Ocean Battlespace Sensing Department

Enabling Revolutionary Naval Expeditionary Warfare Capabilities

16th Annual Expeditionary Warfare Conference
Panama City, Florida

26 October 2011

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Office of Naval Research
Ocean Battlespace Sensing

Revolutionary Research . . . Relevant Results

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CDR Dan Eleuterio
Dr Joan Cleveland

Maritime Sensing	- Wardlaw
Ocean Engineering & Marine Systems	- Swean
Research Facilities	- Schnoor
Undersea Signal Processing	- Tague

Ocean Atmosphere & Space Research Division
Dr Linwood Vincent
CDR Steve Martin

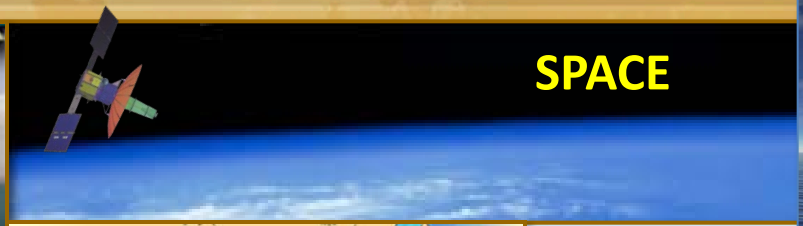
Arctic Science & Integrated Prediction	- Harper
Littoral Geosciences & Optics	- Drake
Marine Mammals & Biology	- Weise
Marine Meteorology & Space Research	- Ferek
National Oceanographic Partnership Program (NOPP)	- Fiadeiro
Ocean Acoustics	- Headrick
Physical Oceanography	- Paluszkiewicz

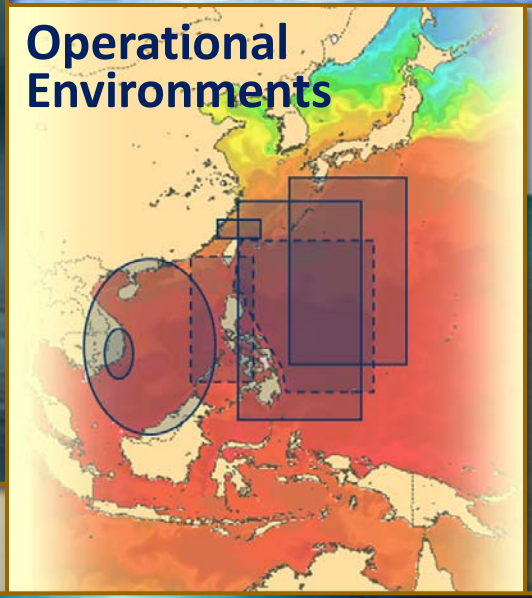
Naval S&T Focus Areas
Assure Access to the Maritime Battlespace
Autonomy and Unmanned Systems
Expeditionary and Irregular Warfare
Information Dominance
Platform Design and Survivability
Power and Energy
Power Projection and Integrated Defense
Total Ownership Cost
Warfighter Performance

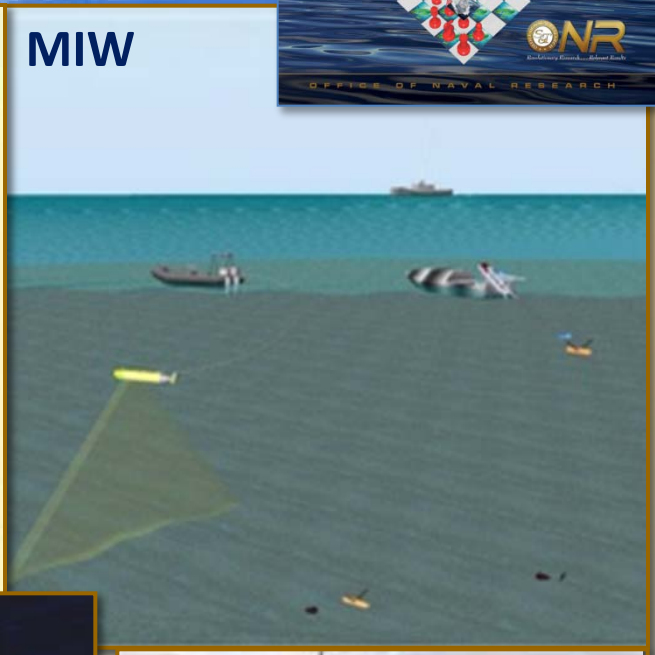
Operational Environments - ASW - MIW - Space Environment

Areas of Responsibility

Revolutionary Research . . . Relevant Results





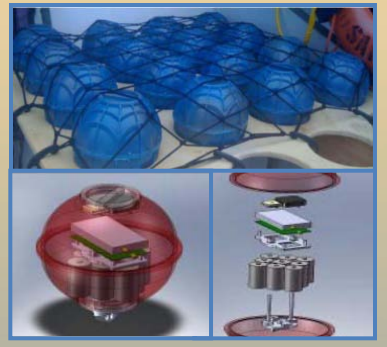


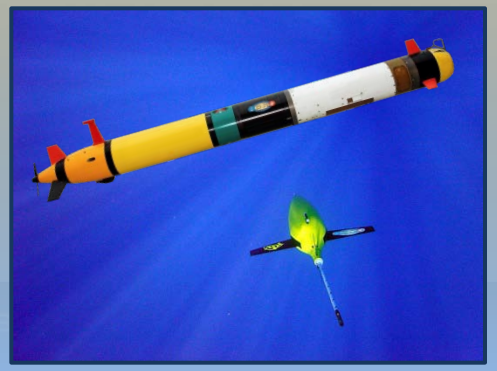
Strategic Precepts

- Future Fleet ship and aircraft assets will continue to decline in number
- Personnel costs will drive efforts to reduce the number of operators for any given mission
- Acquisition dollars will be scarce – close coordination with the Fleet and acquisition authorities is essential to transition
- Networked, platform agnostic, autonomous distributed sensors and effectors will play an increasingly important role in naval operations

