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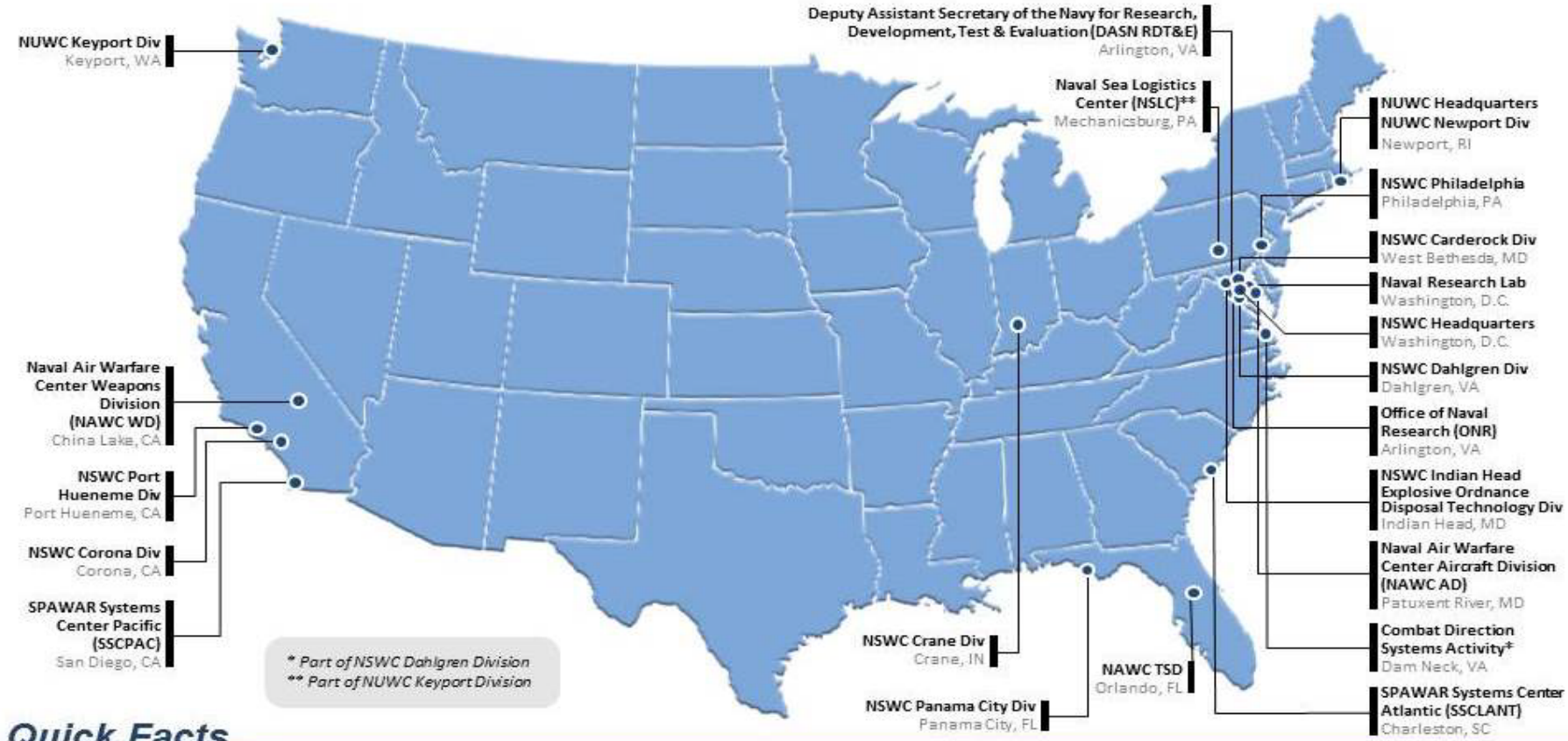
Safe, Common, Affordable Power & Energy Storage (SCAPES) Overview

