



DEMCON | unmanned systems



DEMCON • UNMANNED SURFACE VESSEL

SYSTEM INFORMATION

28-05-2020

INTRODUCTION

This presentation contains information about the in-house developed **Unmanned Surface Vessel (USV)** by DEMCON Unmanned Systems for **inland water (salt & sweet) survey and measurement operations**. Developed together with end-user and launching customer **Van Oord Survey**.

The primary goal is to extend the survey capabilities by enabling operations in scenario's where existing equipment would be inefficient, unsafe or not able to operate. Think amongst others in use cases with very low waters/near shores, nature/drinking water area's and GNSS (GPS) degraded locations.

Strict requirements for the solution were the ability to interface with different payloads, integrate in existing workflows, **at least have the same functionalities as existing manned equipment**, compliant with regulations and standards, and cope with the robustness needs of the user. Providing end users an innovative electric, small, autonomous and environmental friendly measurement platform.

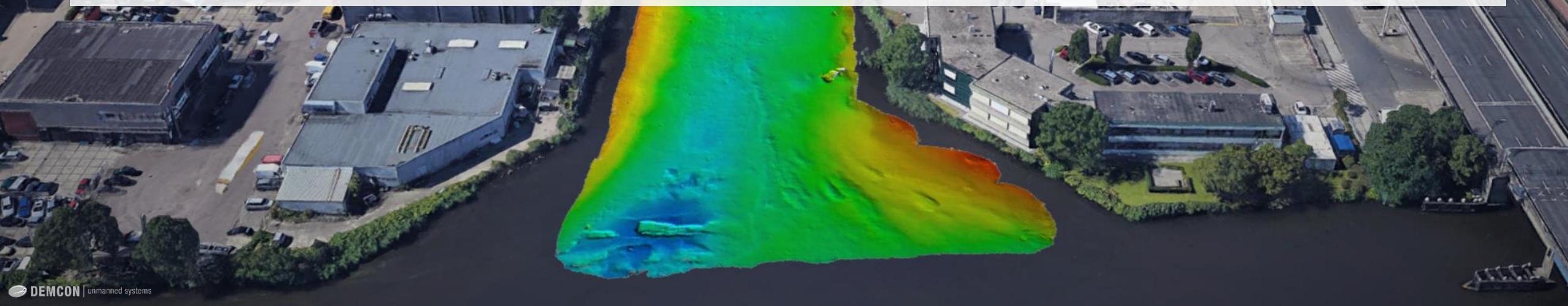


INTRODUCTION

An unmanned autonomous surface vessel offers the following advantages to your operation:

- Increased safety and decreased (physical) workload by minimizing personnel (in hazardous scenario's).
- Rapid deploy ability and compatibility with existing survey, inspection & monitoring sensors and equipment.
- Lower project costs, increased productivity, and automation of existing processes.
- New use cases and operating environments.
- First hand insights and knowledge in new unmanned and autonomous technologies for future innovations. Among others integration of data streams (vessel status, situational awareness & payload data) in off-site/ shore support centre for remote system operations.

In short a versatile, customizable and **future proof** system that will operate in different environments from harbours, nature reserves and drinking water areas to challenging GNSS (GPS) degraded environments as construction pits, underneath bridges and besides steel structures.



