OPENSEA - EOD

Open-Architecture Software
for **Marine EOD Robotics**

GREENSEA

GREENSEA SYSTEMS

We started our company with one goal in mind: to improve the relationship between man and machine. To do so, we built an operating platform for the marine industry that integrates vehicles, sensors, and equipment into one robotic system. OPENSEA® represents a decade of development and cross-manufacturer partnerships; providing a robust environment for new and emerging technologies.

COOPERATIVE ROBOTICS

OPENSEA provides the marine industry an open-architecture and distributed software framework for developing and adopting complex robotic systems. Vehicles work as integrated systems coordinating navigation, vehicle control, and payloads to provide greater operational capabilities. Through coordination of these systems and emerging technologies, we are advancing robotic systems for high level tasking, interoperability, and intervention.

INTEGRATED SYSTEMS

We believe integrated systems with SWaP-C optimized navigation and autonomy will be the key to success and growth in the marine industry. Smaller vehicles that can work cooperatively with technicians provide greater value and greater potential. Greensea develops and implements three primary technologies with OPENSEA to make the systems we work with everyday better: navigation, control, and the user interface. With navigation and control, we provide the vehicles more capability; with better user interfaces, we give their operators a better way of communicating with them.

OPENSEA OPERATING PLATFORM		
NAVIGATION AND LOCALIZATION	CONTROL AND AUTONOMY	HUMAN-MACHINE INTERFACE

The OPENSEA platform is currently running on more than 800 marine vehicles of varying shapes, sizes, and job functions. Using the OPENSEA software platform, Greensea provides flexible, scalable navigation and control systems – allowing the same high-quality, reliable products to run on micro-ROVs, large work-class ROVs, submarines, hybrid vehicles, surface vessels, and more.

OPENSEA-EOD

OPENSEA-EOD builds on the open-architecture platform of OPENSEA to provide a revolutionary navigation, control, and workspace system for expeditionary class ROVs specifically oriented to maritime EOD operations. OPENSEA-EOD provides EOD Technicians supervisory control over their ROV system of choice with automated task behaviors so they can focus on conducting operations safely and efficiently. While OPENSEA-EOD provides an extremely capable solution today, the open-architecture framework allows it to adapt to tomorrow's challenge and evolve with the challenges of the next generation of EOD response requirements.

ENABLING EOD TASKS WITH **OPENSEA**

Perform under varying and extreme conditions: In-field configuration for changing or unforeseen conditions. Vehicle control architecture handles any vehicle faults.

Search & survey areas of critical infrastructure to secure facilities: Pre-plan missions using satellite images, maps, construction drawings then autonomously execute missions. Save for re-use.

Search & survey piers and anchorages prior to arrival of assets: Extremely accurate navigation and localization including multiple navigation modes when within complex environments.

Search & survey ship hulls: Support for hull crawling attachments and navigating within alternative navigation coordinate frames, as on ship hulls.


Easily identify, reacquire and neutralize threats: With highly accurate navigation, mark threat and then autonomously return to threat. 1-click vehicle positioning and automated control for threat relative maneuvering.

Conduct forensic and salvage operations: OPENSEA integrates all sensors, cameras, and payloads of the ROV system into a cohesive user interface that can be distributed to multiple users across a network.