Presented By: Keith DeVries/Alex Askari/Eric Shields

3 May 2017

Naval Research & Development Establishment

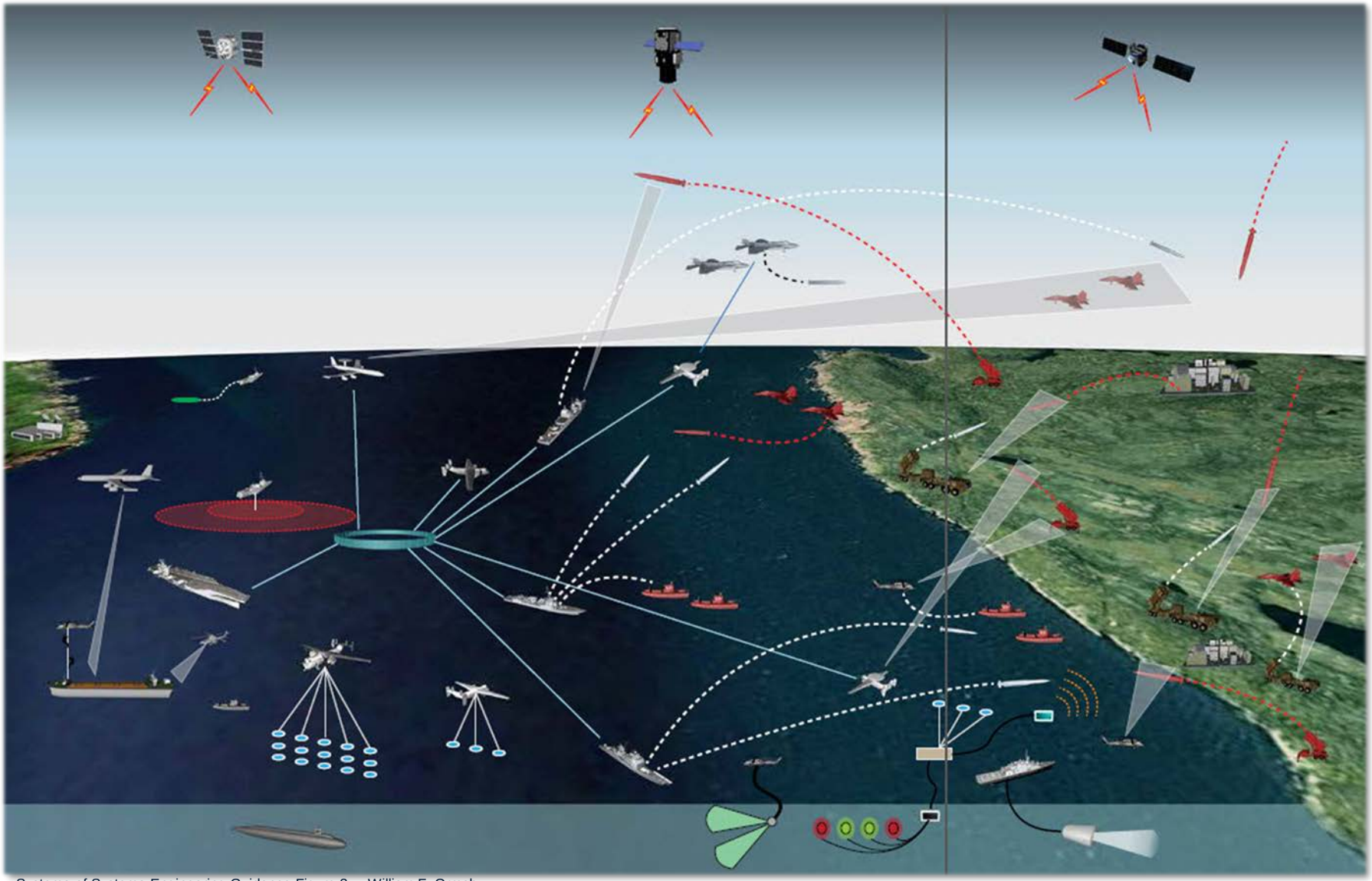


Quick Facts

- Diverse and highly educated workforce with 25,000 scientists, engineers, and technicians (with more than 2,000 Ph.D.s)
- 20 commands across the NAVAIR/NAVSEA Warfare Centers, SPAWAR Systems Centers, ONR and NRL
- Conducts RDT&E for the DoN to discover, develop, transition and field technologically superior naval warfighting capabilities.
- Unique Naval RDT&E facilities including laboratories, test facilities and test ranges
- Serves as principal R&D agents for Navy and Marine Corps Program Executive Offices
- Organizationally aligned to Naval Systems Commands and ONR
  - Naval Sea Systems Command (NSWCs, NUWCs)
  - Naval Air Systems Command (NAWCs)
  - Space and Naval Warfare Systems Command (SSCs)

Aggressive Research, Development, Test & Evaluation for reliable real world solutions.

