SAIL-POWERED USVs

OSHEN

In recent years, uncrewed sensor platforms have gained significant popularity in the survey marketplace as people quickly recognised the cost advantages of autonomous data gathering.

Devices ranging from drifting data buoys to highly sophisticated but expensive autonomous surface vessels have been particularly active in providing services for the offshore wind sector.

One company, Plymouth-based Oshen, has identified a niche within this market: providing a much smaller autonomous platforms with a hull length of approximately one meter. These platforms can deliver large amounts of data while maintaining a price point well below many competitors in the market.

"Any small hullform has two major practical ramifications," said co-founder Anahita Laverack. "They are considerably cheaper to manufacture and much easier to deploy."

Some of the larger autonomous surface vessels need to be taken on-site and lowered into the water using a crane or towed by relatively large and expensive mother vessels. Smaller hullforms, however, require much simpler deployment systems.

Oshen is focusing on applications that require persistent data collection and wide spatial coverage—where deploying 10 or even 50 devices in one location would be practically beneficial "This is particularly useful for weather forecasting," Laverack added.

"Organisations such as the Met Office typically receive just one datapoint from an area, typically from a moored buoy. We're aiming to provide much higher spatial resolution of data from an adaptive network - picture a fleet of platforms automatically repositioning as needed. Not just to better predict the weather in general, but more importantly, to enable warnings of severe weather events.

"We are currently running a project to compare the data we collected from a recent mission in severe weather with up to 8m high waves with the forecast from UKV, the high resolution weather model for the UK.

"Another application is marine mammal monitoring, potentially as part of the environmental assessments required before setting up an offshore wind farm. Presently, this is performed by ships or drones counting counting cetaceans, such as dolphins as they surface.

"Marine domain awareness not the same as the marine mammal monitoring side! Instead, we envision a fleet of fleet of five to ten of our devices operating for months in a proposed offshore wind side, providing a clearer baseline of cetacean activity though our high spatio-temporal coverage. We also envision marine domain awareness applications.

Oshen USV

For example, when addressing illegal fishing, having as many platforms as possible to detect audio signatures is ideal. A large, low-cost network of autonomous vessels with a small form factor, particularly wind-powered for long durations, provides an excellent solution."

"There is a lot of work being carried out around the general concept of numerous vessels working together in a swarm, constantly inter-communicating and aware of each other's positions," Laverack concluded.

Small, low-cost vehicles have a limited energy budget, so we need to find more efficient ways to coordinate vessel control information and receive the data. This can be done from a mothership or even from land We have 9 platforms, and have operated in three continents - we have one in the Pacific.

DESCRIPTION

There are several wind-powered autonomous vehicles on the market, although few, if any, are as small as this. The company advised customers that its first generation platforms could operate in up to 2.5m wave heights, but recently pushed the operating envelope further, including a recent mission in a storm with 70mph forecast winds and 9m high waves.

While the rigid sail provides propulsion, power for the onboard electronics and sensors comes from solar panels mounted on the deck. Standard sensors on the vessel include those for wind speed and direction, air pressure, air temperature, and humidity. It can measure significant wave height, maximum wave height, wave period, and sea temperature at depths of 0.1m and 0.7m.

Additionally, it features a passive acoustic and visual data collection system, though the exact payload is tailored to specific work requirements.

The hull is fabricated from fibreglass, though the structure can be constructed in various ways. The rigid wing sail is made from fibreglass or carbon fibre and is supported by internal struts.

Sail-powered USV

SAILDRONE DATABUOYS

Ocean observation is critical to making informed decisions to protect and preserve the delicate balance of the planet for future generations. It plays an integral role in national security, determining how to defend offshore and onshore assets; creates a time series of ocean data necessary for understanding how climate change is impacting extreme weather events.

The US National Data Buoy Center (NDBC) says there are only about 100 weather buoys to cover almost 100 000 miles of United States coastline. The buoys are located in areas critical to forecasting and in areas that are highly difficult and dangerous to operate in, providing *in situ* awareness for mariners, such as fishermen.

