Shearwater

Open Source Floating Sensor Platform for Measurement and Reporting of Marine Carbon Dioxide Removal

This project is a template and instructions for reproducibly building and operating a floating sensor platform. The platform is designed for medium-term (1-2 years or more) deployments at coastal locations, and is designed to house and optionally provide real-time telemetry from sensors in the domains of ocean chemistry, oceanography, and meteorology.

We believe the design is flexible enough to have substantial variations, though note that we do not advise attempting to deploy this platform aside from coastal settings. Although it could potentially be towed or motored some short distances and operated wirelessly (via a pair of marine batteries for instance) for short periods of time, the platform is intended to be lashed to a dock, pier, barge, or similar, and for it to receive low-voltage shore power.

One of the guiding principles for the project is that wherever possible we chose commercially available, off-the-shelf components (COTS) so that this project will remain affordable and can be reproduced by facilities or individuals who may not have access to (for instance) machine shops to mill custom enclosures or an electrical engineering department to design and send printed circuit boards (PCBs) out for custom fabrication. We leverage the mature industrial automation industry for components wherever possible; companies serving this field have had a good deal of time to make robust and relatively inexpensive components.

Where possible we choose affordable components, bearing in mind that coastal and ocean environments are among the harshest in the world and there will be areas where we choose more rugged or higher-quality components in hopes of those components better surviving harsh conditions.

Although there are a number of different aspect of this project - mechanical, electrical, software - we feel that it could be completed by a small group or even an individual who is ready to learn some new skills. We outline the major subsystems below – groups or individuals who wish to use some parts of the system can use just the one or more subsystems relevant to their specific project.

Physical Platform

Dock Blocks

The first prototype we have designed is based on the commercial Dock Blocks system. This is far from the only choice we could have made for this project, and there was significant debate on whether it was the best choice. Some other options are described below.

One aim of the project was to be able for a small group to be able to assemble the system without the use of heavy or specialized machinery, without the use of a welder or a crane. Although this platform would be difficult to construct on the water in rough conditions, in a calm and protected environment with people who are comfortable working on the water we contend it is possible. The unistrut and the all-thread connectors should be pre-cut or pre-assembled where possible in a shop setting.

Another goal of the platform is to be able to have enough space and buoyancy for one or more humans to be able to do some manual pumping of seawater for lab-based analysis. There is high likelihood that at some point in time some component will fail within the electrical enclosure, and removing the enclosure to troubleshoot and repair in the lab will not always be feasible. Therefore we intend the area around the enclosure to have enough room for such activities, weather permitting.

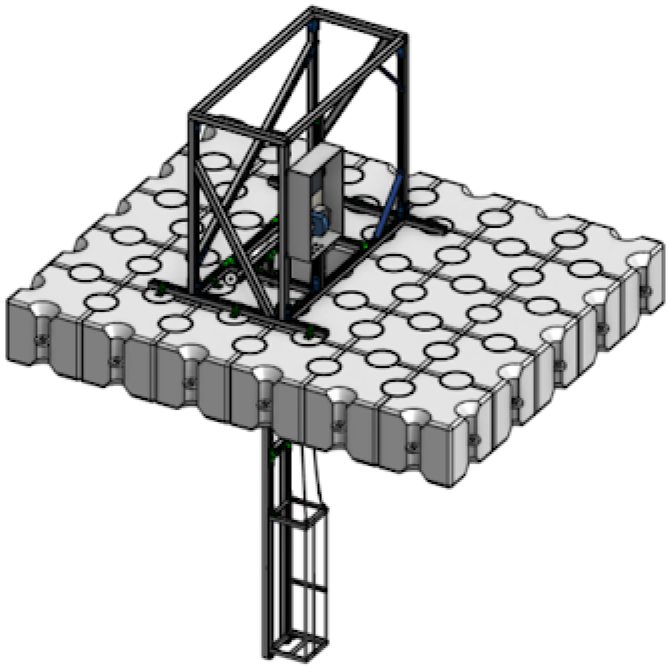
We also strive for being able to service our underwater sensors relatively easily - without requiring a diver. We expect that we will have significant biological growth that will need periodic de-fouling, and many ocean chemistry sensors in particular will require frequent calibration. There may be additional need or desire for mounting sensors on our cage that are not integrated with our live-streaming telemetry; we still want to be able to connect to these sensors for data download and reconfiguration/re-launch. The platform is designed in such a way to allow one or two operators to hoist up the sensor cage and service it while standing on the platform.