Overarching Theme
Autonomous Sensors

Revolutionary Research . . . Relevant Results





TacSat-4 Mission Overview

Revolutionary Research . . . Relevant Results

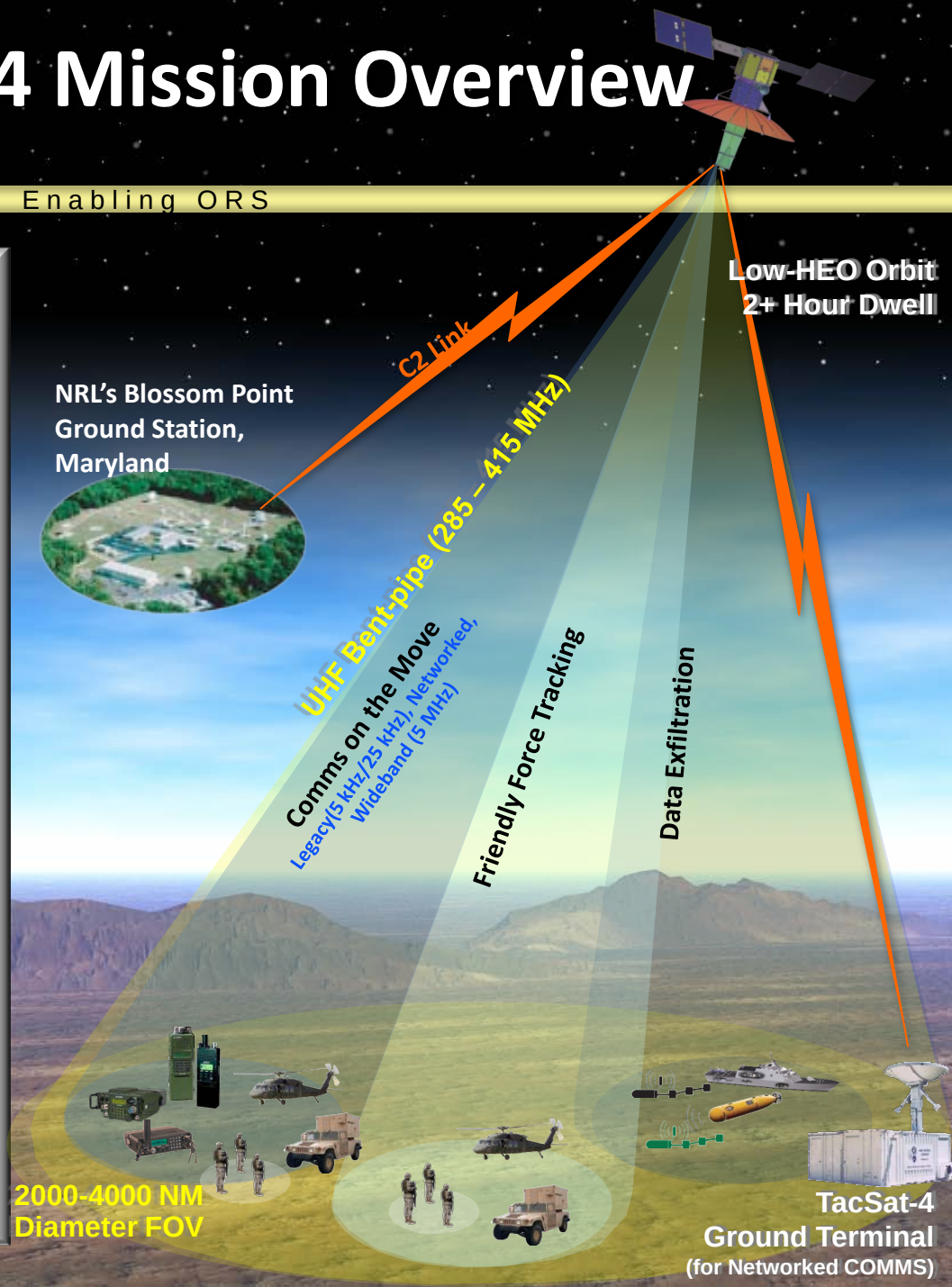
TacSat–4: Providing Communications and Enabling ORS

Augment National SATCOM with:

- 10 Legacy UHF Channels
- COMMS-on-the-Move without User Antenna Pointing
- Networked COMMS on SIPRNET
- A Single MUOS-like Wideband Channel for Early Testing
- UHF Blue Force Tracking (BFT), now "Friendly Force Tracking" (FFT), Collection in Underserved Areas
- Data Exfiltration from Unattended Ground and Maritime Sensors

Enable ORS Long Dwell Missions and Augment National Coverage with a Unique HEO Orbit

Support EMI Location Programs

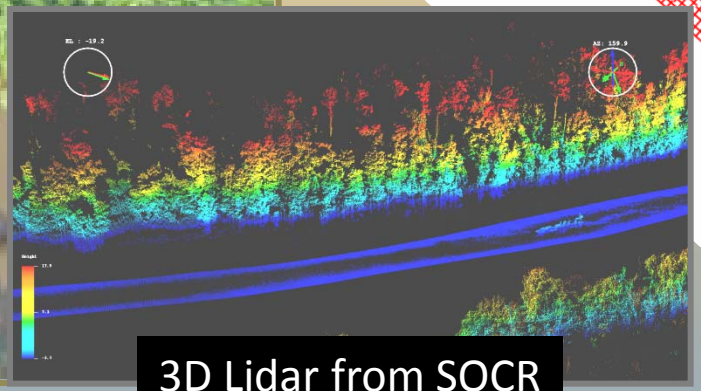


Riverine Reconnaissance

Revolutionary Research . . . Relevant Results

- **Assure access: riverine environments change rapidly – many locations not amenable to remote sensing**
- **Uncertainty reduces optempo and greatly increases risk**
- **Must counter water and land threats simultaneously**