The NDBC Director Dr. William Burnett says there is an urgent need for what he calls a system of systems to resolve observation gaps.

" We need a conglomerate of moored and uncrewed systems working together to resolve ocean observation gaps to protect our communities and grow our economy."

Saildrone uncrewed surface vehicles (USVs) are very similar to weather buoys in the marine observations that they collect. Like buoys, they can stay in one place to provide a timeline of data or be tasked with collecting targeted observations in a much larger area, which would otherwise require a whole network of buoys.

"Using Saildrone USVs could improve the larger picture of ocean observations" said Burnett."Targeted observations could improve numerical weather prediction and provide broader spatial awareness in under-sampled areas, where it might be cost-prohibitive to deploy a group of buoys. In some national marine sanctuaries, buoy moorings and anchors are harmful to the seafloor. In the event of buoy outages, uncrewed systems on standby can be deployed to maintain observations in key areas."

Saildrone

Image: Kyle Hulse - @kylehulse

BLUEBOTTLE

Characteristic / Class	**Bathy**	**Beth**
Power	Solar, Wind, Wave, Diesel Hybrid	Solar, Wind, Wave
Length (Metre/Feet)	7.4/24.4	7.4/24.4
Beam (Metre)|	1.3	1.3
Draft	1.7	1.7
Air draft - mast up	6.0	6.0
Air draft - mast down	2.4	2.4
Weight (Kilograms)	1,500	1200-1350
Top speed (Knots)	6.5	6.5Average
Ave. speed (Knots) |	2.5	1.5
Operating sea state	5	
Max sea state	7	
Wave powered speed (Knots)	0.5-1.5	0.5-1.5

Last October, AUKUS partners cooperated in *Exercise Autonomous Warrior*, a large-scale demonstration of advanced autonomous vessel capabilities. An important feature of the exercise was Ocius' uncrewed surface vessel *Bluebottle*. This has been gaining considerable interest in recent years.

Back in 2022 Ocius received a procurement contract for five vessels from Royal Australian Navy, followed by three more in 2023. In June 2024 it received an order another seven. This has caused Ocius to ramp up production capability and will soon meet a level of one vessel per month. By establishing a pre-production facility, the company is actually on track to reach a production rate of one vessel per week by mid-year. It is envisioning producing a fleet of 1000 autonomous vessels globally within the next 10 years

Ocius also recently announced a collaboration with BMT, to revolutionise maritime data collection and management, providing DaaS (data as a service). The companies will focus on co-developing a commercial model, initially targeting environmental monitoring for offshore wind development projects.

"The Bluebottle platform can operate in a variety of applications", said CEO Robert Dane. "It can carry out Environmental Monitoring (collecting data on sea life, water quality and other environmental parameters); Metocean Data Collection (providing accurate meteorological and oceanographic data to support maritime operations) and Security and Surveillance (providing real-time data on maritime activities).

"This innovative approach enhances the efficiency and effectiveness of maritime operations and offers significant cost savings compared to traditional monitoring methods. Bluebottle vessels have now completed

78 000 miles, equivalent to 3.5 times around the world at the equator and the current vessels average 1000 miles/week in a diverse range of maritime conditions from doldrums to storms.

Bluebottles USV come in two forms, the ***Bathy*** and ***Beth*** but both are characterised by high **power, payload and performance.** They have similar footprints and can operate under all conditions and remain at sea for months at a time.

The ***Beth*** is powered by solar, wind and has a rudder flipper that harnesses the wave energy, while the ***Bathy*** additionally has diesel hybrid propulsion. In both, the sail represents the main form of propulsion. This can fold down if the wind gets too strong and doing so may also provide a tactical advantage while allowing the vehicle to escape from strong currents.

The ***Bathy*** is 400 kg heavier and at 2000 W, has twice the allocated payload power. The payload includes MBS, side scan sonar and sub bottom profiler. There is a keel winch to lower sensors to variable depths.