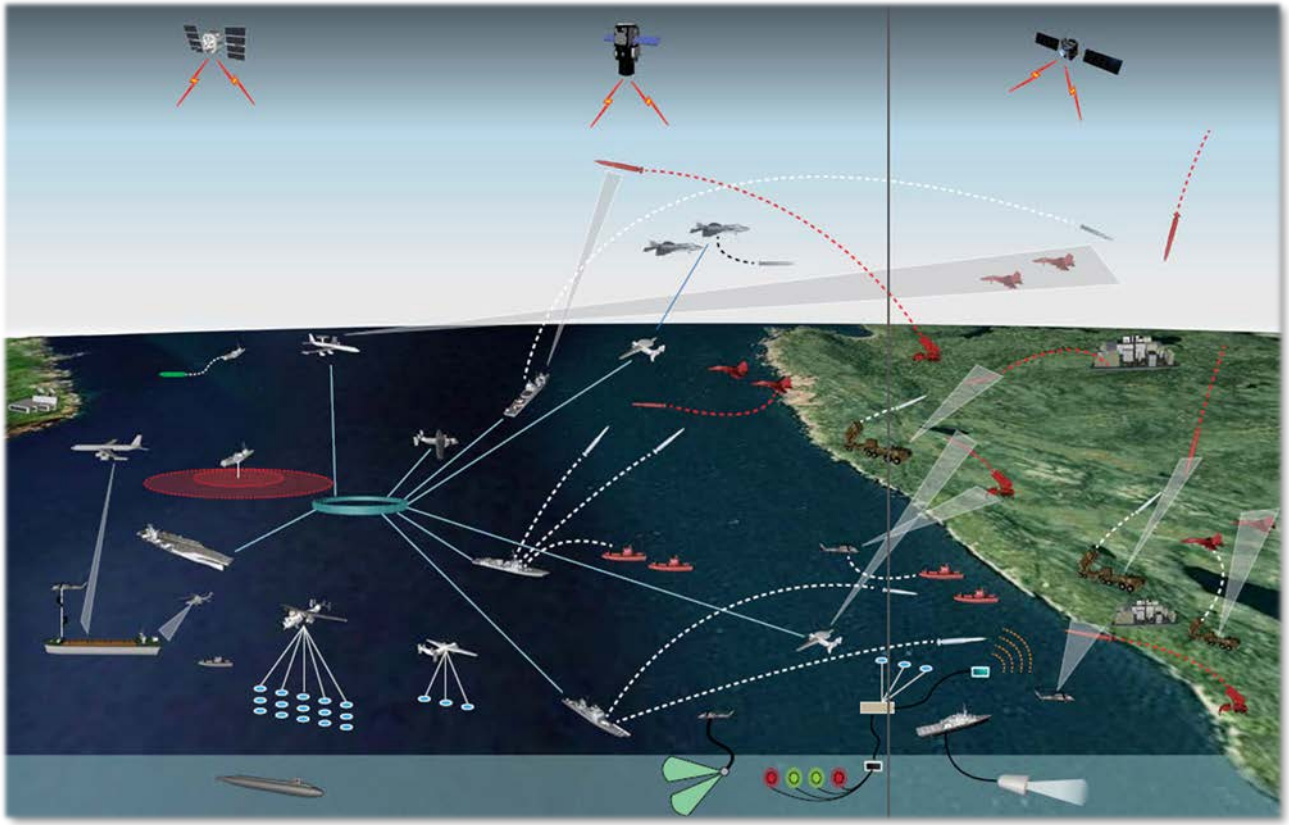
Notional Battlespace Depiction



Systems of Systems Engineering Guidance Figure 3. – William F. Ormsby

Warfare Center Support of Battlespace

Power & Energy Specific



NAVSEA WARFARE CENTERS Philadelphia

NAVSEA WARFARE CENTERS Carderock

NAVSEA WARFARE CENTERS NEWPORT

NAVSEA WARFARE CENTERS CRANE

Power and Energy Systems Division

NSWC Crane

Workforce

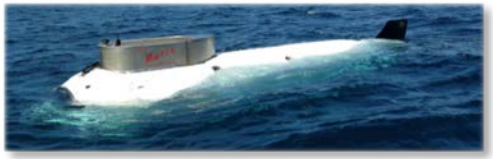
- 143 Government Professionals
- 30 (+) Contractor Partners
- 2000 (+) Years Combined Experience

Education

- PhD – 5
- Master's Degree – 23
- Bachelor's Degree – 66
- Associate Degree - 24

Engineering Assignments

- PMS NSW Engineering Agent for Battery Systems
- Technical Direction Agent (TDA)
  - Standard Missile Batteries (NAVSEA)
- Special Warfare Batteries (WARCOM)
  - AN/WSN-2, 2A & 5 System Batteries
- In-Service Engineering Agent (ISEA)
  - Submarine and Submersible Main Storage Batteries (NAVSEA)
  - Seal Delivery Vehicle Automated Battery Charger (WARCOM)
- Qualifying Agent
  - Trident, Seawolf & Virginia Class Submarine Batteries (NAVSEA)
- Acquisition Agent
  - Submarine and Submersible Main Storage Batteries (NAVSEA)
- Lead Maintenance Technology Center Electrochemical Systems (NAVAIR)






Advanced Power & Energy Branch (APEB)

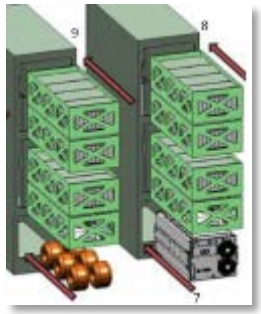
NSWC Carderock

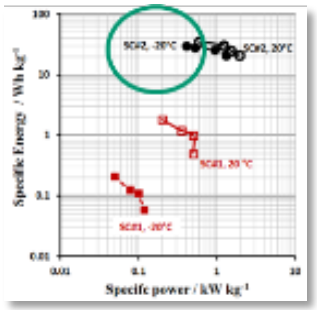
Personnel: 32 (34) ***26 Civilians, 7 Contractors, 2 interns***

