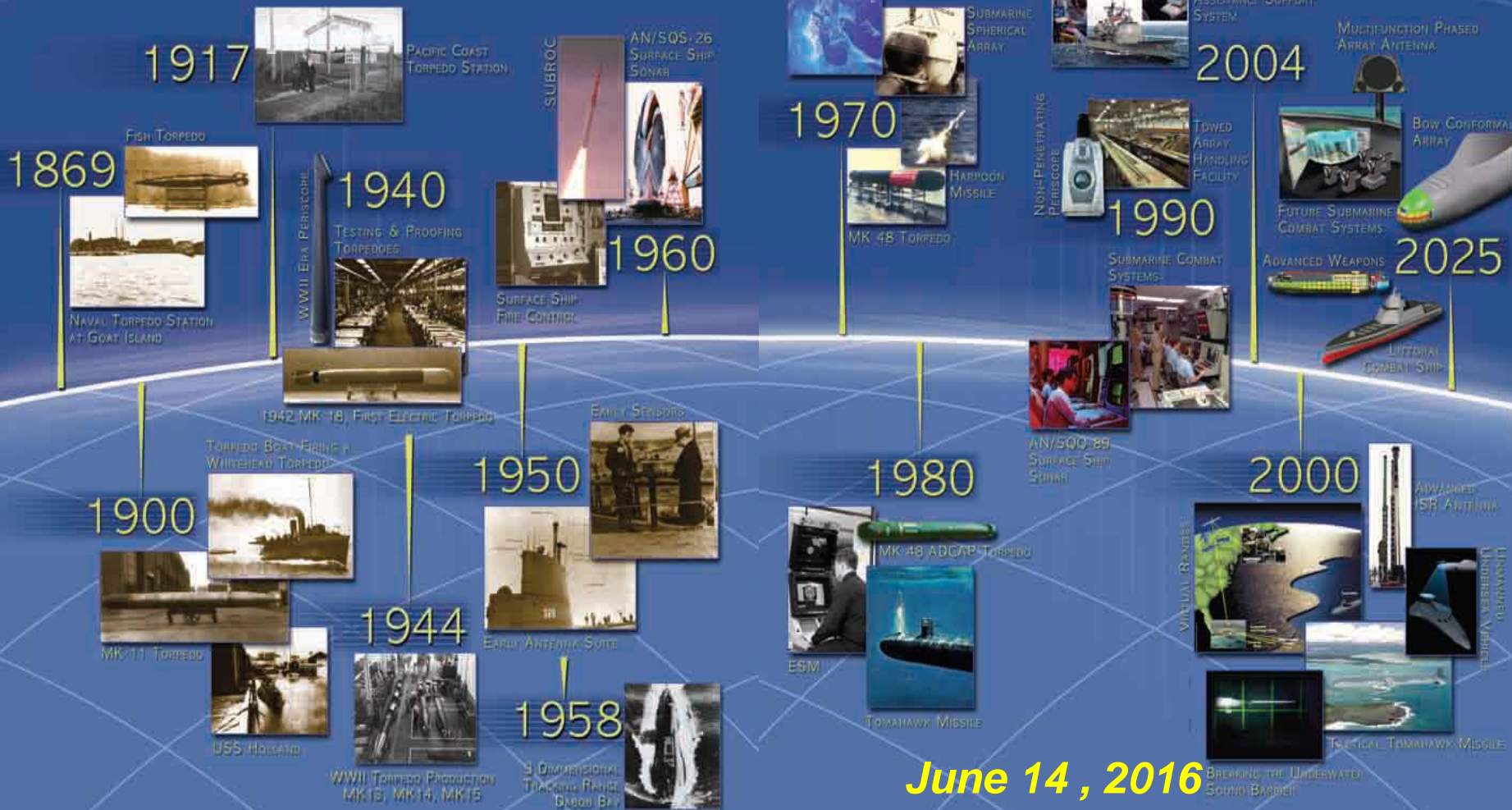
- ***The USW Weapons, Vehicles, and Defensive Systems Department is multifaceted with needs ranging from clerical support to advanced degree experts as well as significant material support.***
- ***Code 85 FY 16 LRE ~ \$190M.***
- ***Onsite Contractor Support in FY16 is 150 WY's.***
 - ✓ *Represents significant part of in-house WY's (> 25%)*
 - ✓ *Anticipate similar percentages in future*



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June 14, 2016

NUWC Events Timeline

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