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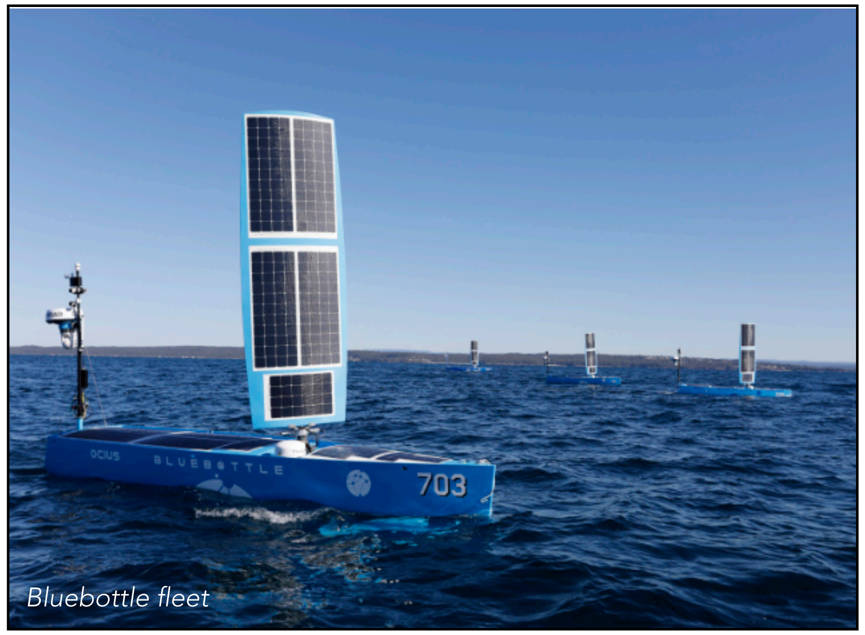
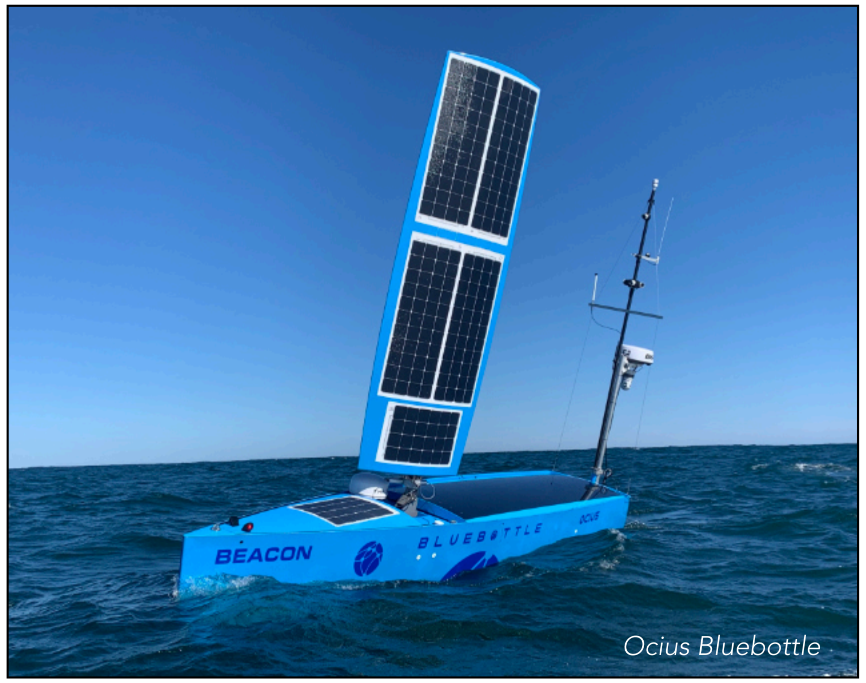


Bluebottle fleet

environmental monitoring for offshore wind development projects. With the aim of deploying a fleet of 1000 autonomous vessels globally within the next 10 years, BMT and Ocius will be able to provide a persistent and networked system of remote sensors to support a range of applications.