Location: NSWC Carderock - West Bethesda

TC: CD16 Alternative Energy and Power Sources R&D

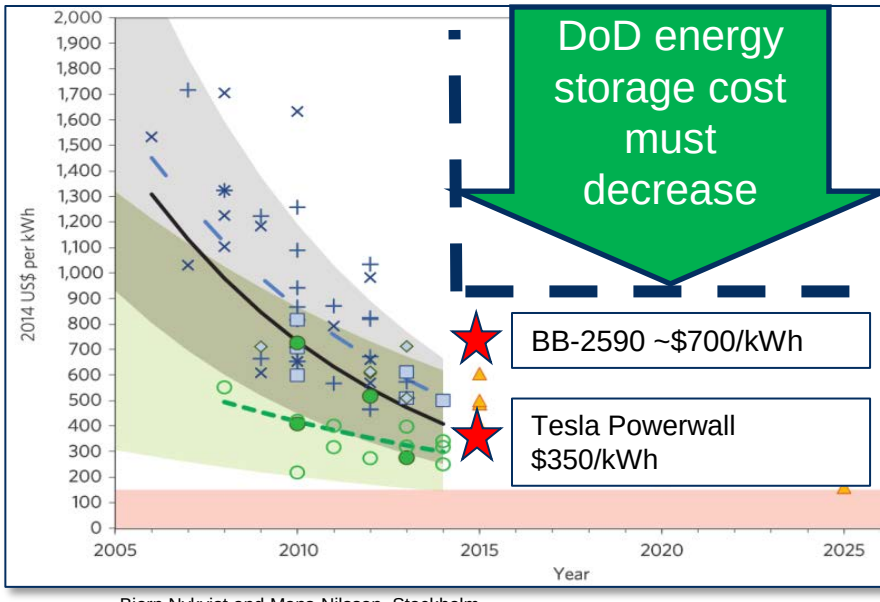
Provides the research and development (R&D) personnel, equipment, facilities, and necessary body of knowledge **to investigate, develop and implement programs in emerging alternative energy source technologies**. Combines the strengths of the Navy's recognized leaders in **electrochemical power sources (e.g. batteries and fuel cells)** R&D and leadership in marinization and ship integration with other disciplines such as nuclear technologies, biotechnology, physics, materials science, and shipboard electric power systems enabling the development of energy source specifications, which effectively address safety and environmental issues as well as performance requirements. Includes certification of advanced technology energy/power sources.





The Lithium Battery Affordability Problem

- Commercial lithium-ion batteries have dropped 90% in price of the past 10 years
- Many Navy lithium-ion batteries cost 20 - 30x the price of comparable commercial batteries
- The DoN operational requirements drive unique and expensive solutions (Safety Evaluation Costs per system up to $5M and 2 year effort)



Bjorn Nykvist and Mans Nilsson, Stockholm
Environmental Institute Journal of Nature Climate Change 5, 329-332
http://www.rtcc.org/2015/03/23/falling-battery-prices-boost-outlook-for-electric-vehicles/

- Goal is to supplement DoN and OPNAV initiatives (i.e. Task Force Energy) thru development of a coordinated plan to address the affordability through commonality and other initiatives
- Focus is primarily on addressing current and future lithium-ion operational energy needs

Commercial Standardization

- Family of Common Batteries
- Single Battery Interface
- Multiple Energy Densities
- Multi-platform
- Safe
- Cost Effective
- Upgrade as technology advances

Examples of Operational & Fiscal Impacts

Present Operational Impacts

- Custom battery charging lockers makes fielding mine sweeping UUVS difficult
- Anti-Tank systems can't be operated by Marines immediately landing on a beach. The battery is flown in separately.
- Platforms requiring custom charging battery room on ships