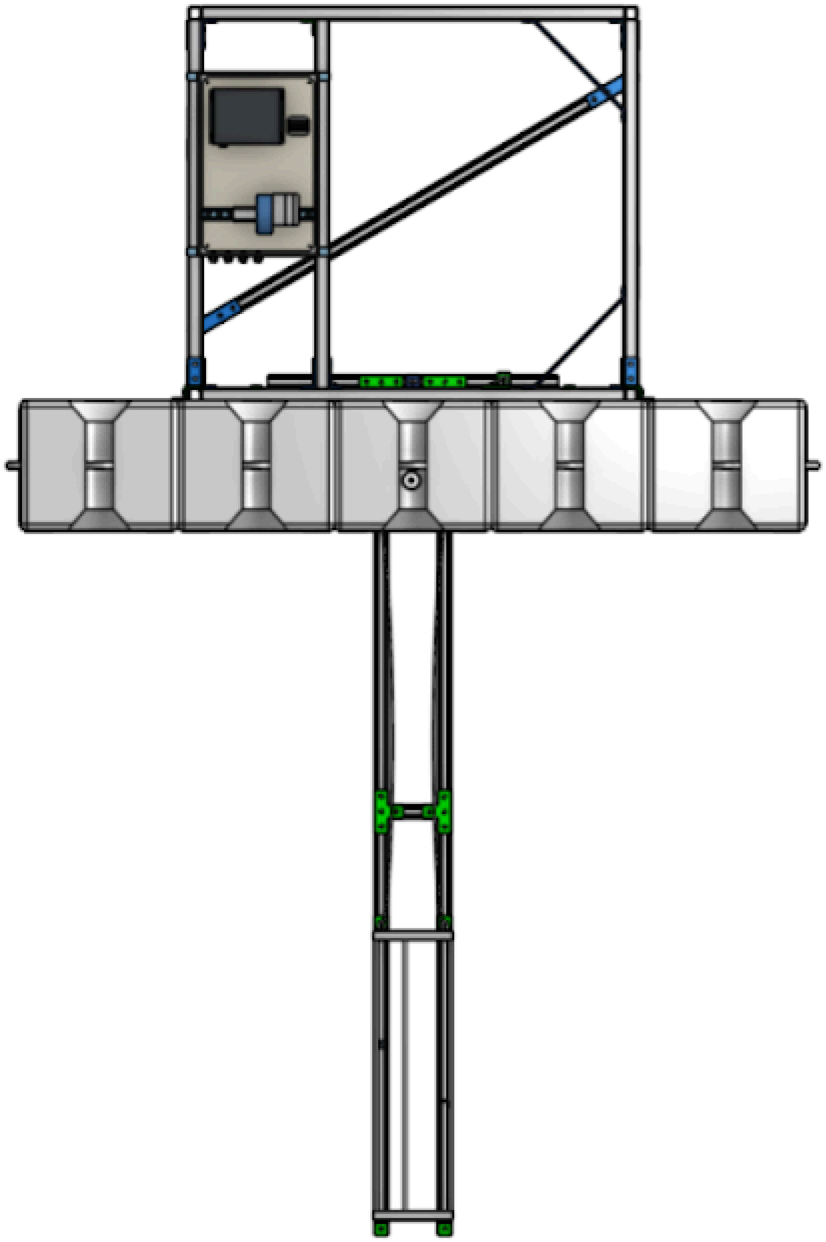
Note that care should be taken to prevent pinnipeds from taking perch on the platform. Dock-blocks has a new railing system in development, if this component is available we think it could be effective at preventing pinniped ingress:

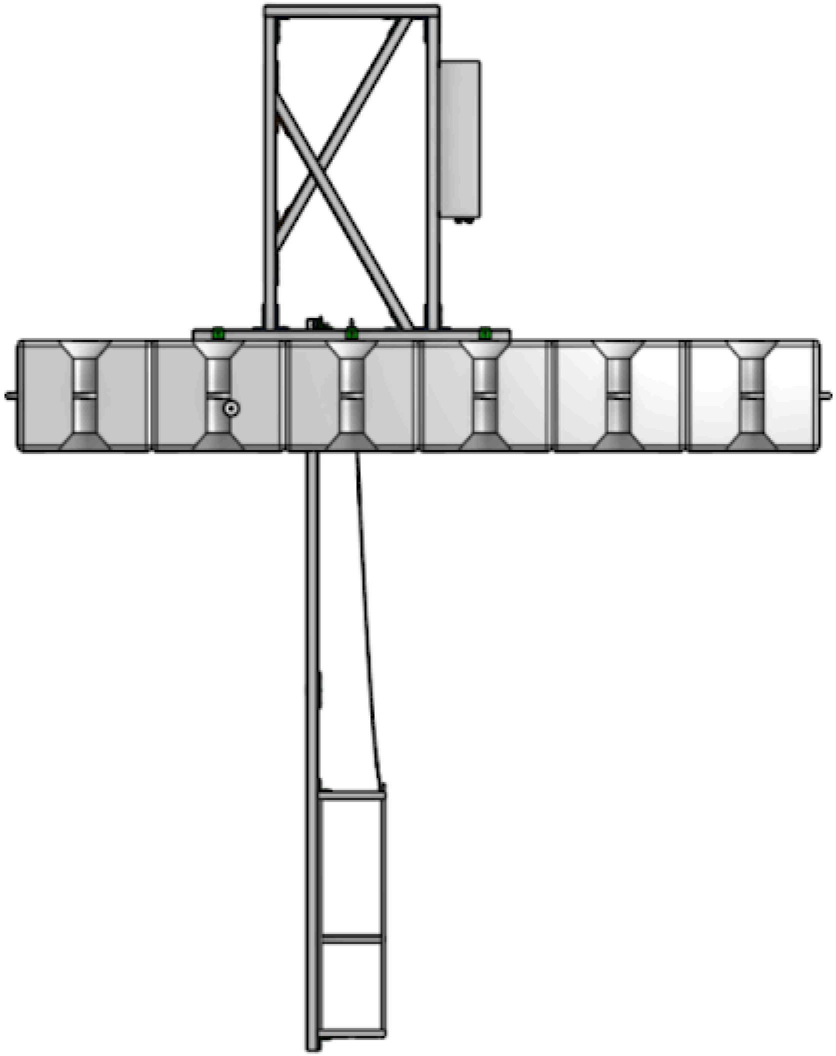
Until this is available, we propose using the traditional dock-blocks handrails (pictured below) with rope netting along any areas of the platform that might be accessible by pinnipeds. Other approaches may work as well or better, but we encourage implementers to not forget this operational consideration.

Platform Design

We use OnShape as our CAD platform, we will eventually provide public links to these models; in the meantime below are some screenshots. For our use case and the time being we are assuming the sensor cage itself is a welded stainless steel cage (we had one already) that we attach to the unistrut super structure. Future iterations or different applications by others may look different. Although we initially planned on having the central “moon pool” 2 blocks wide (each block is ~.5m square) we have since contracted to one block; your usage may vary.







Scaffolding

We chose stainless steel unistrut as our scaffolding infrastructure. Unistrut is commonly available in many places worldwide, and there are many fittings available. Stainless steel is one of the more expensive unistrut options available, but especially for initial builds we determined this was the option most likely to have a successful outcome. If you are using stainless unistrut, make sure you use stainless fittings to avoid galvanic corrosion.

We also considered fiber-reinforced plastic (FRP) struts. This may be a significantly cheaper option that will resist corrosion, although there have been reports of it not performing well in constant sunlight and forming dangerous hairs that easily embed in the skin. If you choose this path for your scaffolding, take great care when cutting, use of power tools to cut this material can generate a great deal of fibers that can get into the skin or lungs and be very difficult to clean up – advise use of hand tools to cut (a hacksaw has been reported to work well here).