Ocius Bluebottle

SAILBOTIX

Last year Sailbotix was launched, offering a range of micro autonomous boats, engineered for extended data collection over months at sea. The company was founded by Colin Angus, a co-founder of Open Ocean Robotics.

“The inception of Sailbotix was driven by the ambition to overcome several pervasive challenges within the USV industry, including regulatory hurdles, prohibitive costs, and issues with reliability,” said Angus.

“Larger uncrewed surface vessels often face operational difficulties due to stringent government maritime regulations. Sailbotix vessels, in contrast, are designed to be compact enough to qualify as steerable buoys (legally categorised as “flotsam”), thereby avoiding regulatory challenges.”

The hull, decks and sails are made with vacuum infusion technologies and are comprised of S-Glass and vinylester resin. Vinylester has almost the same mechanical properties as epoxy but is better suited for vacuum infusion.

S-Glass is an exotic composite with similar strength to carbon fiber. Unlike carbon fibre, it is transparent to radio waves, so is more suitable for housing antennas within the hull and is invisible to radar.

The solar panel is 20 watts, and will generate about 40-100 Wh/day. The vessels use under 2 Wh/day for basic electronics, sensors and communications. The vessels can carry up to 4 kg (properly balanced).

A 300 Wh battery can store power and provide increased power for short periods.

Sailbotix offers three different models

WIND WANDERER


Wind Wanderer

The lowest cost boat, it is a trackable free drifter guided solely by the prevailing winds and currents. Measuring under 4ft (105 cm) in length, it is powered by a cloth sail. Its progress can be followed in real-time via a satellite tracking

It can be can be equipped with additional sensors to collect environmental data, such as water and air temperatures, barometric pressure, wind speed and direction, and wave height.

Data collected by this boat is logged onboard, and can only be obtained when the boat is retrieved.

Silicon Sailor

SILICON SAILOR

Claimed to be the world’s most affordable deep-ocean Uncrewed Surface Vessel (USV), this employs a a a rigid wing sail controllable through satellite.
It can operate non-stop for up to six months, even in low-solar conditions

A proprietary feature of the design is the elimination of a traditional rudder for steering.

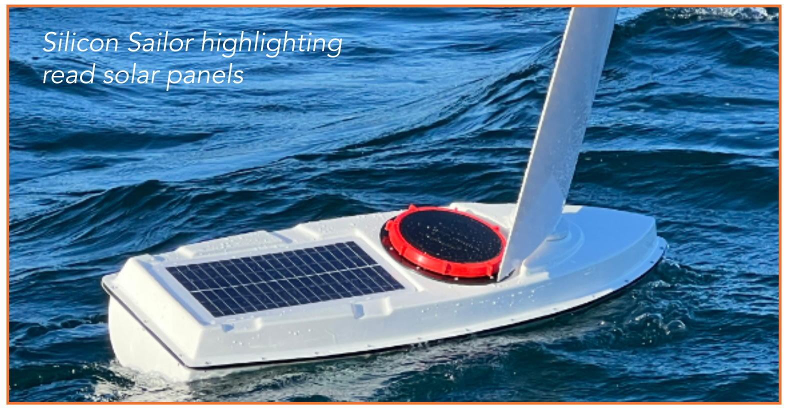
“The number one point of failure in sailing USVs is the rudder.,”said Angus.”The rudder is vulnerable to getting jammed or tangled in seaweed or debris.Additionally, the rudder servo (motor) is heavily worked.

“We have completely eliminated the need for a by balancing the rigid wing sail relative to the keel.

“The rigid sail revolves around a stationary mast using a magnetic coupling. By having the mast stationary, rather than an integrated part of the wing sail, it provides a stable mount.