UAV mapping



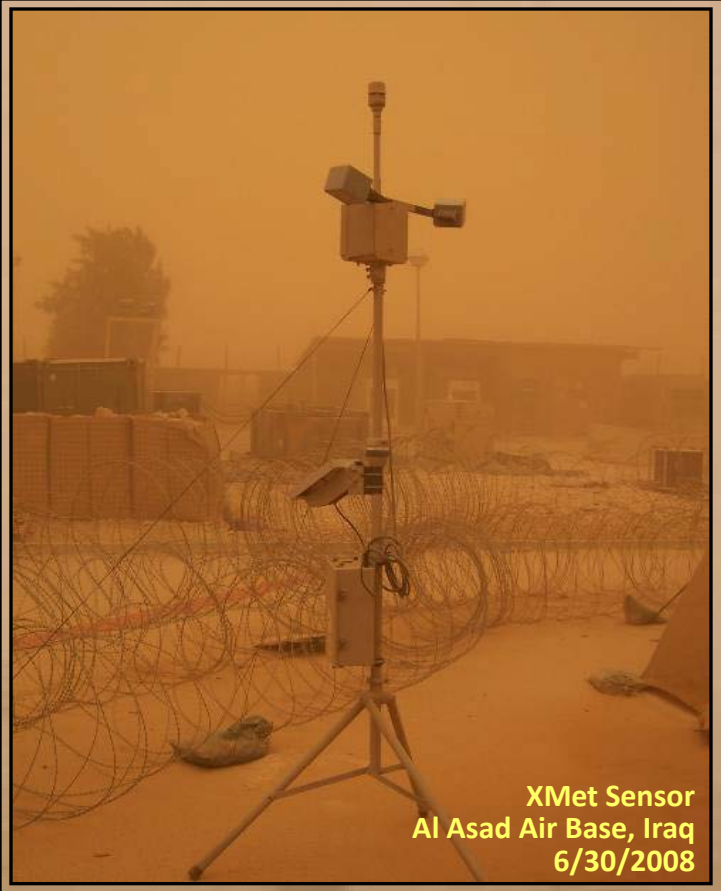
3D Lidar from SOCR

GPS/Depth Drifter

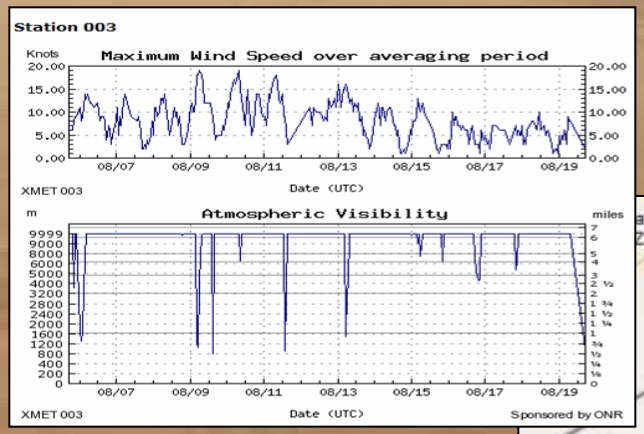
River depths from remote sensing

Riverine reconn exploits satellite, UxV and in situ observations of river characteristics to provide predictive models for tactical decisions

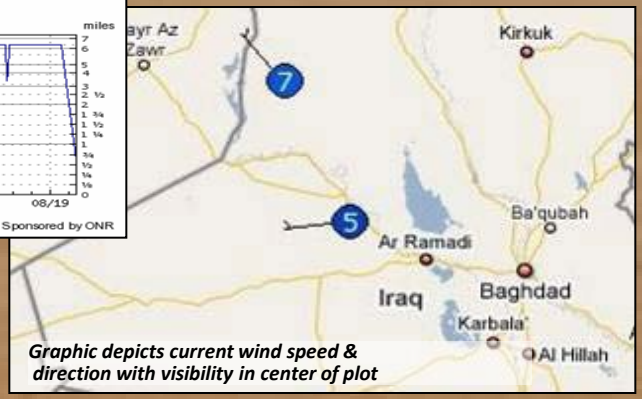
Expeditionary Meteorological Sensor


XMet Sensor
Al Asad Air Base, Iraq
6/30/2008

- *A cooperative effort between the U.S. Office of Naval Research and U.S. Marine Corps to develop and test a rapidly-deployable, proof-of-concept meteorological sensor system to autonomously sense and report weather and visibility conditions at remote locations*
- *Provides situational awareness of rapid weather changes which impact local operations*



Data collection for validating and improving forecast models



Graphic depicts current wind speed & direction with visibility in center of plot

Capabilities:

- *Wind speed/direction*
- *Visibility*
- *Air temperature*
- *Relative humidity and dew point*
- *Barometric pressure (QNH/PA/DA)*
- *Global communications using SATCOMs*
- *Hourly weathergram transmitted via email*
- *Web interface to data and mapping of near real-time conditions*
- *Solar powered for unattended operation*
- *Based upon technology used in ocean buoys*
- *Low Cost*

Basic and Applied Research for Building the Navy's Environmental Prediction System

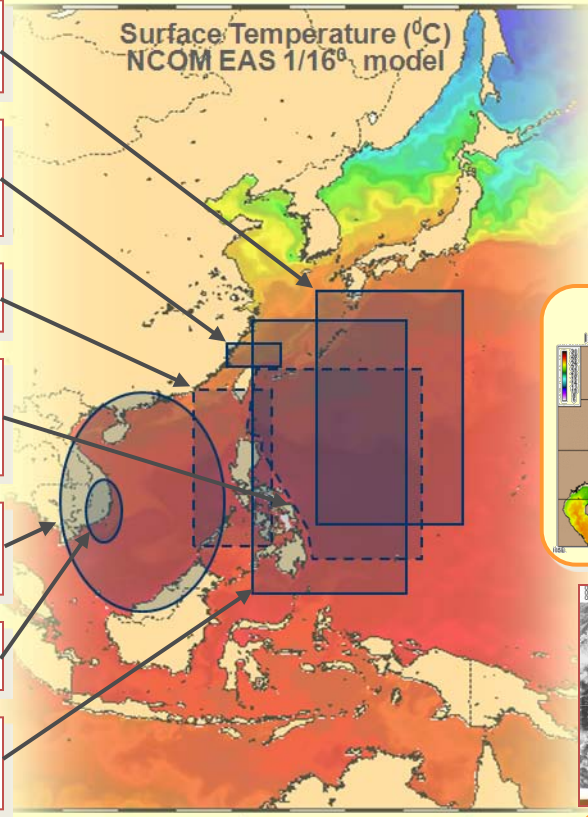
(The world's largest operational, integrated environmental prediction system)

Revolutionary Research . . . Relevant Results

WESTPAC Basic Environmental Research → **Observations, Discoveries, Inventions** → **Develop/Improve 25+ Operational Prediction System Components**

*ONR Field Studies**

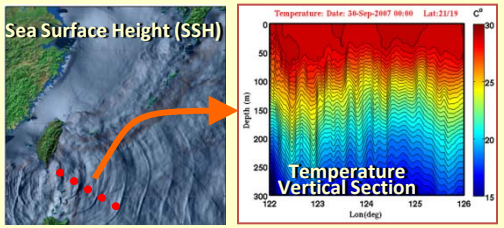
- Impacts on Western Pacific Typhoon Predictability
- Quantifying, Predicting, Exploiting Uncertainty
- Internal Waves in Straits Experiment
- Origins of the Kuroshiro and Mindanao Currents
- Vietnamese Shelf and South China Sea Variability
- Remote Sensing of Deltas
- Typhoon Impacts on the Western Pacific Ocean