USV SPECIFICATIONS

- Dimensions : 2.5m x 1.1m x 1.0m (lxbxh, in transport), 0.8-1.5m (h-h, height in operation from water surface)
- Hull : Durable aluminum hull and hatches with watertight bulkhead separating compartments
- Draft/ depth : 0.39m incl. payload, able to operate in very shallow -0.5m waters (will turn over soil/ suck debris)
- Hull speed : Up to 9.5km/h, optimal cruise speed 8 km/h and mission speed 5 km/h
- Ratings : Developed according to IP67, ISO9001, EMC and CE compliant
- Wind (wave) resistant : up to 18m/s (average wind speed Bft 7 field tested)
- Payload bracket moon-pool : Removable bracket 63cm x 39cm x 44cm for under water sensors/equipment, up to 100 kg
- Payload bracket antenna bridge : 16cm x 95cm for above water sensors/ equipment, up to 5 kg capacity
- Payload bracket deck hatches : Able to mount brackets on the 8 deck hatches, t.b.d. mounting capabilities
- Sensors : Depend customer application needs,
: AIS, 360 IP cam, navigation-,warning-, signal lights, lidar
- Safety : 198 kg (excl. moonpool payload bracket & sensors), 300 kg max design weight (tested up to 370 kg)
- Weight : Full electric system with 2x stern and 1x bow rim driven thrusters
- Propulsion : High-performance lithium battery 5.000 Wh, UN38.3 lithium battery safety tested (DG shippable)
- Endurance & charge time : Up to 5 hrs or 25 km sailing & (220V) 2 hours charge time (depending on charger)
- Positioning system & accuracy : DUAL - RTK GPS, Position Accuracy (HRMS) depends on desired GPS system
- Vessel control + companion computer : Real-time control system (Autopilot/DP) + separate industrial PC (NUC-Ibase, Nvidia or equivalent)
- Communications (redundant) : 2.4/ 5.8 GHz, 4G-LTE Module (EU) & dedicated control & emergency stop link 433/868 MHz

TECHNOLOGY DEVELOPMENT & IP

Developed from the ground up based on specific technical and functional user requirements. The total system is designed, assembled and tested **in-house**. This process included the development of the required control (propulsion) configuration and algorithms as well as the **watertight and segmented hull** design in simulations and with a scale model tests. Which resulted in a **novel Vessel Positioning System** (patent pending).

Design choices and sailing properties have been cross-checked with an independent naval architect and fluid dynamic consultants in order to **validate the performance** of the vessel. And more important analysing the flow near the underwater sensors to ensure optimal measurement performance. The aluminum hull is manufactured in cooperation with an independent shipyard. Electronics, assembly and integration of (maritime) components have been done in-house.

By developing the system in-house DEMCON Unmanned Systems has control over the hardware and software. Thereby having the ability to fully customize the vessel, and gaining the knowledge and competences to **design, build and test new vessels for different use case** and scenario's (other sizes, functionalities, payloads, etc.).

USV SYSTEM HIGH LIGHTS (1/3)

BRIDGE SENSOR BRACKET

Different mounting points for communication antenna's (4G, 5,8/2,4 GHz, and sensors like GNSS (GPS) receivers, dedicated control link, IP cam, navigation lights, deck lights, orange signal light, LiDAR, etc. additional 5 kg payload capacity

ADJUSTABLE BRIDGE

In 3 different heights lockable positions in order to obtain best signal reception and for easier transport and accessibility underneath low hanging structures (bridges, pipes, etc.).

REDUNDANT PROPULSION

3 thruster configuration able to return to shore/ home when any of the thrusters fails.



FULL ELECTRIC SYSTEM

Silent, environmental friendly and powerful electric system, 100% liquid free system

REDUNDANT SAFETY FEATURES

Multiple hardware and software safety systems stops in/on the vessel and the control station.

ALUMINUM HULL

Industrial and watertight aluminium hull. Segmented by watertight bulkheads minimizing impact risks, shielding electrical components in different compartments and making the hull unsinkable.