“Normally, the boat sails passively straight downwind but the sail can be configured to propel the vessel sideways.” said Angus. “This is useful for launching the vessel from areas where the wind blows parallel or towards shore.

“An alternative option, suitable for research purposes, is having the sail drop into the water, turning into a drogue. This slows the boat down, making it an ideal platform for gathering metocean data. This option is called SailTimer and is available in our store as an option. It is ostensibly designed as an educational platform.


Silicon Sailor highlighting read solar panels

When the angle of the sail is changed, the boat will passively sail at a different angle relative to the wind. Since the vessel is balanced, no rudder or control system is required to hold course. When winds are steady, the sail servo may not need to be moved for days.

Communication and control is achieved through LTE and satellite communications. A cloud-based dashboard allows data visualisation and vessel control from anywhere in the world.

Silicon sailor is only 105cm long and weighs 14 kg.

HYBRID VOYAGER


Hybrid Voyager

This is the same as Silicon Sailor, but with an auxiliary thruster motor, allowing the USV to thread its way through congested waterways and then carry on to cross an ocean.

The sail is still the primary mode of propulsion but the thruster is available when the wind dies or precise navigation is required. The highly efficient pod can power the vessel for up to 10hrs/day at 2kts using exclusively harvested solar energy

OCEANDRONE

OCEANDRONE is an independent spin-off from INNOVO to deal with submarine robotics and autonomously guided surface naval vehicles.It develops mechanical and control systems in-house. In recent years, the company had been carrying out R&D work on a 4.5m prototype. This is now complete, heralding construction of a new 9m USV for blue water activities..

"In recent years, we have undertaken numerous endurance tests to verify and validate its capabilities and features" said Stefano Malagodi, CEO of OCEANDRONE, the engineering and construction house developing the system.

"A key feature is the use of Artificial Intelligence (AI) in decision-making to improve operations and enable fully autonomous navigation in order to maximise efficiency and safety. The AI will process data from multiple sensors, including cameras, LiDAR and sonar, to identify and classify vessels and foreign objects. It will also analyse weather data information, enabling the vehicle to adapt its route to optimise safety and efficiency.

"In case of unexpected events or emergency situations, the AI can be programmed to respond appropriately, such as altering the route or notifying the control centre. Furthermore its Collision Avoidance technology allows safe sailing in crowded and restricted waters."

At the centre of the vehicle is its large rigid sail which is balanced by an underwater keel.

A feature of traditional cloth sails is that they can be drawn in to reduce surface area when suddenly encountering severe environmental conditions.

The OCEANDRONE design incorporates an innovative telescopic sail system. This patented mechanism allows the sail to be retracted either partially or fully into the pocket keel when not in use, protecting and preventing damage to the sail even if the vessel capsizes.

While the sail provides the primary propulsion system, it is complemented by and electrical driven propeller powered from a Lithium battery within

Oceandrone

the hull. This is constantly charged by solar panels on the hull and sails. The battery also powers the bespoke sensor suite and optional payload.

The vehicle is equipped with a diverse array of sensors and positioning systems, including cameras electro/optical, LiDAR, and a weather station, etc.

Additionally, it supports a range of payloads such as Side Scan sonar, multibeam, USBL, hydrophones, among others. These systems can be seamlessly integrated beneath the keel within a dedicated gondola.

OCEANDRONE supports a variety of communication systems, enabling beyond-line-of-sight (BLOS) operation. These include Wi-Fi, 4G LTE, and satellite communication.

The designers envisage that it will operate across various domains.of applications including seabed infrastructure protection, maritime domain awareness and a communication hub between land and sea.

"Potential markets include offshore energy, renewables, ocean sciences, marine environmental protection and military," said Malagodi. "We believe it could also be attractive for telecoms, subsea data storage, ocean research, fish farming, seabed mineral exploration, carbon capture, hydrogen generation and ocean science.