We also discussed other options, unistrut also has galvanized variants which will be more affordable, and there is a very flexible metal strut option with anodized aluminum called 8020 that some users may find good options. We were nervous about corrosion with the galvanized steel options. Some thought the small grooves on 8020 might be prone to biofouling, and note that if operated with ocean alkalinity enhancement projects the anodization may tend to dissolve.

Connections

The dock-blocks system has a single polyethylene “pin” that connects any two blocks together. This pin rotates to lock in place.

Although not officially supported by dock-blocks, many of their customers have connected hardware to these pins to mount things like our unistrut scaffolding to the platform without having to get underneath the platform to make the attachments. ½” all-thread with two jam nuts is one hardware option we believe will work well here.

Unistrut could be directly mounted to the bolt or all-thread, but another option our team discussed in order to separate the platform/pins from the scaffolding is to use a piece of custom stainless hardware (yellow in the marked-up image below) to lock into the (green) unistrut with standard unistrut fittings (red) regardless of orientation:

Alternate Platforms

There are other similar modular dock systems out there that could work for a platform like this, we have not exhaustively vetted everything else. For significantly more capital expenditure there are companies which will build and deploy a platform for you – see for instance https://www.marinefloats.com/.

We also discussed modifying a small pontoon boat or catamaran to serve as the floating physical platform – this could certainly work as well. See below for more details.

Another alternative we discussed was using (& modifying) a COTS boat, something like:

Primary Sensor Selection

We specified several sensors for our primary use case, marine Carbon Dioxide Removal, other uses may have other requirements; our design here should accommodate different/additional sensors. The sensors we've designed for include:

- Seabird HydroCAT-EP V2 (including pH)
- Sunburst SAMI-CO2
- Sunburst iSAMI-pH
- Gill Maximet Marine GMX560

We believe this set of sensors to be a good choice for baselining and field operations for marine-based Carbon Dioxide Removal.

Electronics enclosure

Sub-sections below detail different groupings within the enclosure. A table of possible components along with possible sourcing is listed below.

If you haven't worked with electronics in this way before, rest assured that this is something that you can learn. DIN-rail mounting and things like terminal blocks make working with electronics accessible to many, especially the fairly safe low-voltage electronics present in this project. Note that you will need to practice a keen attention to detail with this work, however, and you will want to be careful about things like stripping, crimping, and tightening wires and connecting screws.

Enclosure

For the enclosure itself, we use a larger model from Polycase (we used WQ-81-02). Others may well be suitable. Polycarbonate reinforced with fiberglass, with stainless steel fittings and a continuous gasket is a good choice. In an ideal world we would hope to assemble the enclosure contents in the lab, install, and never have to open it up on the water. In the real world, this is likely to be a relatively common occurrence for troubleshooting and maintenance. The enclosure should include DIN rails - we use these where appropriate for mounting components. The DIN rails get mounted to the interior panel which you should also purchase with your enclosure. We used the ABS plastic version here: WQ-81P-01. Use self-tapping sheet metal screws with a drill to mount the DIN rails or other non-DIN rail mounted components.

Incoming Power

In line with many of the industrial automation components we're using throughout the system, our primary power bus is 24v. Note that since this is < 50v this is considered low voltage and hence generally safe to work with, though we still advise taking care when operating with electrical equipment.

We advise a small Uninterruptible Power Supply (UPS) that can be DIN-rail mounted to provide continuous power when unexpected events occur. Our 19.2 Wh Phoenix Contact UPS can provide on the order of tens of minutes of operation, and can be wired such that software can react and gracefully shut down when main power is interrupted. The UPS also functions as a power conditioner, outputting a steady voltage despite possibly noisy input. Because the floating sensor platform might be a long physical distance from the power supply that is supplying DC power, and DC will suffers from voltage drop dependant on resistance, distance and other factors, we recommend setting upstream DC output to be well above 24V and relying on the UPS as a power-conditioning capacitor. Calculators are widely available to help with determining output voltage based on length, wire material, and wire size (gauge, often AWG in the USA). Particular care should be taken with the upstream transformer – AC connections at 120V, 208V, or 480V are considered high voltage and are all life-threatening, especially in wet environments.