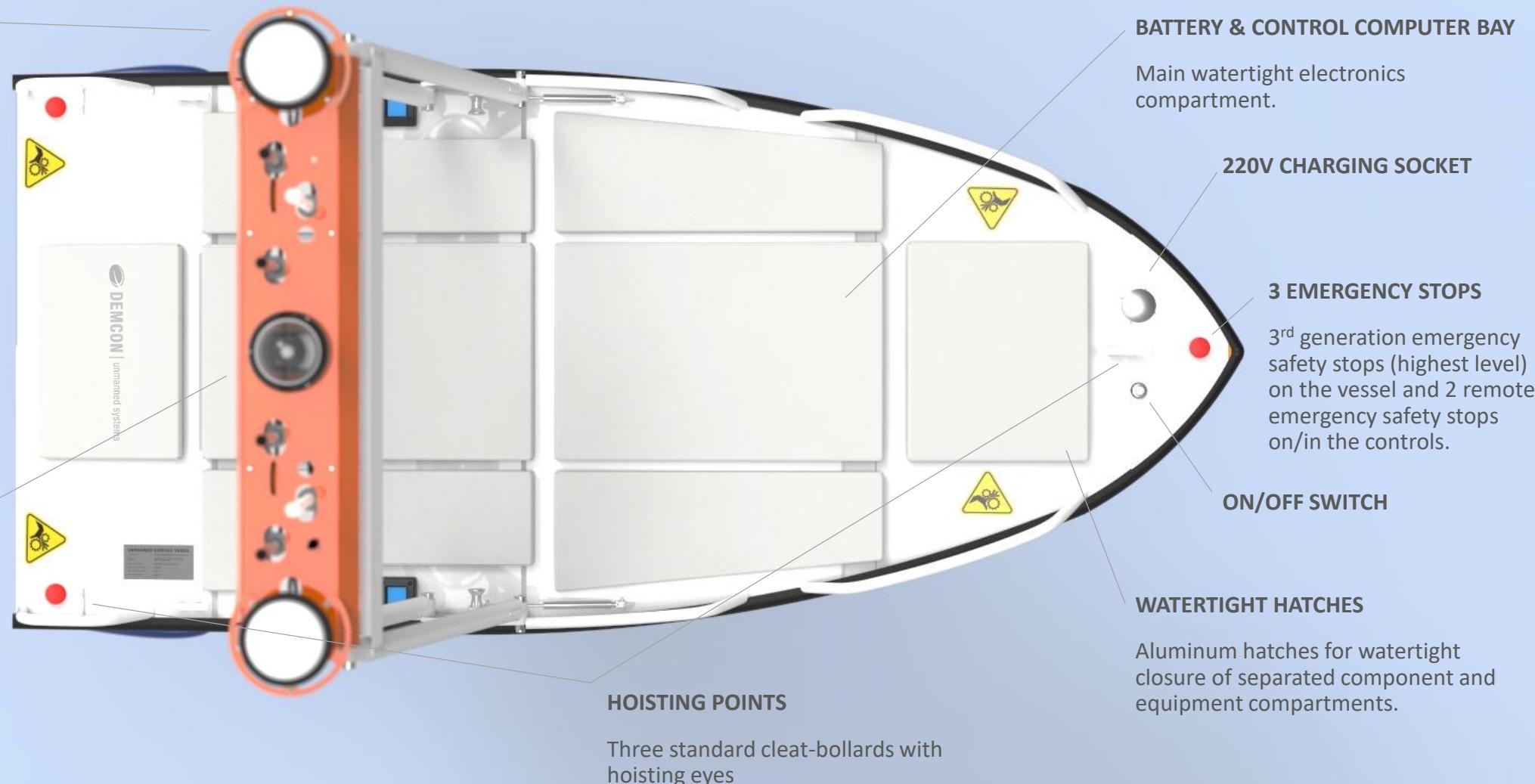
USV SYSTEM HIGH LIGHTS (2/3)