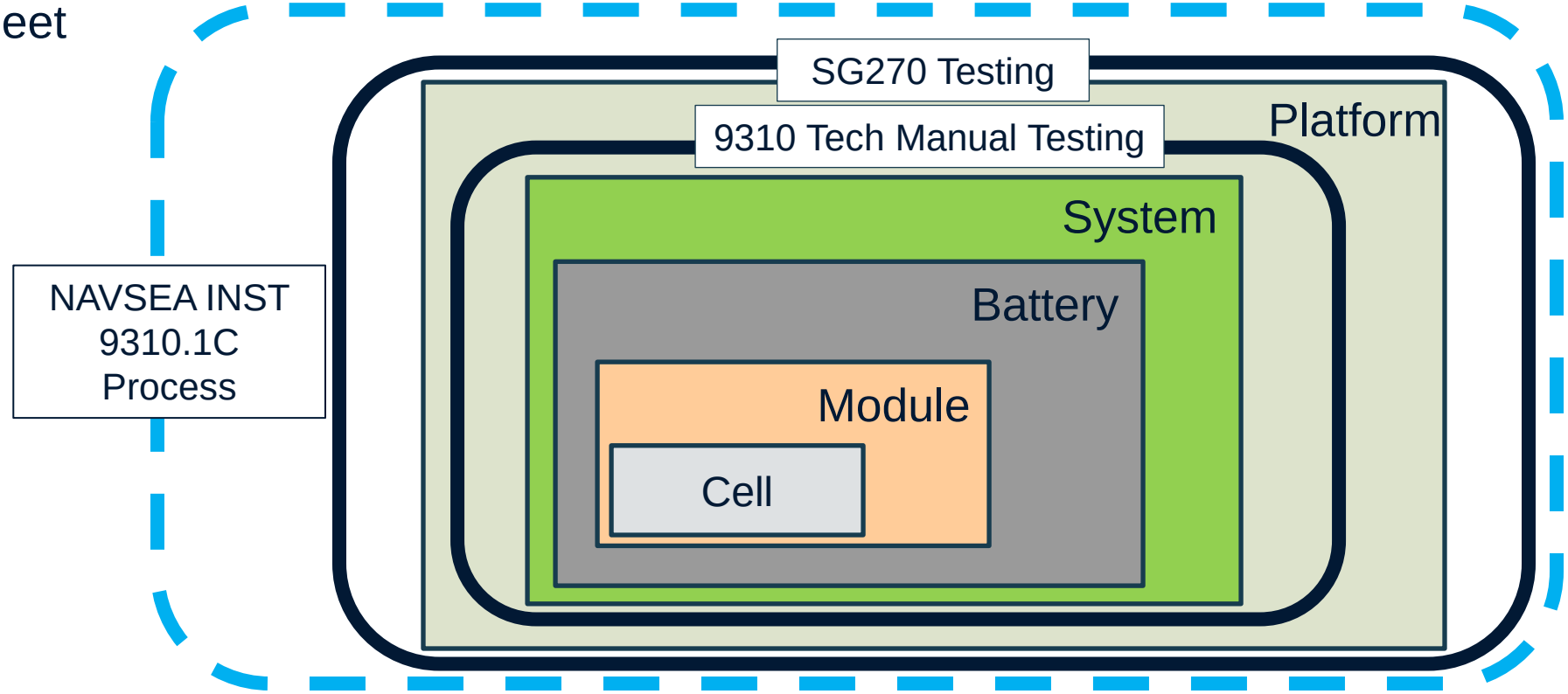
Fiscal/Manpower Impacts

- Certain aircraft batteries, being custom and low volume, cost > 400x commercially available equivalent
- Full safety testing of a large fielded lithium battery may cost $2-5M per battery

This problem is expected to get worse as unmanned systems proliferate

The Navy's Safety Certification Process

The Navy has two levels of certification for deploying lithium batteries in the fleet



*NAVSEAINST 9310.1C - Certifies a battery, on some platforms, in a system, made of modules & cells