Power distribution

External power is supplied to the UPS; everything else in the enclosure should be powered via (downstream of) the UPS. Care needs to be taken here, however: because our oceanographic sensors expect 12V power instead of the 24V standard in industrial automation, we have a step-down transformer to convert from 24V to 12V, and expect that all of the sensors are connected to the 12V rail. We specify that 12V rail is the bottom-most DIN rail. Outputs to sensors need to be fused so that any possible sensor malfunction does not have the opportunity to short out the rest of the system.

It is important that we have programmable control of sensor power; we want to be able to power off sensors to conserve power, and there will be times where we will want to power cycle sensors for troubleshooting. We do this by means of an industrial relay controller or smart relay. Optimal choice here is the Revolution Pi Relay Module, but we have also demonstrated that the Arduino Opta will function here. These modules will have their default connection to 'Normally Open'; power will be off by default and need to be enabled by software control.

Panel penetrations

There will be a few penetrations in the enclosure. Try to avoid 'compression fittings' or gland fittings. Though these may be IP68-rated, this is the most likely source of salt-water ingress. MacArtney SubConn is the most dependable solution here. For our case, our chosen oceanographic/biogeochemical sensors already have these connections and hence avoids having to design any adapters. Note that this may mean you need to have appropriate cables made by MacArtney.

Power and Ethernet

Depending on usage, you will likely need to have at least "battery power" bulkhead input, 2- or 3-pin. The MacArtney pair you will need here is BHB2F/BHB2M. (If possible, aim to connect the ground pin to a real ground from the shore side.) In general with these male/female pairings you should plan to have the 'hot' connector be the female side to minimize possible shocks or short circuits. Where the hot end is coming from will depend on your situation, more on this below.

If your platform is intended to be connected to hard-line ethernet, you should plan on a separate 8-pin ethernet bulkhead - SubConn DBHRA8F/DBHRA8M.

For typical installations, both power and ethernet are fed to the platform via shore lines, likely fed from whatever barge or pier the platform is lashed to. A number of factors can inform how these cables are routed. If you intend for your installation to be stationary for a long time and permitting allows it, the most stable way to connect will be to run the ethernet and low-voltage power cables through an appropriately-rated, waterproof conduit underwater to the platform. But other options exist, including running the cable above water, possibly routing along whatever lines are lashing the platform to the barge or pier. Much care should be taken here, as these cables will be less durable in response to chafing than standard marine lines. Because the power lines are carrying low-voltage DC current we can be confident that even if insulation gets worn away we will not endanger life, but this situation should still be avoided to ensure equipment is not damaged and continues working as designed.

Because unexpected things happen, forklifts or vessels can catch a stray cable, storms can wrench our platform away from whatever it is lashed to, we design for the power and ethernet connectors from shore to be able to break away without damaging equipment.

Sensor Connections

Unless you are simply using the platform to house sensors that are battery-powered and self-logging, you will also likely need to have one or more power/communication cables that connects to the sensors. Many oceanographic sensors rely on 6-pin power + serial (typically rs232, sometimes rs422) connectors. Use MacArtney SubConn bulkheads connectors, one of MCBH6M/F for each (oceanographic) sensor you are connecting and powering from the system - different sensors may have different gender connectors. Some oceanographic sensors will ship with pre-made SubConn cables, but may be special cables that have DB9 or USB-B connections forked out to connect to a laptop. These forked connectors will not be waterproof and should be avoided. If you are comfortable with potting compound you may be able to cut and re-seal the cables; safer operation will be to have MacArtney manufacture the proper-length cables with appropriate 6-pin ends.

Plan to get color-coded sleeves so that operators can quickly see what connectors go to what sensors. All of the 6-pin power + serial connectors are likely to have the same connector, but quite possible to have different pinouts, and connecting power to pins that are not expecting it may damage sensitive equipment. We unfortunately do not have any great solutions for this problem other than careful education and standards around which connectors go to which sensors. There are other cable manufacturers which provide keyed connectors for this purpose. MacArtney does not provide such keys as of this writing, perhaps some day they will add this to their catalog. It might also be possible to build your own custom keys on top of our enclosure and the cables. If you successfully figure this out please share with the community!

We advise putting penetrations on the bottom of the enclosure, where possible. Gravity means that waves or condensation on cables will drip down away from the enclosure, rather than towards it.