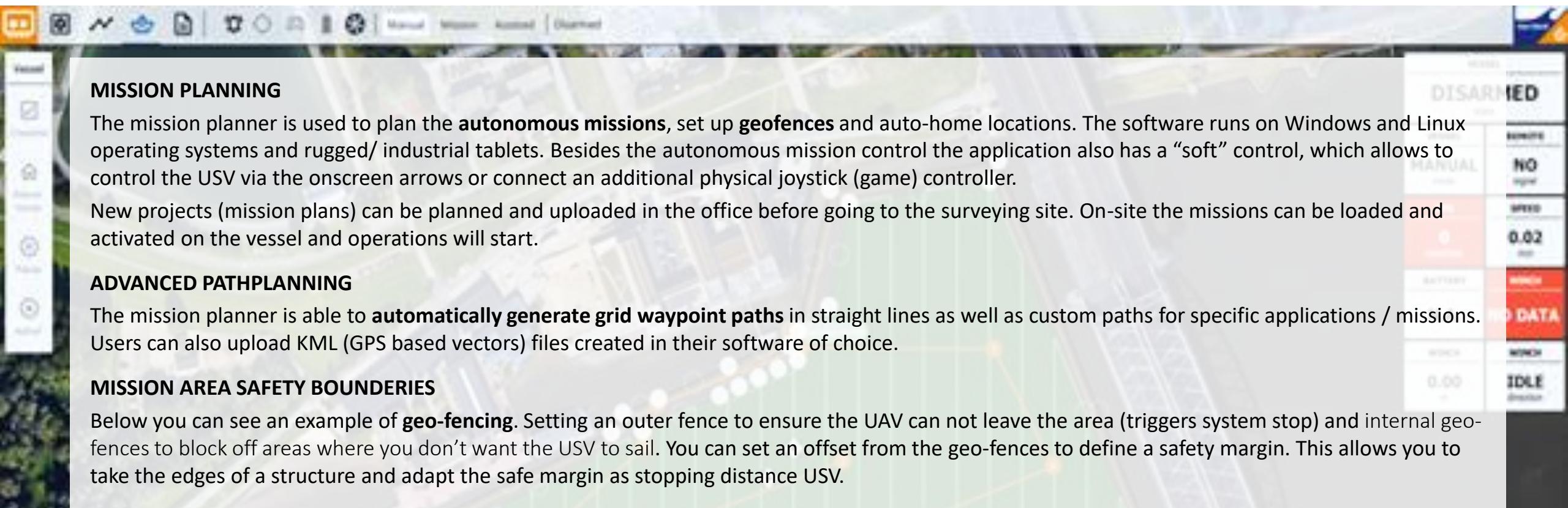
USV SYSTEM HIGH LIGHTS (3/3)

DUAL RTK GPS ANTENNAS

Precision positioning system with a dual antenna setup used to determine heading of the system, eliminating the need to rely on a magnetometer that can be heavily influenced by steel structures.



MISSION PLANNER & WORK PLANNING



MISSION PLANNING

The mission planner is used to plan the **autonomous missions**, set up **geofences** and auto-home locations. The software runs on Windows and Linux operating systems and rugged/ industrial tablets. Besides the autonomous mission control the application also has a “soft” control, which allows to control the USV via the onscreen arrows or connect an additional physical joystick (game) controller.

New projects (mission plans) can be planned and uploaded in the office before going to the surveying site. On-site the missions can be loaded and activated on the vessel and operations will start.

ADVANCED PATHPLANNING

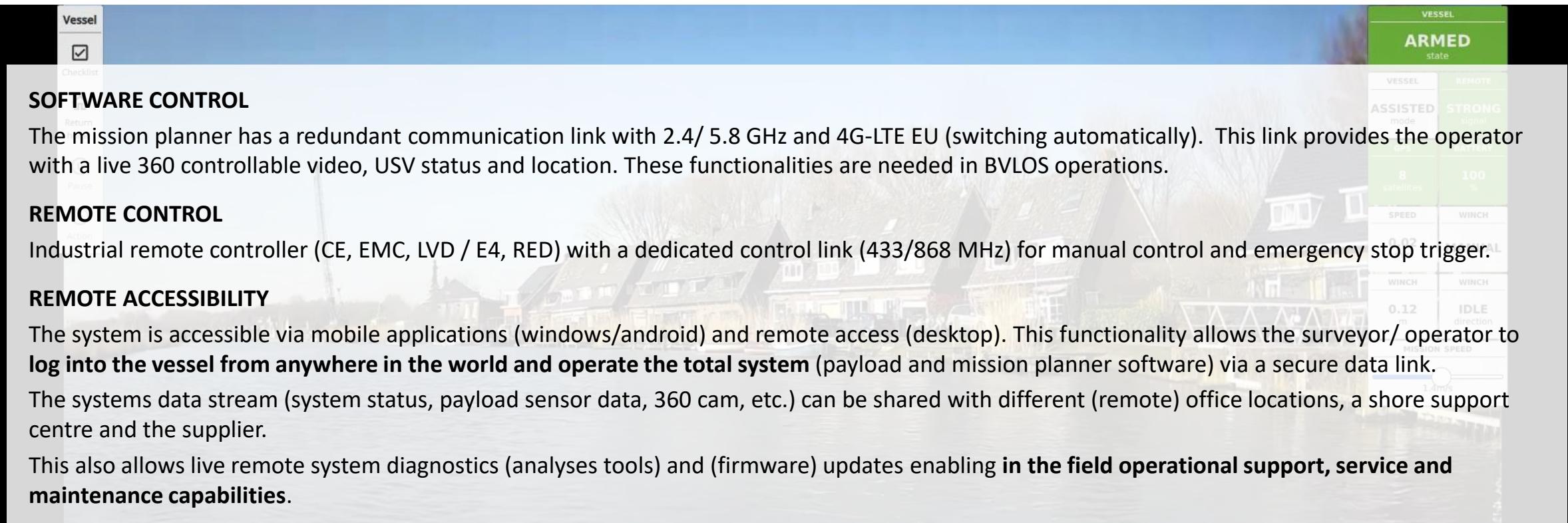
The mission planner is able to **automatically generate grid waypoint paths** in straight lines as well as custom paths for specific applications / missions. Users can also upload KML (GPS based vectors) files created in their software of choice.