SAILBUOY

Offshore Sensing's Sailbuoy design was one of the very first autonomous sail powered vessels on the market. The Sailbuoy MK 4 uses wind power for propulsion with solar panels providing power for the electronics and actuators. Data communication and control are established in real-time using the satellite system through a user-friendly web interface.

In 2018, it became the first USV to autonomously cross the Atlantic, proving its endurance and reliability. By 2024, over 30 Sailbuoy units were sold to energy companies, government agencies, and defence organisations, reflecting the growing demand for sustainable, cost-effective ocean data collection.

"The Sailbuoy technology makes the vessel use very little power," said CEO, Max Hartvigsen. "The internal autopilot battery pack holds enough energy to navigate for six months without charging. Batteries and solar panels power the onboard electronics and actuators. Being independent on solar power for navigation, the Sailbuoy is an attractive platform for high latitudes with limited light.

To conserve energy, the sensor payload can revert to a low-power state until the Sailbuoy arrives at the area of interest or until the solar panels recharge the payload batteries. This is a unique feature not found on other autonomous vessels."

"The sea surface is a harsh environment with many mechanical stresses, corrosion, and wear. An uncrewed surface vehicle has to withstand this environment for long periods of time. The Sailbuoy is designed and tested to withstand the environmental stresses of the North Sea, including cold, severe weather and little sunlight during the winter.

They currently operate across Europe, North America, South America, and Australia, supporting environmental monitoring, defence, offshore operations, and fisheries.

The Sailbuoy has a length of 2m and displaces 60 kg. It can carry a 10 kg payload and move at speeds of 1-3 kts. It has passed tests in 30 m/s winds and has a mission duration of 6 months. The solar panels provide 30W of power.

Sailbuoy

DATAMARAN

Autonomous Marine Systems (AMS) has developed a patented twin-hulled uncrewed ocean-going robot powered by wind and solar.

The kickstarter campaign to develop a self righting sailing catamaran originally commenced in 2013. A year later, AMS moved to Massachusetts to become a part of the robotics community clustered around MIT, WHOI and other established maritime institutions. 2016 saw a seed round to fund the DATAMARAN Mark 7.

By 2019 the next generation DATAMARAN Mark 8 advanced multi-hulled autonomous sailing platform was launched.

Last year, AMS was acquired by JASCO Applied Sciences.

The Mk 7 was conceived for small, power frugal, sensor packages. With a length of 3.7 m (12ft), a beam of 2m (6.6 ft), a mast height of 3.1 m (10.2 ft) above water and a 0.3 m (1ft) draft, it has a displacement 192kg (425 lb) fully loaded.

It has a minimum speed of 3m/s and the maximum of 21 m/s. It has a typically end endurance of six months. The hosted payload is contained in a package 1m X 0.2 m X 0.2 m *per hull* It has through-hull access to water.

The Mk8 version is larger at 5m (16.4 ft) in length, with a beam of 3.3 m (10.8 ft), a mast height of 4.0 m (13.1 ft) above water and a draft of 0.8 m (2.7 ft). It displaces 360 kg (800 lb)

The catamaran cat travel at a minimum speed of 3 m/s up to a maximum of 20 m/s and also has a typical endurance of months