Serial communications

Most of the sensors used in this space will have serial communication as an option, on many this will be the only option. As this is how we communicating with the sensors, and the sensors are the primary purpose of this entire platform, we advise investing in quality equipment here if the computer you choose does not have enough native serial ports.

We have explored some usb-to-serial options; this does offer some efficiencies of space and will be the lowest-power option. Something like this adapter from StarTech could be a reasonable choice. But despite the ubiquity of USB for personal computing, using it in an embedded system should be avoided if possible, USB tends to be an unreliable protocol especially where there might be electrical noise present.

A more reliable option than serial-to-usb is serial-to-ethernet. Moxa makes the highest quality equipment in this space. If you can get by with 4 ports, the NPort 5000ai is a reasonable choice, but note that it will consume 5W of steady power. If you need 8 or more ports, the NPort 5610-8-DT-T might be a good option, tho note that this will bump you up to over 7W and $940 as of this writing. If you are only ever planning on operating from shore power then power consumption should not be a concern here.

Moxa makes single port options, and you can find these from other vendors too (though be warned that you will tend to get what you pay for in this space) – but multi-port options are ideal as we'd rather support fewer ethernet ports.

Enclosure sensing

It will be important to have environmental sensing within the enclosure - in particular we want to measure temperature, humidity, and pressure. We may be able to get some additional information about some of our internal devices (eg CPU temperature).

For humidity and temperature, colleagues at NOAA have successfully used this chip (purchase link) with high accuracy and fast response time – but this will require a PCB and I2C integration, so we will likely steer clear of this. Sensirion also makes quality temp/humidity sensors but again are bare components that will need PCB integration.

Others have successfully used the Bosch bme280 - which measures temperature, humidity, and pressure at levels that should be sufficient for us, but again would require PCB and I2C (or SPI) integration.

A reasonable option might be the iMet-XF UAV Sensor - this is a bare PCB that will require some care with mounting and connecting (and possibly conformal coating?) but would give us temperature, humidity, and pressure with a RS232 interface (possibly connecting to our serial-to-ethernet hub above?). There is also a optional uBlox CAM M-8 GPS module that integrates here which might be a good backup option.

Networking

For the networking we're doing in this enclosure, there should generally be no need for anything higher than simple, unmanaged switches with 10/100Mbps connections. If you're planning on doing security (or underwater) camera connections within the system you should use a gigabit switch (1000Mbps), and may wish to consider a managed switch. Another option could be to have two physically separate networks,

We've mainly been using simple unmanaged DIN-rail mounted switches such as the ones listed below from TrippLite or ATOP.

Another consideration would be something like https://www.brainboxes.com/ or https://botblox.io/

Compute infrastructure

OS Choice

Unless you are planning on using the platform strictly to house self-logging or directly-networked sensors, you'll need to have a computer on board. Many scientists, engineers, and technicians who have dealt with oceanographic and similar sensors will be very familiar with connecting their Windows laptops to these sensors to configure them or download data. Apple computers will also be familiar to many.

While Windows and MacOS operating systems are totally appropriate for desktop/laptop use, and with some of these sensors you will need to use your laptop to initially configure some sensors, we will only be supporting Linux on our platform. The stability, security, performance, and ability for "headless" (i.e. no keyboard, mouse, or monitor) operation make Linux a good choice, and we'll be able to effectively use tools and technologies that have been maturing for decades in the software development space. In contrast, features of Windows and MacOS such as system updates, windowing systems that expect users to click on buttons to proceed, and blue screens of death will make developing for and operating our platform very challenging.

Linux has many different 'flavors' – we favor Debian/Ubuntu but if you are coming from a world of Fedora, CentOS/RHEL, OpenSUSE, or others this is not a problem. Much of what we will build and deploy here will be containerized with Docker to abstract away from the low-level Linux OS.

Computer Selection

Since we have a higher power budget and more space than platforms like buoys powered strictly by renewables, we are not limited to very low power single-board computers and are able to afford a beefier "Industrial PC". Note that this term is somewhat loaded - over the years this has typically implied a Windows OS, which is not what we'll be running here, at least as the primary OS. These days it is straightforward and commonplace to run Linux on an "Industrial PC". All of the options we considered are fanless here – care should be taken to leave enough room around the computer for adequate cooling.