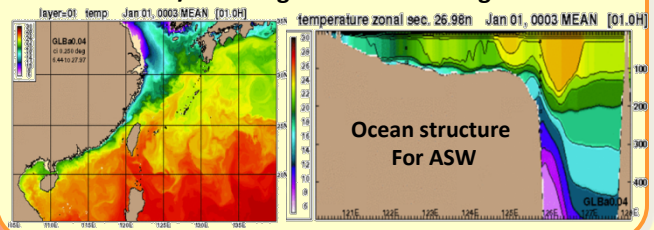
* Ongoing FY11

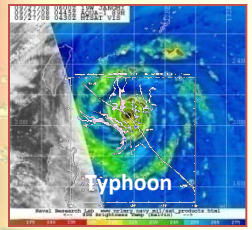
ONR Model Development

Internal Waves = Propagation Variability

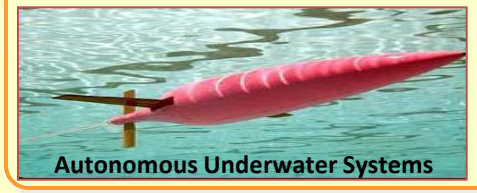


HYCOM 1/25th Degree Tide Resolving Model

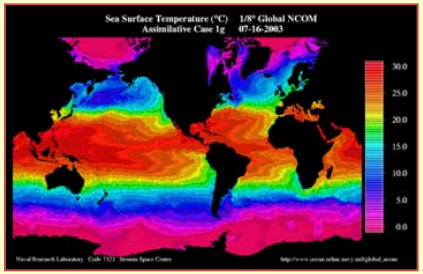




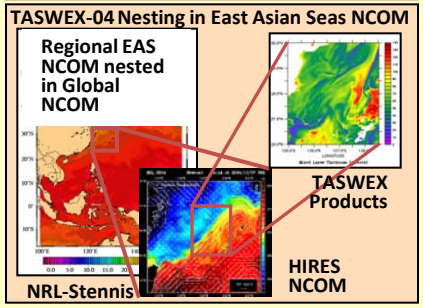
New technology



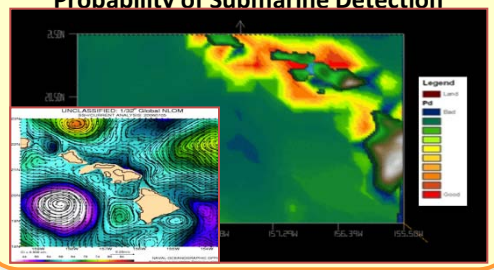
CNMOC Transitioned Predictions



TASWEX-04 Nesting in East Asian Seas NCOM



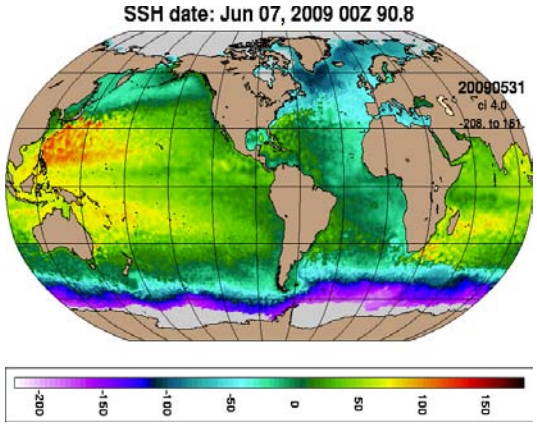
Probability of Submarine Detection

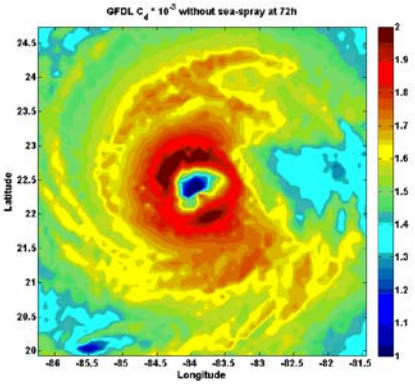


FNMOC &NAVOCEANO distribute 1000s of product sets per day to Support Navy and other DoD users in Peace and war.

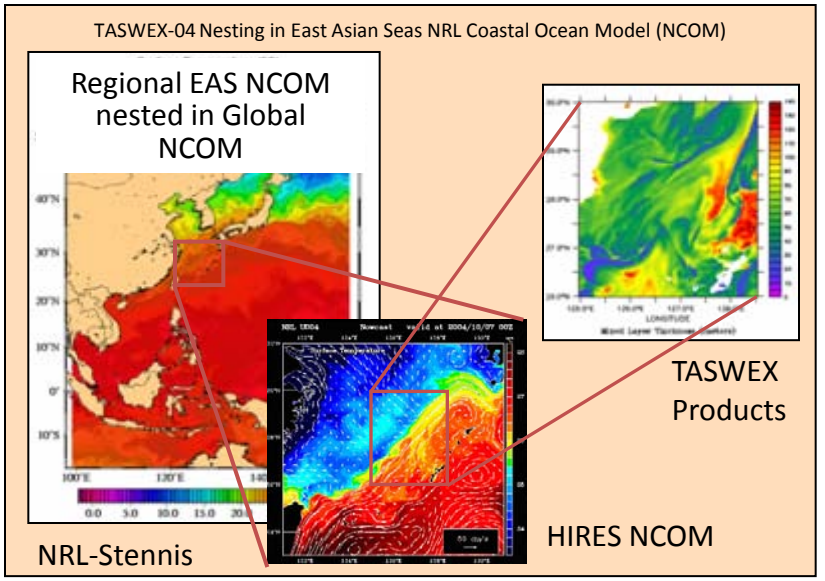
Navy R&D focus on OCONUS areas of special operational interest and for specific Warfare missions

Ocean and Atmosphere Models and Prediction Systems





High-resolution Regional and Coastal Prediction Systems



ONR S&T: Develop/Improve 25+ Operational Prediction System Components

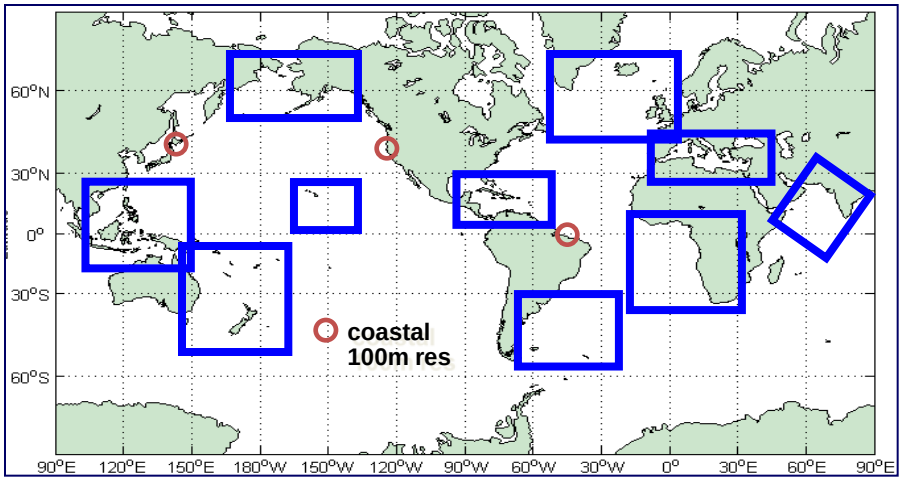
Research: Process studies, Theory, Model Development:

- Ocean
  - Currents, Circulation
  - Waves, Surf
  - Mixing
  - Ice
  - Sediment Transport
  - Acoustics, Optics
- Atmosphere
  - Global, Mesoscale
  - Tropical Cyclones
  - Dust, Visibility
  - EM/EO Propagation
- Observation Systems
- Advanced Data Assimilation

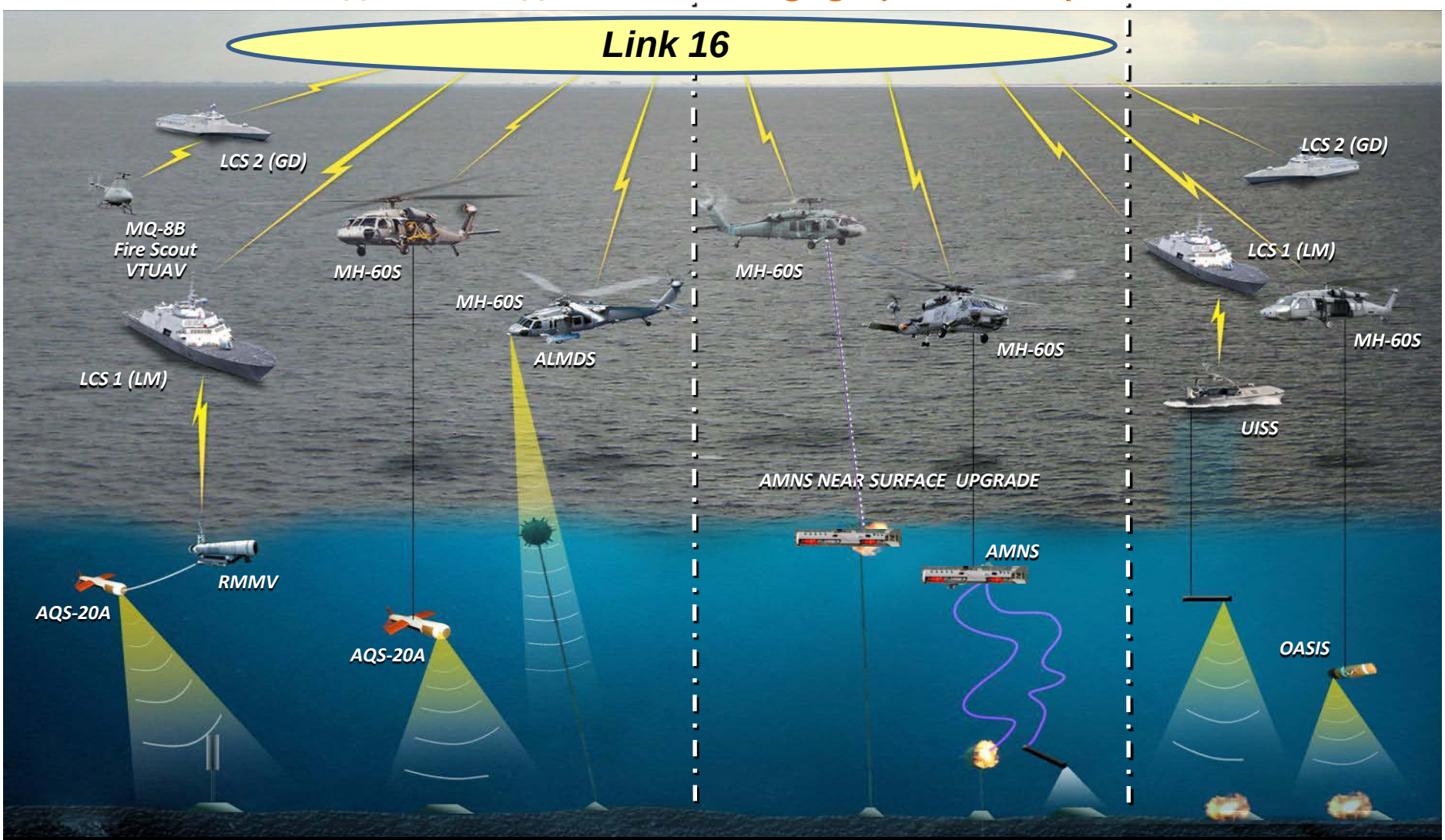
Operations:

- Global ocean models
  - SWAFS
  - NLOM
  - GNCOM
  - GHYCOM
- Regional ocean models
  - RNCOM
  - COAMPS
- Coastal ocean models
- WW3 (Waves)
- Sea Ice
- Atmosphere models
  - COAMPS
  - NAVGEM

Relocatable anywhere within the global system



LCS Mine Countermeasures Concept



OASIS: Organic Airborne and Surface Influence Sweep / **AMNS:** Airborne Mine Neutralization System
RMMV: Remote Multi Mission Vehicle / **UISS**: Unmanned Influence Sweep System / **ALMDS:** Airborne Laser Mine Detection System

Future Naval Capabilities
Advanced LCS MCM Mission Package

Revolutionary Research . . . Relevant Results

Airborne Mine Neutralization System (AMNS) Improvements

Compact Modular Sensor Suite (CMSS) for Detection & Classification of Surface/Near-Surface Drifting Mines

New Start – FY12

Surface/Near-Surface Drifting Mine Neutralization Capability for AMNS

New Start – FY13

Ultra Light Structures

Unmanned Systems Common Control (SUMMIT)

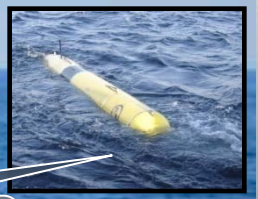
Automated Mission Module

New Start – FY12/13

MCM Sensor Data Fusion

Mine Drift Tactical Decision Aid
Automated Mission Planning

New Start – FY13



Single Sortie Detect-to-Engage (DTE) Payload for USV

UUV Buried Mine Sensor (LFBB)
Long Range LFBB Sonar

FY12 FNC: Compact Modular Sensor/ Processing Suite (CMSS)