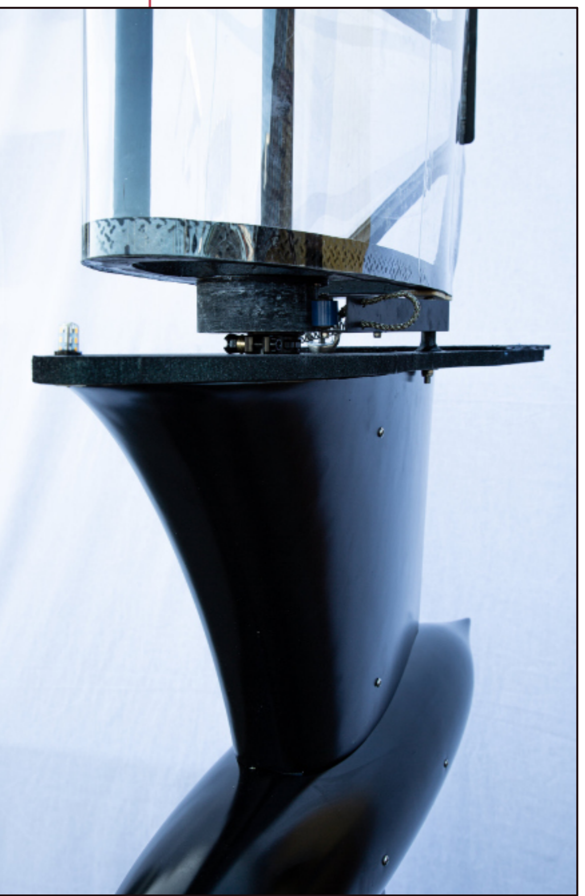
It has a larger payload of 1.5 m X 0.3 m X 0.2 m per hull and can accommodate a payload weight 70kg (150lb). The available power is 95W continuous, 200 W peak with 24, 12, 5 and 3V available

Communications systems include Acoustic (1 Kbps), Satellite (2.4 Kb) GSM (12 Mb) and Wi-Fi (35 Mb) along with an AIS Class B transceiver.

It is designed for advanced metocean surveys including taking wind velocity profiles with altitude, water current, conductivity, temperature profiles with depth, hi-resolution bathymetry, sub-bottom profiling, magnetometer measurements.

SUBSEASAIL

SubSeaSail (SSS) has received an award from the U.S. Department of Defense's (DoD) National Security Innovation Capital (NSIC) to help move its semi-submersible HORUS vehicle through manufacturing engineer design and long-duration testing into mass production (contract



Automatic mechanism that optimises sail position

manufacturing) as rapidly as possible. The multi-million dollar award from NSIC will help reduce the time to market for the SSS HORUS vehicle.

The HORUS USSV is an economical, long-duration sensor and payload platform. Wind is the primary source of propulsion with a thruster for station-keeping in low/no wind conditions and propulsion for near-shore navigation.

Solar panels charge the battery arrays to power sensor packages, payloads and thruster. The platform is capable of full autonomy, swarming, and manual modes.

The hull below the surface with wingsail above (patented): This reduces friction/drag with very little wake and a very low visual signature - or high visual signature if preferred.

The passive wingsail control mechanism does not include electronics, lines, or pulleys are required to optimally position the sail with respect to the wind direction, speed and desired path.

This feature significantly reduces cost and complexity, while increasing reliability. A single electro-mechanical servo for the rudder is the only moving part required for sailing control.