MISSION AREA SAFETY BOUNDARIES

Below you can see an example of **geo-fencing**. Setting an outer fence to ensure the UAV can not leave the area (triggers system stop) and internal geo-fences to block off areas where you don't want the USV to sail. You can set an offset from the geo-fences to define a safety margin. This allows you to take the edges of a structure and adapt the safe margin as stopping distance USV.



CONTROL, COMMUNICATION & SHORE SUPPORT



Vessel

Checklist

SOFTWARE CONTROL

The mission planner has a redundant communication link with 2.4/ 5.8 GHz and 4G-LTE EU (switching automatically). This link provides the operator with a live 360 controllable video, USV status and location. These functionalities are needed in BVLOS operations.

REMOTE CONTROL

Industrial remote controller (CE, EMC, LVD / E4, RED) with a dedicated control link (433/868 MHz) for manual control and emergency stop trigger.

REMOTE ACCESSIBILITY

The system is accessible via mobile applications (windows/android) and remote access (desktop). This functionality allows the surveyor/ operator to **log into the vessel from anywhere in the world and operate the total system** (payload and mission planner software) via a secure data link.

The systems data stream (system status, payload sensor data, 360 cam, etc.) can be shared with different (remote) office locations, a shore support centre and the supplier.

This also allows live remote system diagnostics (analyses tools) and (firmware) updates enabling **in the field operational support, service and maintenance capabilities**.

VESSEL		REMOTE	
ASSISTED mode	STRONG signal	WINCH	WINCH
8 satellites	100	0.02	0.02
SPEED	WINCH	WINCH	WINCH
0.12 m	IDLE direction	0.12 m	0.12 m
WINCH	WINCH	WINCH	WINCH
0.12 m	IDLE direction	0.12 m	0.12 m
WINCH	WINCH	WINCH	WINCH



AUTOPilot (DYNAMIC POSITIONING)

The Vessel Positioning System (patent pending) enables full control over its movements allowing the vessel to **move in any direction** independent of its orientation (holonomic motion) and **accurately hold a position and heading**. This advanced control results in increased accuracy and safety.

FUNCTIONALITIES

- Manual control, full control over thrusters;
- Assisted, operator controls position and orientation of the USV and the control system executes desired position changes. When no inputs are given the USV holds its current position and heading;
- Point of Interest mode to perform automated tasks at a specific coordinate (such as lowering a winch for water column measurements);
- Mission/waypoint mode. Executing a mission or survey plan for full automation and repeatable data acquisition;
- Safety feature such as Position Hold, Return to Home, Geo-fencing for safe operating corridors;

DEPLOYABILITY & HANDLING

VERSATILE & MULTI PURPOSE

Due to the universal payload bracket on the bridge **for above water measurements** AND the moonpool bracket for **underwater measurements** the system is sensor agnostic and can be equipped with different (user specific) sensors/equipment. Increasing the deployability for different applications and environments.