Processor architecture can be a very deep topic. We are not tied to a particular processor architecture, but do note that ARM-based processors are very capable nowadays and depending on operating parameters definitely could do the job here, probably at a lower price- and power-point as comparable Intel-based processors. Older ARM processors may support only 32-bit operations – this will be sufficient for what we intend to do on our platform. Newer or more powerful processors may run 64-bit, which is also ok for what we will be doing on this platform.

RaspberryPi has been a mainstay of hobbyist-level electronics work for a long time – we are cautiously optimistic that the onset of the more industrialized RevolutionPi variant here may make this platform a suitable choice for this project. We have been prototyping with a RevPi Connect 4, 8GB RAM, 32GB SSD. Note that you will be running a 64-bit ARM processor here. Note that the RevPi will have no native serial ports and only 2 usb ports - if you go this route you'll want to either pursue serial-to-ethernet converters for the sensor hookups or a serial-to-usb hub. Despite the lack of serial port, the RevolutionPi product line could be a very attractive option when combined with some of the other industrialized components this vendor offers. We have been mainly interested in the relay module, to programmatically control power to the sensors, but analog and digital inputs and output, and being able to treat this suite of modules as a Programmable Logic Controller (PLC) could be a very welcome addition depending on what other components need to be interfaced with.

Maple Systems have Industrial PCs that are powered by 24V, are DIN-rail mountable, and that you can purchase directly without having to go to a sales representative. We've been able to successfully prototype with one of their machines. There are 2- and 3-serial port models from this manufacturer.

There are many other fanless, small form-factor computers you can find on Amazon and elsewhere which can work here, though do pay attention to the power requirements: many of those we looked at required 12v power. We do employ a 12v step-down transformer in our system, and so a 12v computer could be powered from this, but we would prefer if we can keep the computer powered by the "primary" 24v rail and avoid being downstream of the transformer. Keep an eye out for systems which have native serial ports to avoid having to rely on serial-to-usb to serial-to-ethernet converters.

We've also successfully used the POC-400 from the company Indsutrial PC, as well as the older POC-300. These are much more powerful units than the ARM-based Revolution Pi's, these are an excellent choice if you can afford them, both in terms of cost and power. You will have some native serial ports here.

Communications

The shearwater platform is designed to have a reliable connection to the cloud. As far as this platform is concerned, the easiest way to do that is to have a hard-line ethernet line that is connected to something like a broadband provider. For our primary use-case, where we are operating at the edge of, or within the confines of an industrial plant, this is straightforward (aside from the challenging nature of running an ethernet cable to a platform on the water) as the plant will already have an internet connection.

In some cases this will not be feasible or practical. Another alternative is to use a cell (or even satellite) modem. We are leaving off this component from our official documentation, but enterprising integrators will be able to find several very functional cell modems available in the US and elsewhere. Note that this will mean you will need to have a SIM card and data plan. Most of the companies providing cell modem hardware will be able to connect you with a local or national provider here - be aware that there will be monthly charges associated with a SIM card.

In this day and age network security is almost always something you should think about. If you use a cell modem, the cell modem will also likely serve as a firewall, router, and DHCP server. It will be important to set this up properly and securely if you use a cell modem. Other components in the enclosure will need to be served DHCP addresses. If the platform is simply receiving a network connection via a hard-line from elsewhere, ensure that this upstream provider will provide adequate safety as well as operate as a DHCP server.

The DHCP server is a convenient, centralized place to assign IP addresses, which are crucial to the operation of the system. As you are bringing up your system, we advise starting out with this DHCP set up to be able to quickly assign and view the static assignments and addresses. As your system becomes more stable, we advise switching to static IP addresses, keeping the static DHCP assignments in place in the event that any unit gets reset and forgets its static configuration. (Many devices will default to DHCP when reverted to factory settings.)

Bill of Materials

This is not a hard and fast list, as initial builds of shearwater are still prototypes and we are still experimenting with ideal components.