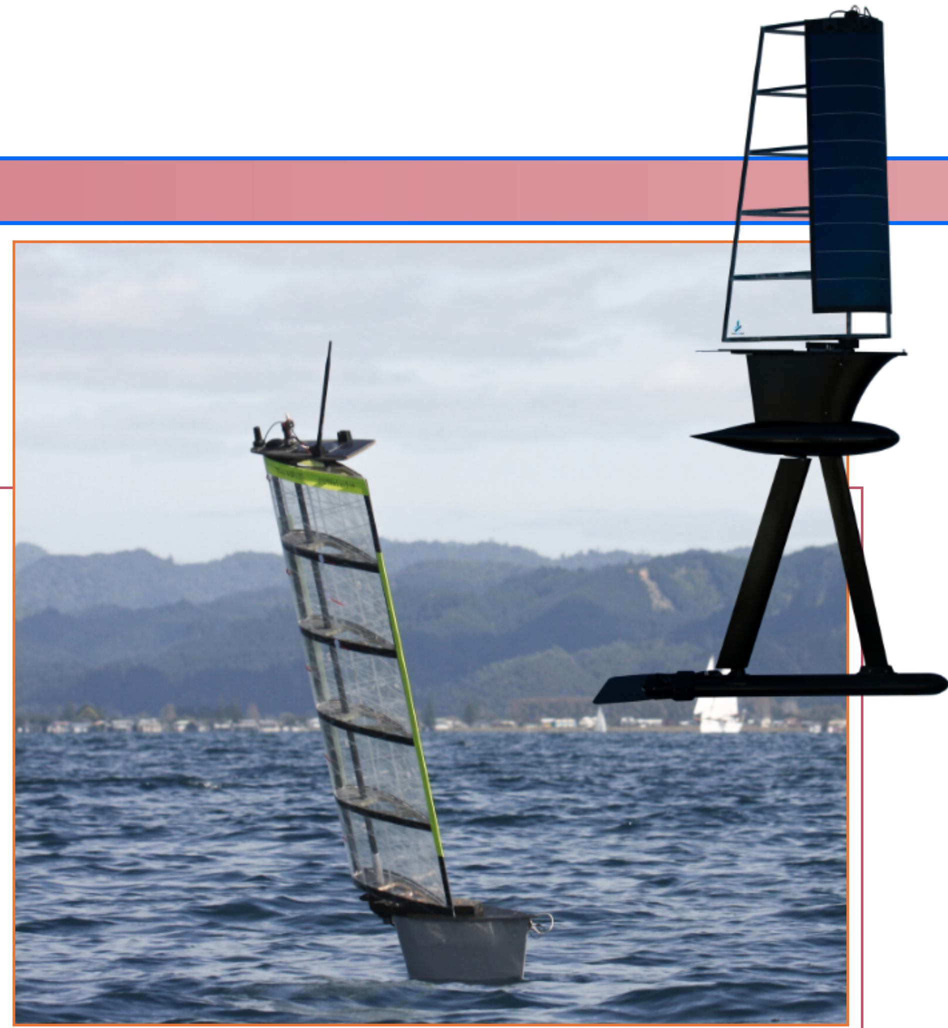
The user can select Solar power within the wingsail; a transparent wingsail and solar deck at the waterline for a lower visual signature, or a combination of panels on the deck and wingsail.

SSS is focused on design, prototype development, testing and sensor package and communication integration. It plans to outsource production to experienced contract manufacturing organisations that

The HORUS under sail

can ramp up production rapidly as demand warrants.

NSIC is a component of the Defense Innovation Unit (DIU) that has a mission to accelerate commercial technology into the DoD. NSIC provides funding to early-stage companies to accelerate product development for innovations that can be used for both commercial and national security applications.

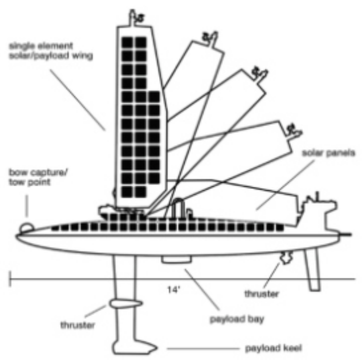


The HORUS sailing and in profile

OCEAN AERO

Ocean Aero's Triton is the world's first and only Autonomous Underwater and Surface Vehicle (AUSV). It can sail and submerge autonomously to collect data both above and below the ocean's surface and relay it to you from anywhere, at anytime.

The Triton was built to be versatile and to handle a range of missions across a number of industries. Our pre-packaged



payloads will cover 90% of the applications in the defence, research, and off-shore energy sectors, but the system is designed to support rapid NRE efforts for more specific use-cases.

Optional state-of-the-art payloads include advanced modal communications for high bandwidth data transfer in remote areas as well as obstacle avoidance software/hardware to ensure autonomous reactions to unexpected mission complications.

The TRITON can sail autonomously for 3 months on solar and wind power at speeds of up to 5 knots. The TRITON acts a submarine and can submerge autonomously for 5 days at a time at speeds of 2 knots.

Triton USV

On-board communications packages include iridium, WiFi, 900Mhz, and some of the most advanced radio mesh networks in the world. Additional communication equipment can be outfitted to fit niche needs.