LAUNCH, RECOVERY & TRANSPORT

Equipped with an automatic RC hooking **launch and recovery system** for safe out of reach operations from any kind and height of quay wall, boat ramp or softer waterfront surface.

A custom road legal trailer with hydraulically stabilized crane to launch and recover the USV in all different scenarios. The crane has a reach of 4m and a 20m winch able to hoist from every side of the trailer. The trailer includes vessel support/securing brackets and lockable equipment boxes.

The trailer/crane/vessel combination fits in a **standard 20ft container** for project shipment, transport or storage purposes. The USV alone can also be shipped by air cargo for **rapid deployment** purposes in a standard air cargo crate (including Dangerous Goods documentation).

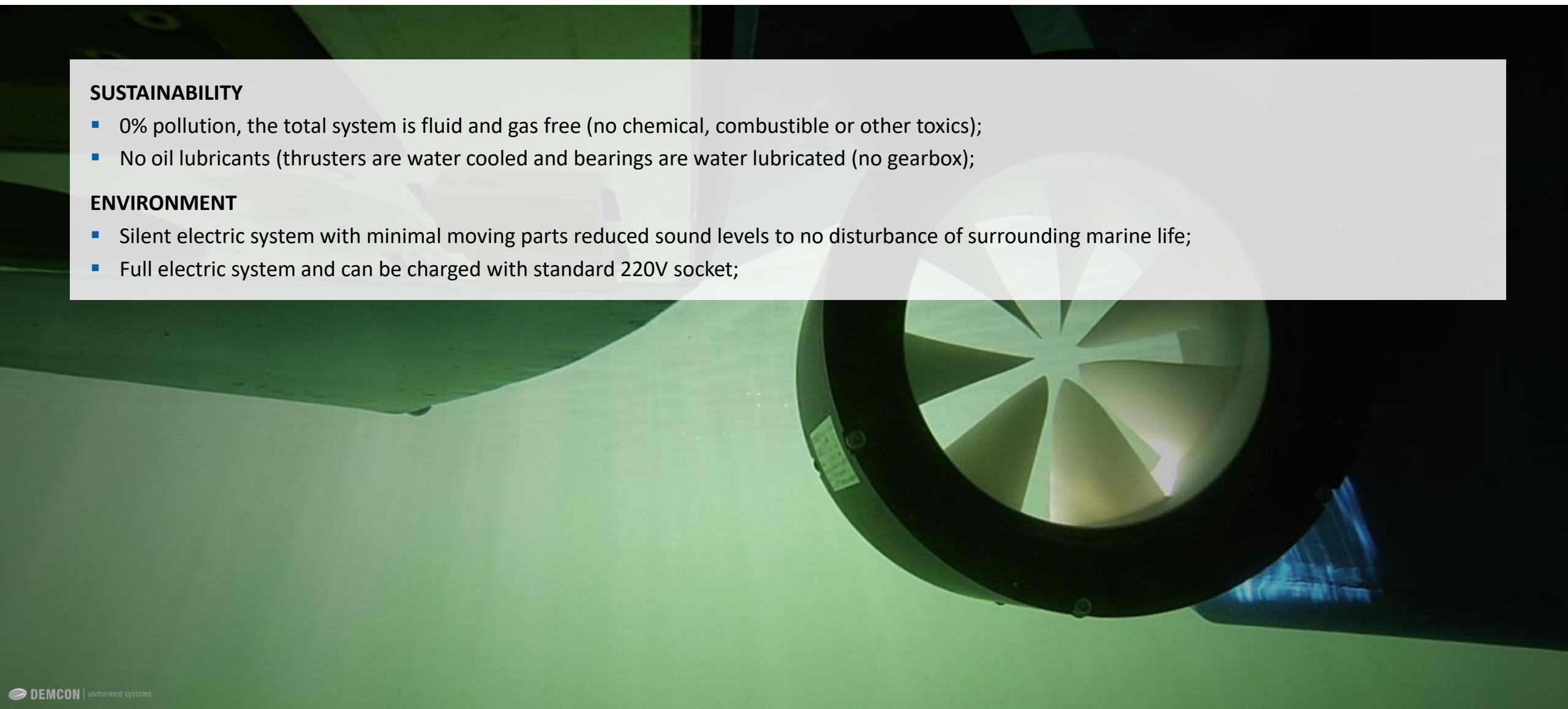


SUSTAINABILITY

- 0% pollution, the total system is fluid and gas free (no chemical, combustible or other toxics);
- No oil lubricants (thrusters are water cooled and bearings are water lubricated (no gearbox);

ENVIRONMENT

- Silent electric system with minimal moving parts reduced sound levels to no disturbance of surrounding marine life;
- Full electric system and can be charged with standard 220V socket;