Revolutionary Research . . . Relevant Results

CMSS
- Small Multi-mode Sensor Package
- Real-time Detection/Classification
- Surface and Near-Surface Mines
- Drifting/Oscillating (Moving) Mines

Real-time processing eliminates requirement for off-board classification

Fusion of Compact Synthetic Aperture RADAR and Active/Passive Electro-Optics for improved clutter rejection

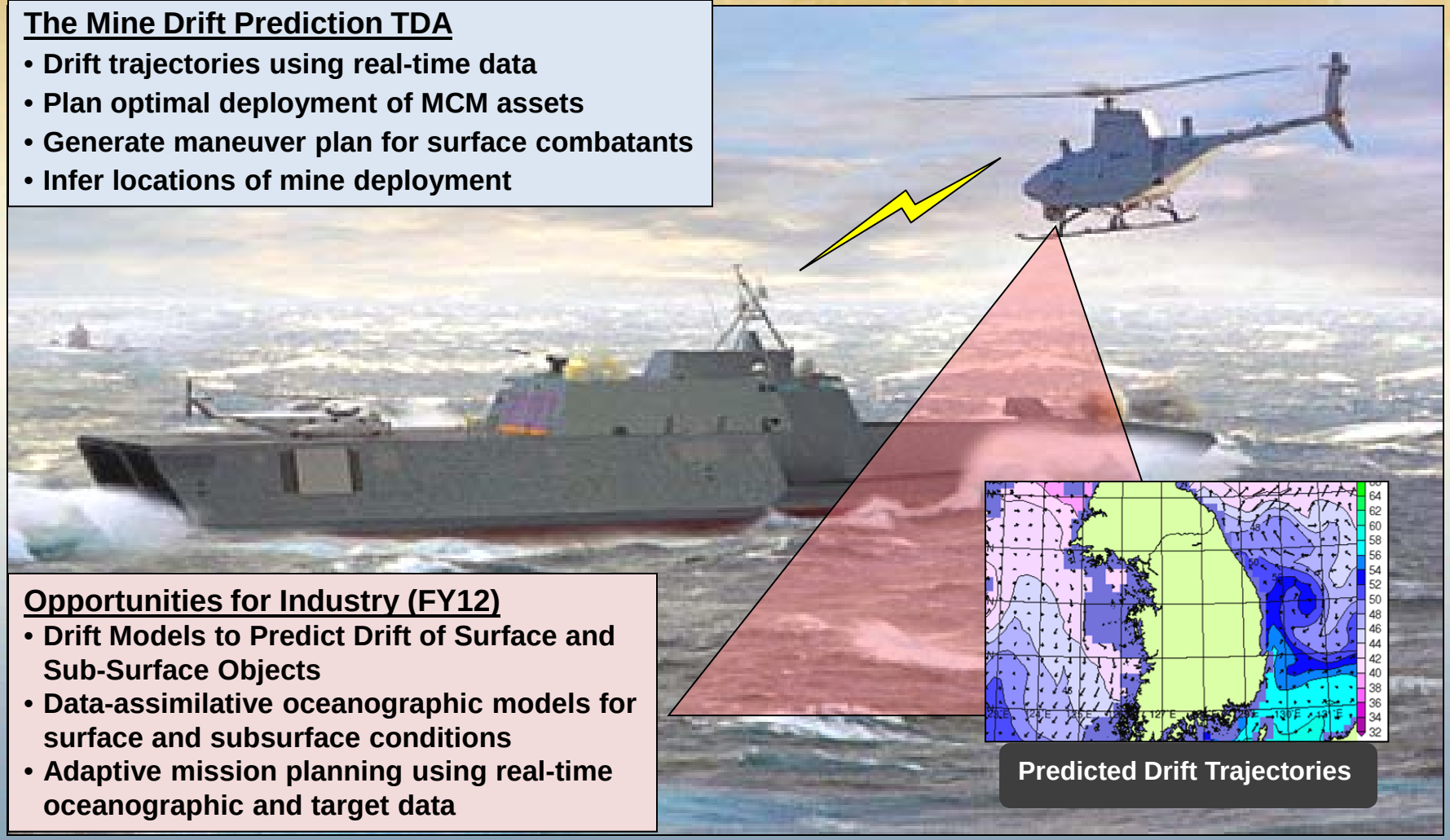
Opportunities for Industry (FY12):
- Sensor System with Multiple Sensing Modalities (Active/Passive Electro-Optic, Synthetic Aperture RADAR)
- Real-Time Onboard Target Classification
- Advanced Target Recognition Algorithms
- Real-time In-Situ Characterization of the Environment (waves, currents)

FY12 FNC: Mine Drift Prediction Tactical Decision Aid (TDA)

Revolutionary Research . . . Relevant Results

The Mine Drift Prediction TDA

- Drift trajectories using real-time data
- Plan optimal deployment of MCM assets
- Generate maneuver plan for surface combatants
- Infer locations of mine deployment



Opportunities for Industry (FY12)