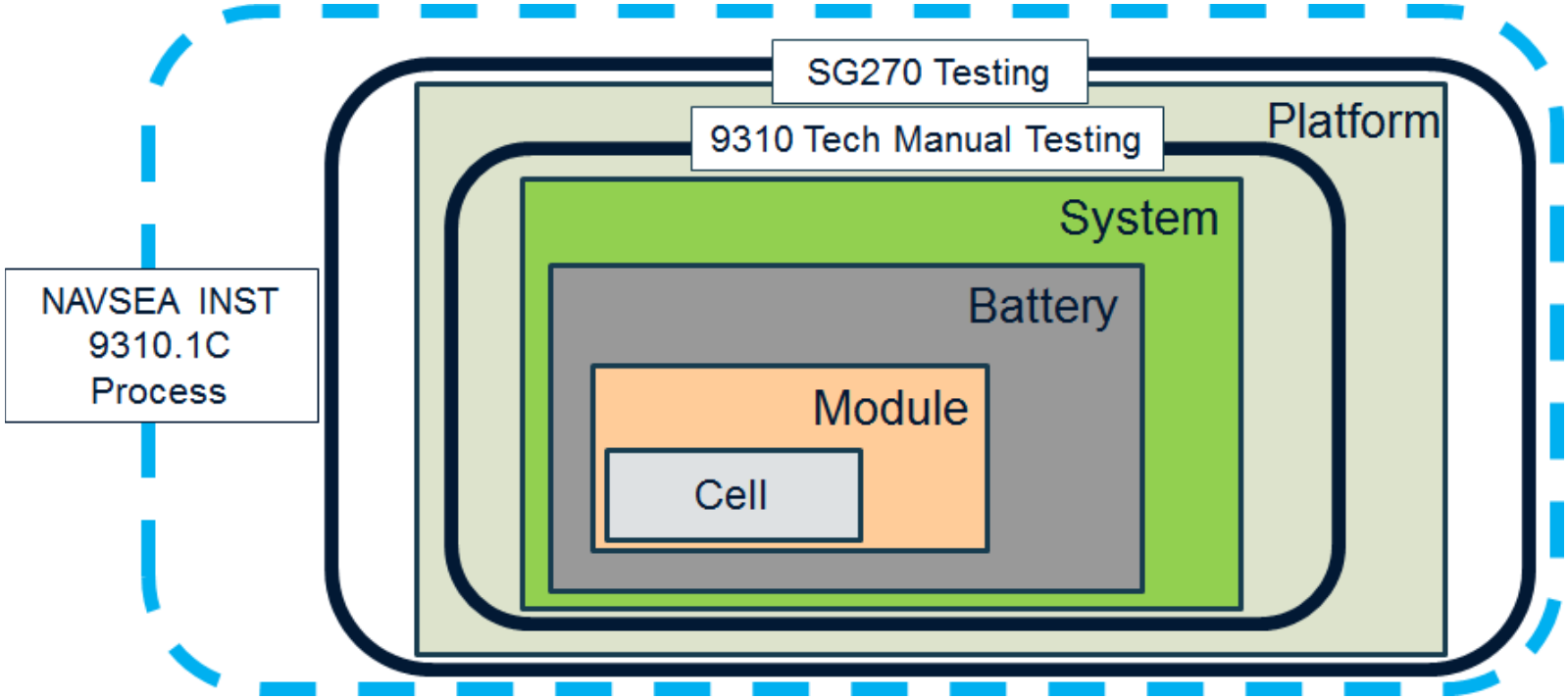
*SG270-BV-SAF-010 – Takes that certification and adds a step to characterize and accept risk and impact to the platform in a large format/high-risk battery casualty

The Navy's Safety Testing

Program Office

To certify the safety of these systems, it tests the:

$	Cells	(9310)
$$	Modules	(9310)
$$$	Battery	(9310)
$$$	Battery in the system	(9310)
$$$$	Battery in the system in the platform	(SG270)