Item	Link	Notes
Enclosure		
Polycase WQ-81	https://www.polycase.com/wq-81	
DIN rail kit for WQ-81	https://www.polycase.com/dr-45	
ABS Panel for WQ-81	https://www.polycase.com/wq-81p#WQ-81P-01	Use the ABS panel, not the steel one
Pressure relief	https://www.jmesales.com/gits-1655-series-2-in-nps-polyethylene-low-profile-dual-purpose-pressure-vacuum-relief-vent-viton-seal-5-psi-pressure-5-psi-vacuum/	Want to use a mechanical, spring-loaded vent so we are not constantly cycling humid air into the enclosure
Bulk-head fittings	https://www.macartney.com/connectivity/subconn/	Bulkhead and cables dependent on sensor choice
Electronics		
Power Distribution		

UNO DIN Rail 24VDC UPS	https://www.digikey.com/en/products/detail/phoenix-contact/2905907/5875364	Note that there may be long lead times on this component
Wire for 24v positive	https://www.automationdirect.com/adc/shopping/catalog/bulk_wire_-a-_cable/single_conductor_wire_-a-_cable/mtw18bl10	Ebb adopted a standard for low voltage wiring to use blue for positive, white and blue striped for common. There are many established standards for high voltage wiring, we were not able to find any for low voltage. Advise using a different color for 12v positive
Wire for 24v common	https://www.automationdirect.com/adc/shopping/catalog/bulk_wire_-a-_cable/single_conductor_wire_-a-_cable/mtw18wb10	
Terminal blocks	https://www.automationdirect.com/adc/shopping/catalog/wiring_solutions/terminal_blocks/single-level_feedthrough_terminal_blocks/kn-t12blu-100	AutomationDirect has a large selection of different terminal blocks, separators, jumpers. You'll need to learn how to use these, they are relatively cheap and a seemingly minor part of the system but integral to the functioning of it all. Use different color blocks for 24v and 12v, positive, negative, and ground.
Terminal block circuit protection	https://www.automationdirect.com/adc/shopping/catalog/wiring_solutions/terminal_blocks/circuit_protection_terminal_blocks/kn-f10l24dc	Determine appropriate fuse size. Use these upstream of sensors to ensure damaged sensors do not take down entire system
Arduino Opta Lite Relay PLC	https://store-usa.arduino.cc/collections/home-automation/products/opta-lite	Use this to programmatically deliver power to the connected sensors
RevPi Relay Module RO	https://revolutionpi.com/shop/en/relay-output-module	Use this (if you can get a hold of one) if you're using a RevPi Connect4 as your compute module
Networking and Serial Communications		
8-Port Gigabit Switch	https://www.digikey.com/en/products/detail/tripp-lite/NGI-U08/15298480	Or comparable products from ATOP. Or see notes above around other options such as brainboxes
Moxa NPort 5610-8-DT-T	https://www.digikey.com/en/products/detail/icomtech,-inc./NPORT%25205610-8-DT-T/17881666	Or see other options above
StarTech.com 4 Port USB to Serial RS232 Adapter	https://www.amazon.com/StarTech-com-USB-Serial-Adapter-Hub/dp/B008U3OVHW?th=1	Use if serial-to-ethernet not a good option for you, and if there are not enough serial ports on your compute

		platform
Compute (only need one of the following)		
RevPi Connect4 8/32	https://revolutionpi.com/shop/en/revpi-connect4	Note that not able to buy directly from vendor unless in EU. Make sure to get the 8GB RAM/32GB SSD version, less than 8GB you will have a hard time
Maple Systems bpc2310a	https://maplesystems.com/product/modelname/bpc2310a/	Or similar system from Maple -- this form factor not ideal for DIN rail mount but note 3 native serial ports
IndustrialPC PC-400	https://industrialpc.com/product/poc-400/	
Sensing		
Enclosure environmental sensing	https://www.intermetsystems.com/products/imet-xf-uav-sensor/	
Tools/hardware		Invest in decent tools for both physical platform and electronics panel, and practice using them
Ferrule crimping kit	https://www.amazon.com/Self-adjustable-AWG-23-7-Electrical-Connectors/dp/B0B23V7ZQJ/	Use this on all of your wires
Wire cutter/stripper	https://www.amazon.com/Klein-Tools-Cutter-Stripper-Stranded/dp/B00080DPNQ	