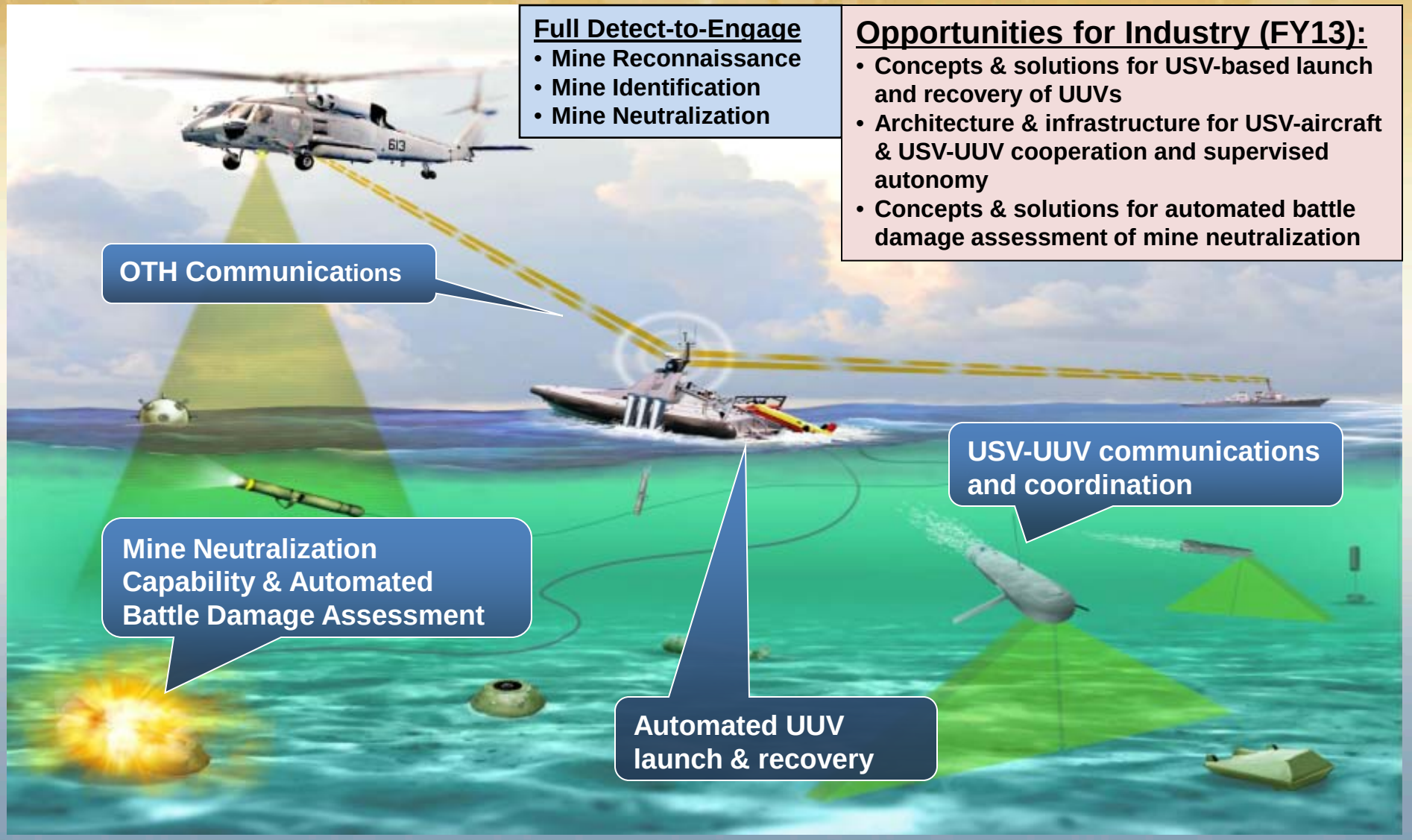
- Drift Models to Predict Drift of Surface and Sub-Surface Objects
- Data-assimilative oceanographic models for surface and subsurface conditions
- Adaptive mission planning using real-time oceanographic and target data

FY13 FNC: Single Sortie MCM Detect-to-Engage Payload

Revolutionary Research . . . Relevant Results

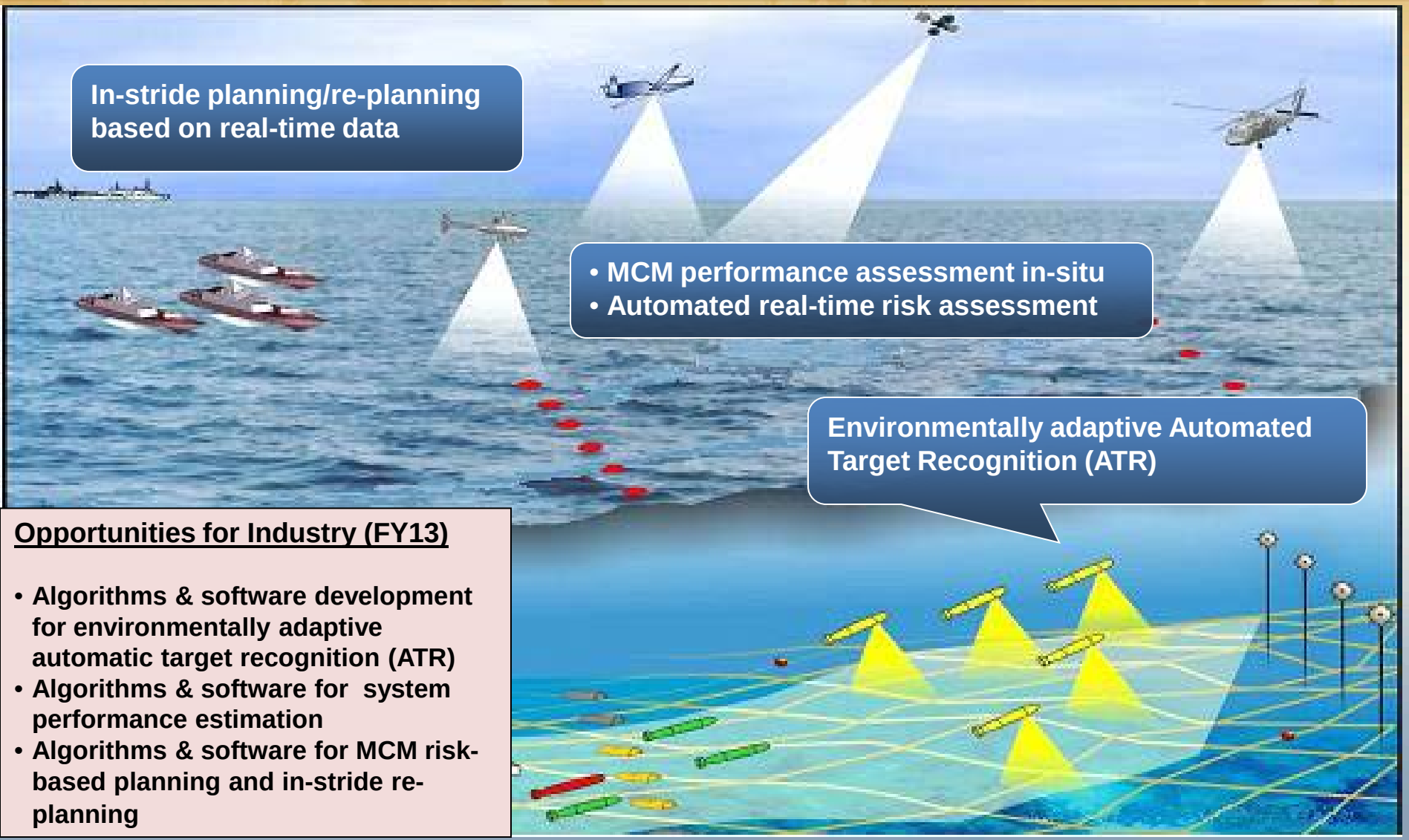
Full Detect-to-Engage
- Mine Reconnaissance
- Mine Identification
- Mine Neutralization