Navy Leadership Support

Energy Storage Commonality Plan MEMO

Signed May 16th 2016

Dr. Burrow, (DASN RDT&E) | Mr. Bryan (DASN Energy)

- Directed the Naval Research & Development Establishment to develop a plan to improve battery commonality in the Department of the Navy and to reduce costs

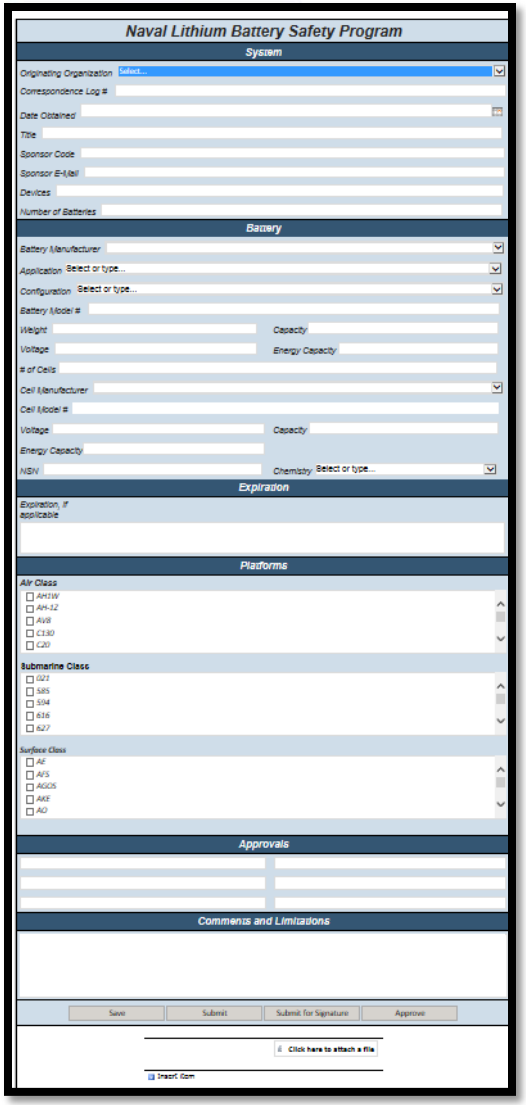
DoN Safe Common Affordable Power & Energy Storage (SCAPES) Implementation Plan