EOD-WORKSPACE
A SINGLE INTERFACE FOR THE ENTIRE MISSION
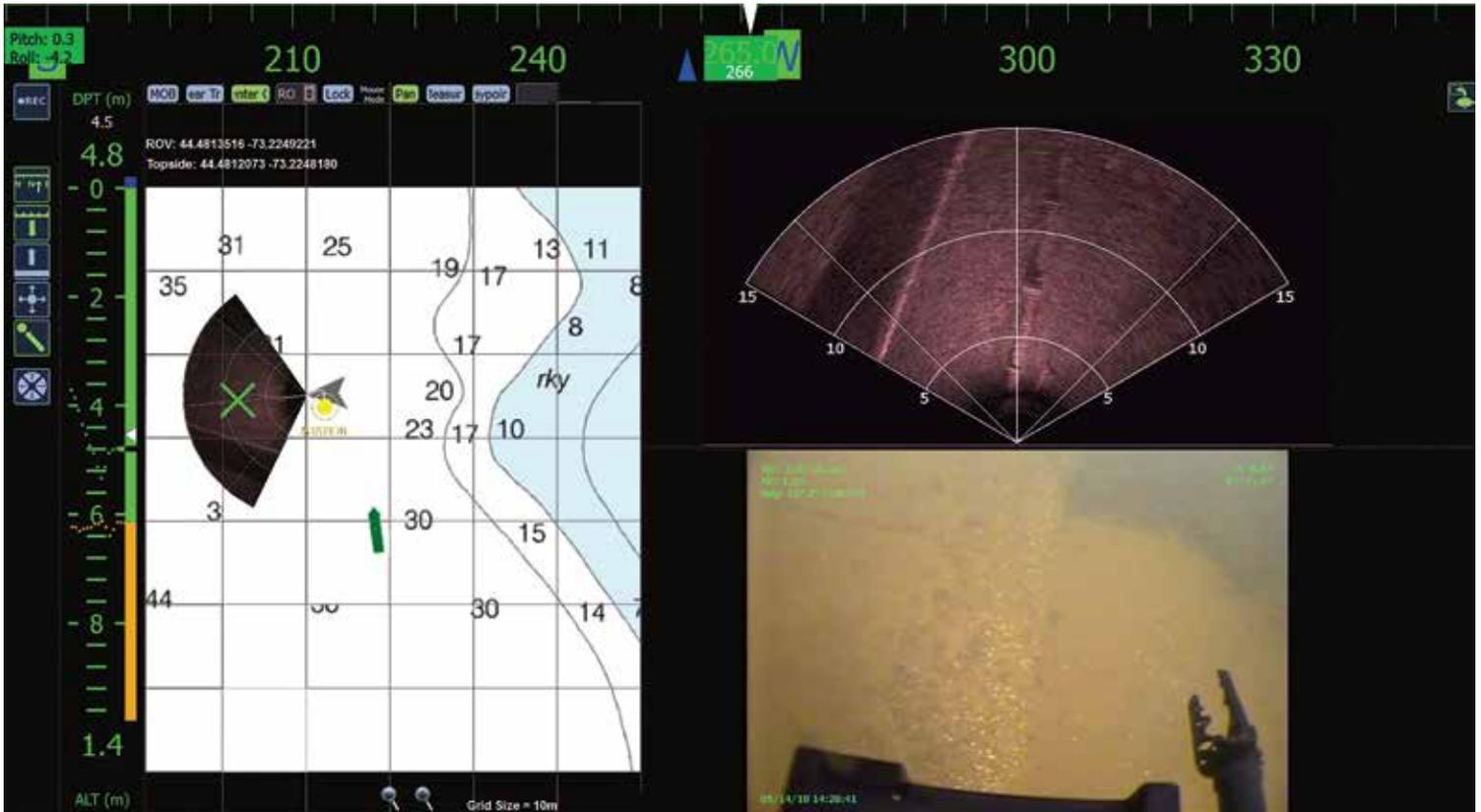
Flight Control: Features and Automation

Multi-mode vehicle control allows EOD Technicians to pass as much or as little responsibility onto the vehicle as the operation requires. Click-and-go, drag-and-follow, and point-of-interest relative control allow EOD Technicians to focus on threat neutralization.

AUTOPILOTS
- Heading
- Pitch
- Roll

POSITIONING
- X-Y Positioning
- Depth
- Altitude

MOTION
- Cruise control
- Speed control
- Jog position
- Click-and-go
- Drag-to-move
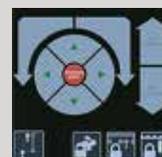
CONTROL OPTIONS
- Screen Control
- Hand Controls

TASKING
- Waypoint and route navigation
- Point-of-Interest relative control
- Sonar target relative control
- 3-D Surveys

FEATURES

Diagnostics: Comprehensive diagnostics provide real-time health and status information. Alarm manager allows technicians to watch system conditions and receive proactive alerts.

Expansion Technology: Easily add sensors, even in the field, or add additional vehicles to allow one operator to monitor and control multiple assets.

Wide-area Workflow: Network multiple operators to coordinate operations or add remote supervision for operator support.

Communications: Wired/wireless Ethernet, radio, cellular, Iridium, and acoustic communications.

Sensor Support: Brand agnostic, native support for hundreds of sensors, devices, and protocols.

Data Management: Real-time data is time-stamped and georeferenced. Single data model organizes each source as a unique data channel for addition, subtraction, or substitution.

Vehicle Integration: Brand and vehicle agnostic with manned, unmanned, and optionally manned configurations.

Software Stability: Used on 800+ systems worldwide including U.S. and international militaries. Robust architecture utilizes a common library and fully distributed application suite.

Data logging: Inclusive data logging utility logs raw sensor data, video, and sonar on the entire OPENSEA network. Post-processing tools for exporting data.

Playback: Playback logged data in the workspace. Visualize recorded missions and seek to marked events.

Geodata: Support for geodata layers in mission view workspace. View and manage satellite, chart, sonar, contact, and bathymetry data.

System maintenance: Backup and restore utility saves current system configuration and installed software revisions for easy configuration management. Software updater allows easy application and installation of new features, bug fixes, and new system configurations.

Task-specific configurations: Easily defined and selected screen configurations optimize display for critical tasks.