Opportunities for Industry (FY13):
- Concepts & solutions for USV-based launch and recovery of UUVs
- Architecture & infrastructure for USV-aircraft & USV-UUV cooperation and supervised autonomy
- Concepts & solutions for automated battle damage assessment of mine neutralization



FY13 FNC: MCM Payload Automation

Revolutionary Research . . . Relevant Results



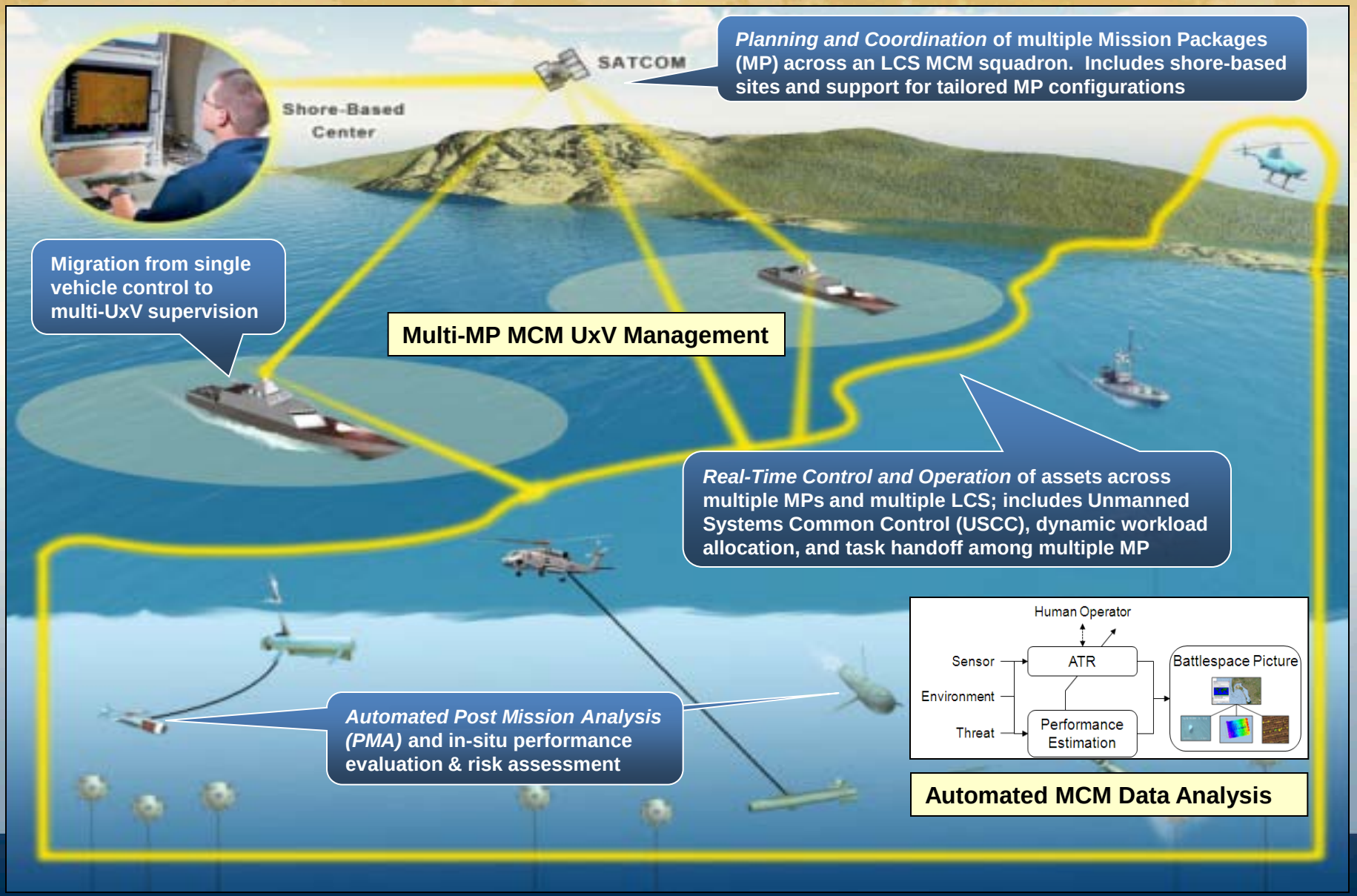
Opportunities for Industry (FY13)

- Algorithms & software development for environmentally adaptive automatic target recognition (ATR)
- Algorithms & software for system performance estimation
- Algorithms & software for MCM risk-based planning and in-stride re-planning

Multi Mission Package MCM Automation

"The MCM MP must support squadron-level operations"

Revolutionary Research . . . Relevant Results



Large Diameter Unmanned Undersea Vehicle

Naval Strategic Priority

Revolutionary Research . . . Relevant Results

Product Description:

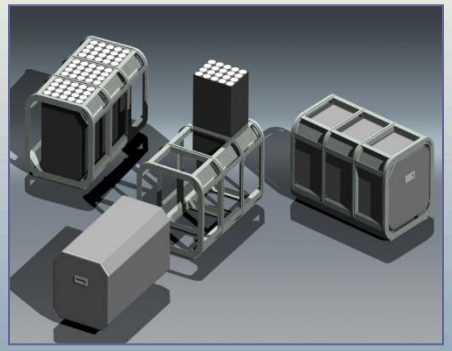
- Reliable Long Endurance UUV capable of 60+ days of operation in the Littorals.
- Program will develop the needed Autonomy, Energy, and Core UUV systems to operate in complex ocean environment near harbors, shore, and high surface traffic locations

Key Program Goals

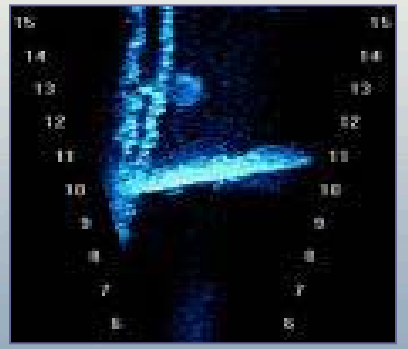
- Double Current UUV Energy Density
- Autonomous in the Littorals:
- Open Architecture
- Open Ocean/Over the Horizon Operations

Opportunities for Industry:

- Power and Energy technologies
- Autonomy in the Littorals
- Endurance and Reliability technologies



Open Architecture Modular Payloads



Autonomous Operation

Ocean Battlespace Sensing Department

Enabling Revolutionary Naval Expeditionary Warfare Capabilities

16th Annual Expeditionary Warfare Conference
Panama City, Florida

26 October 2011

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