Signed October 14th 2016 by:

DASN RDT&E – Dr. Burrow | DASN Energy – Mr. Bryan

*NAVSEA05Z
*MARCORSYSCOM
*NAVAIR
*NAVFAC
*NAVSEA06
*NSWC Crane
*NSWC Carderock
*NSWC Philadelphia
*NUWC Newport
*NAVFAC EXWC
*SPAWAR Pacific
*SPAWAR Atlantic

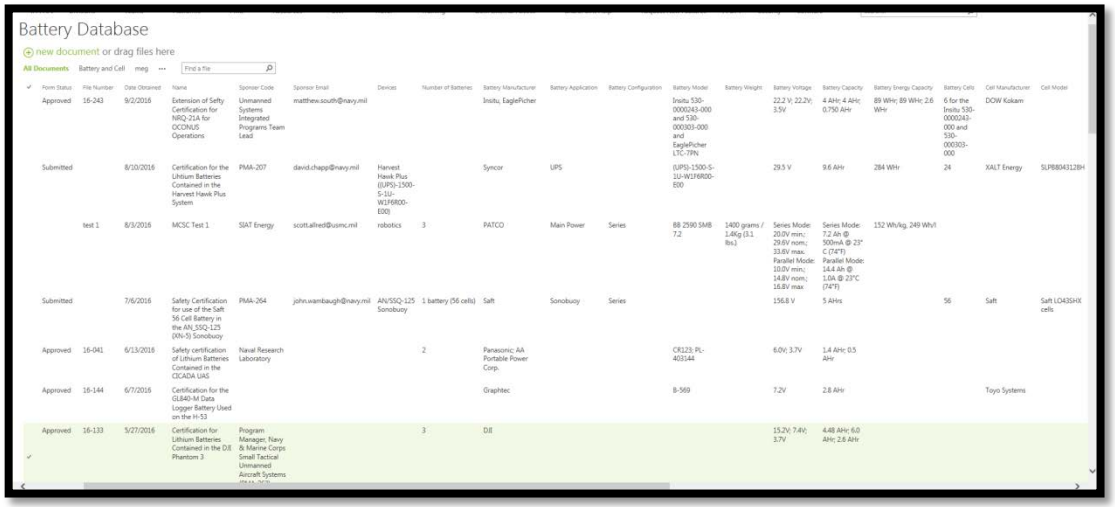
DON-wide Energy Storage Database



Blank entry form for lithium battery database

- Initiated development of a DON-specific lithium battery database which will be made available to Naval System Commands, technical labs, the modeling community, and other stakeholders.

- To date, the prototype battery database has been used for more than 30 lithium battery certifications. The database has been shared with MARCORSYSCOM and NAVSEA for evaluation and incorporation, with the goal of Navy-wide implementation.



Examples of lithium battery information stored in the database

Special Thanks

- DASN-Energy and DASN-RDT&E offices
  - James Caley and Marty Irvine

- SCAPES Program Management
  - Alex Askari (NSWC Carderock)
  - Eric Shields (NSWC Carderock)
- Undersea Working Group
  - Joe Fontaine (NUWC Newport)
- Surface Working Group
  - John Heinzel (NSWC Philadelphia)
- Expeditionary Working Group
  - Matt Huffman (NSWC Carderock)
- Aviation Working Group
  - Bert Frowein (NAWCAD Pax River)
- Facilities Working Group
  - Ken Ho (NAVFAC EXWC)