TASK-SPECIFIC WORKSPACE VIEWS
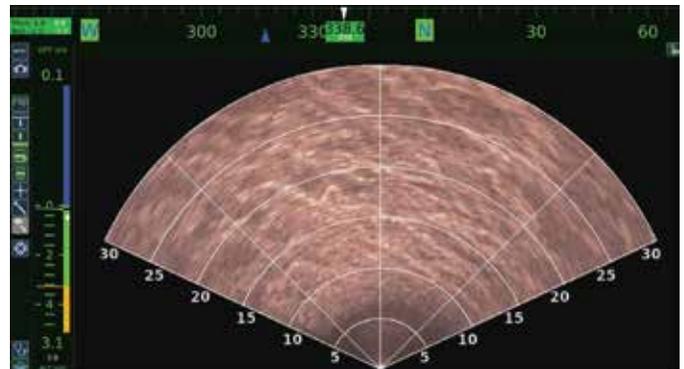
GREENSEA SERVICE & SUPPORT

Greensea is committed to supporting the success of our customers' missions – not just the success of our product. That's why Greensea engineers spend about 30 days offshore each year, working side-by-side with customers. A deep understanding of technology applications has led to highly intuitive products and training programs designed around real-world operations. Greensea's four-part service plan was developed to fully-support operators in-and-out of the field and to facilitate high-levels of engagement to drive continuous product enhancements.

Engage in an EOD-Workspace professional training program to fully-realize the benefits of the OPENSEA technology. Training programs begin in the classroom to learn overall software technology concepts before moving to on-water experiences.

TRAIN

Utilize a state-of-the-art simulation model designed to enhance operator proficiency and mission planning. Easy-to-use and available for any make or model vehicle running a Greensea system.

SIMULATE

Reference a comprehensive Knowledge Base filled with over ten years of important information compiled by Greensea engineers. Included in documentation are quick "how to" instructions, troubleshooting help, and industry reference information on inertial navigation and autonomy. All information is easily searchable and content is continuously expanding.

DOCUMENT

SUPPORT

Customize a support package to meet the needs of your team. Select from full-service, fee-based plans or discrete multi-day packages. Greensea's highly knowledgeable engineers are ready to provide assistance either in person or through remote technologies. Greensea is committed to excellent customer satisfaction.

INTEGRATORS & DEVELOPERS

OPENSEA is continuously maintained and updated based on feedback from hundreds of operators utilizing the technology across many different applications worldwide. Direct customer engagement allows us to constantly expand our technology. New sensors and components are continuously integrated and there is a rapidly expanding number of automated tasks driving operational efficiencies. Being a part of the OPENSEA community allows system integrators and developers to take advantage of the latest updates to OPENSEA, provide technology feedback, and develop their own technologies on the OPENSEA framework.

Software Development Kit. The OPENSEA SDK includes everything a developer needs to configure or expand on their Greensea system. Implement changes, develop new features, or innovate new technologies on a open, robust architecture.

Custom Configurations. OPENSEA is easily configured for new capabilities and new deployments without code modification. Use the same base software, with different vehicle configurations for different missions.

System Expansion. The OPENSEA application suite is designed for flexibility and scalability. Utilize a comprehensive toolbox of distributed software components that can easily add capability to existing systems.

ANY **VEHICLE**

Open Architecture

The open architecture of OPENSEA and modular design enables customization to occur without extended lead times while keeping development costs under control.

Build now. Modify tomorrow.

Vehicle Agnostic

No other software solution offers the same operating platform and user interface across a range of vehicles: ROV, diver delivery system, surface vehicle, or AUV.

Train once. Deploy many.

ANY **PAYLOAD**

Sensor Agnostic

No other software solution offers the ability for total sensor integration: from cameras or manipulators to magnetometers or compasses.

Endless possibilities.

OPEN ARCHITECTURE INTEGRATION & CONTROL

VEHICLES	SENSORS		EQUIPMENT	
Diver propulsion	CTD	INS	Sonar	Ground fault monitoring
ROV	Salinity	DVL	Cameras	Relays
AUV	Luminescence	Compass	Lights	Joystick
Glider	Fluorometer	USBL/LBL	Pilot chairs	Battery
Submarine	pH	GPS	Winch	Fiber optic MUX
Workboat	Speed of sound	IMU	Black box/Data recorders	Motor controller
Ferry	Oxygen	AHRS	Manipulators	Valve packs
Bridge erection boat	Magnetometer	Altimeters	Pan & tilt	DAQ
USV	Power monitoring	Pressure		Laser
Tow fish				
Sidescan sonar sled				
Buoy				
Custom build				

This is a partial list.
Contact us for more information.

Greensea improves the relationship between man and machine by developing technology to make the work they do together more productive.

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View our capability statement: www.greensea.com/capability.pdf