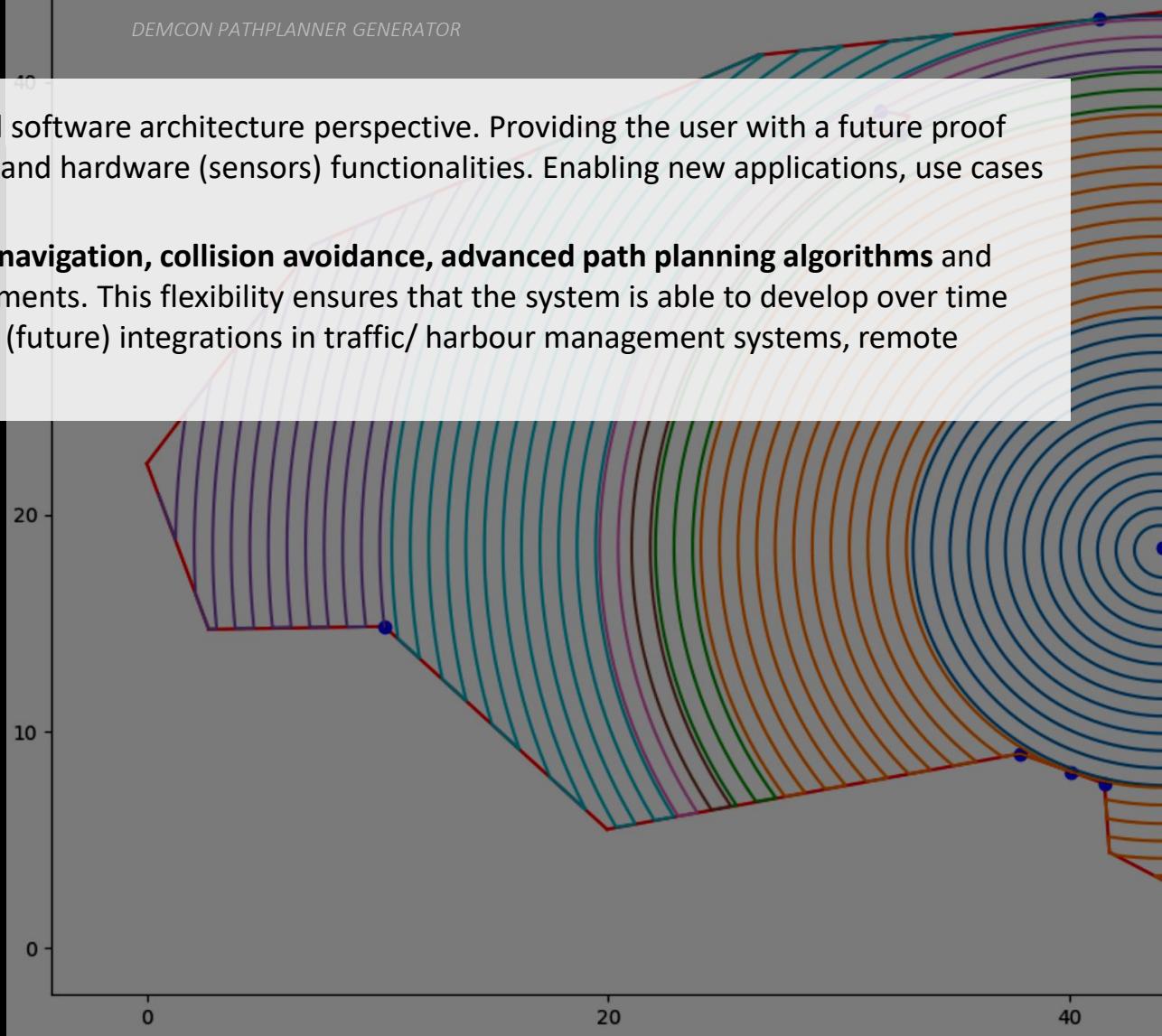


FUTURE PROOF & SCALABLE PLATFORM

DEMCON USV 3D LIDAR DATASET



DEMCON PATHPLANNER GENERATOR

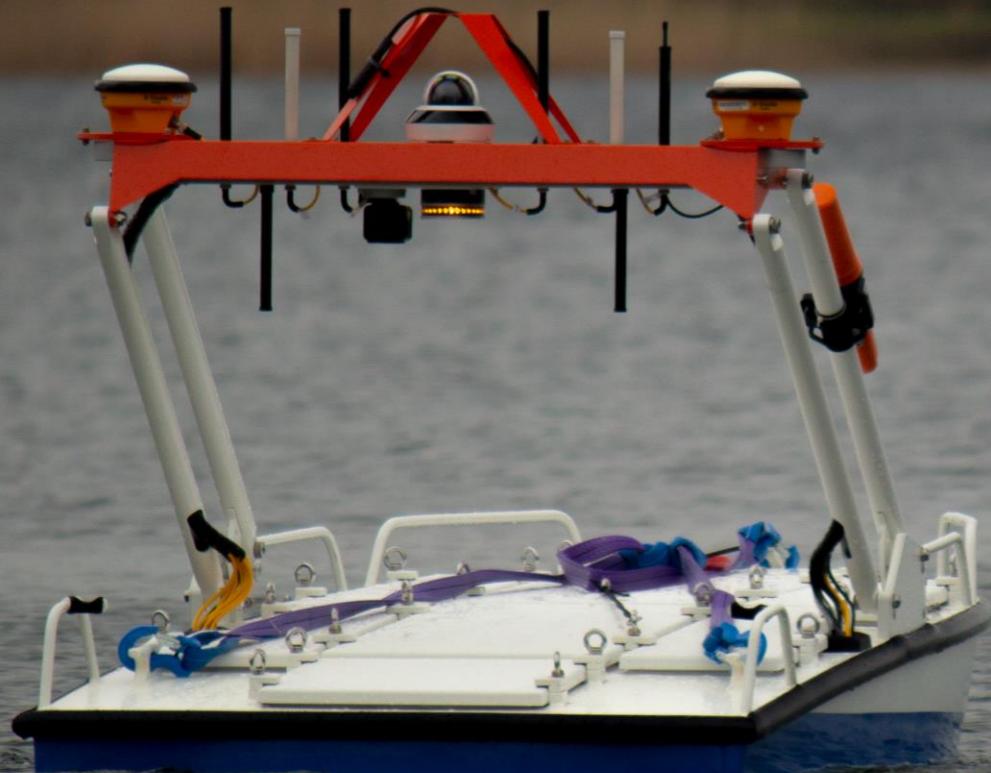


The system is designed from a multi-purpose and adjustable hardware and software architecture perspective. Providing the user with a future proof platform that can evolve by adding new technology, software (algorithms) and hardware (sensors) functionalities. Enabling new applications, use cases and operating environments.

Extensions include adding different **situational awareness**, **GPS-degraded navigation**, **collision avoidance**, **advanced path planning algorithms** and **communication** solutions depending on specific user and scenario requirements. This flexibility ensures that the system is able to develop over time and cope with changing regulations and safety standards. Enabling further (future) integrations in traffic/ harbour management systems, remote control (shore) support centres, and user workflows.



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