# ADVANCES IN COMMERCIAL DEPLOYMENT OF MULTI-AUV AND REMOTELY OPERATED VESSELS

SYMPOSIUM ON THE AUV APPLICATION DEMONSTRATION PROJECT

SEAN FOWLER - OCEAN INFINITY

TOKYO - JANUARY 21ST 2025

# OCEAN INFINITY


“Our purpose is to use **innovative technology** to **transform operations at sea,** to enable **people and the planet to thrive.**”

# OCEAN INFINITY

- Private company formed 2017
- 800+ employees globally
- We are a **builder**, **owner** **and** **operator** of the largest fleet of commercial remote controled vessels in the world
- Markets: Deepwater Search & Salvage, Traditional Energy (Oil & Gas), Renewables (Wind), Government, Defence, Scientific Research
- Services: marine robotics, automation, geophysical & geotechnical data collection and processing


Offices in UK, Portugal, Norway, Sweden, New Zealand, Australia, Singapore and the USA.

# MARINE TECHNOLOGY JOURNEY

2016

2018

SMALL UNCREWED VESSELS

2020

2022

TRANSITION TO LARGE, REMOTE OPERATED VESSELS

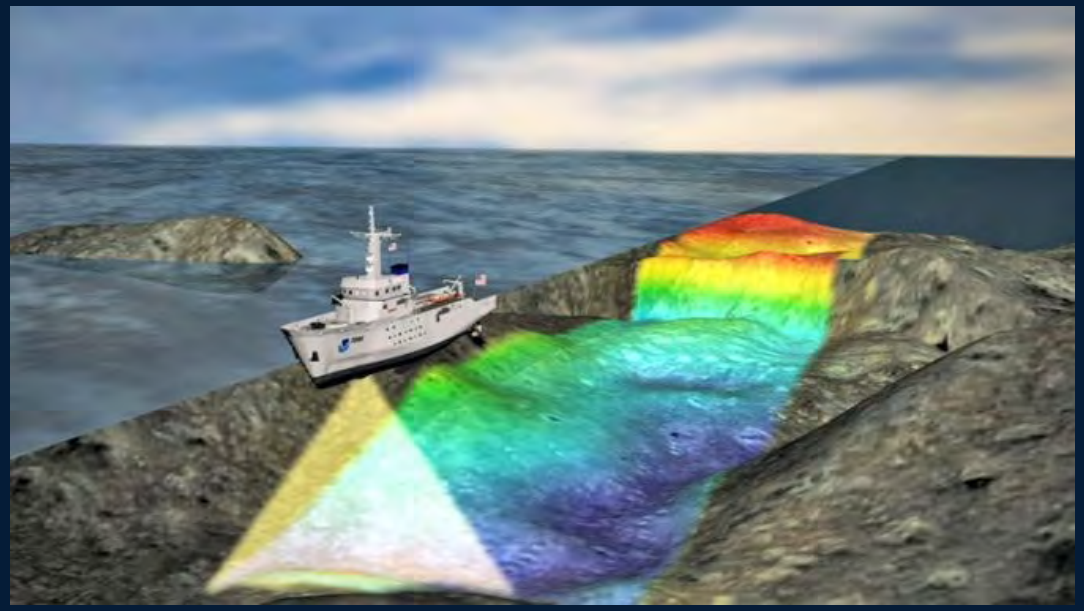
Today

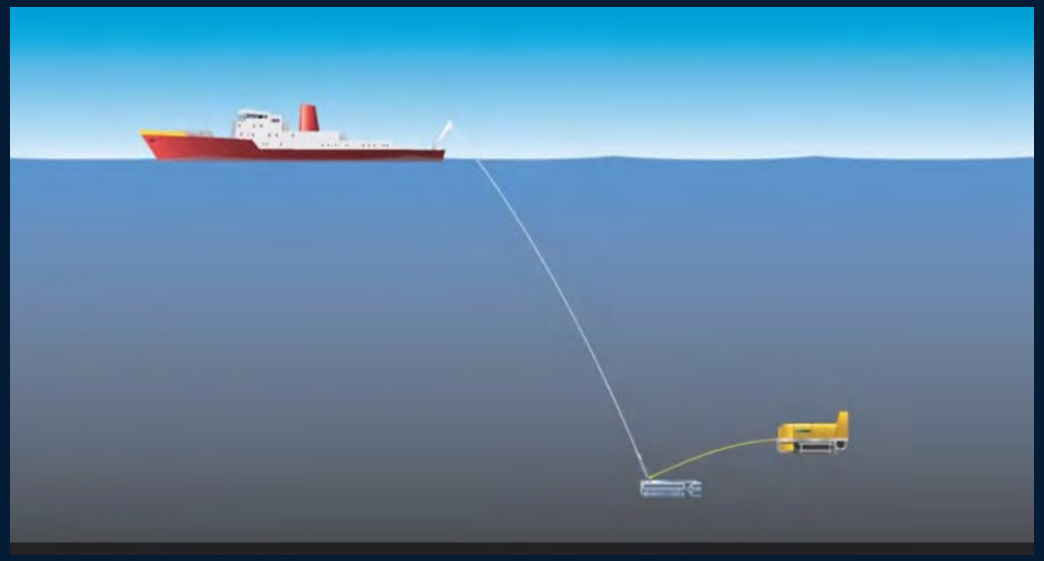
AUTONOMOUS UNDERWATER VEHICLES AT SCALE

NEW BUILD FLEET OF AUTONOMOUS / LEAN-CREWED REMOTE VESSELS

# OCEAN INFINITY – ORIGINS (2016)

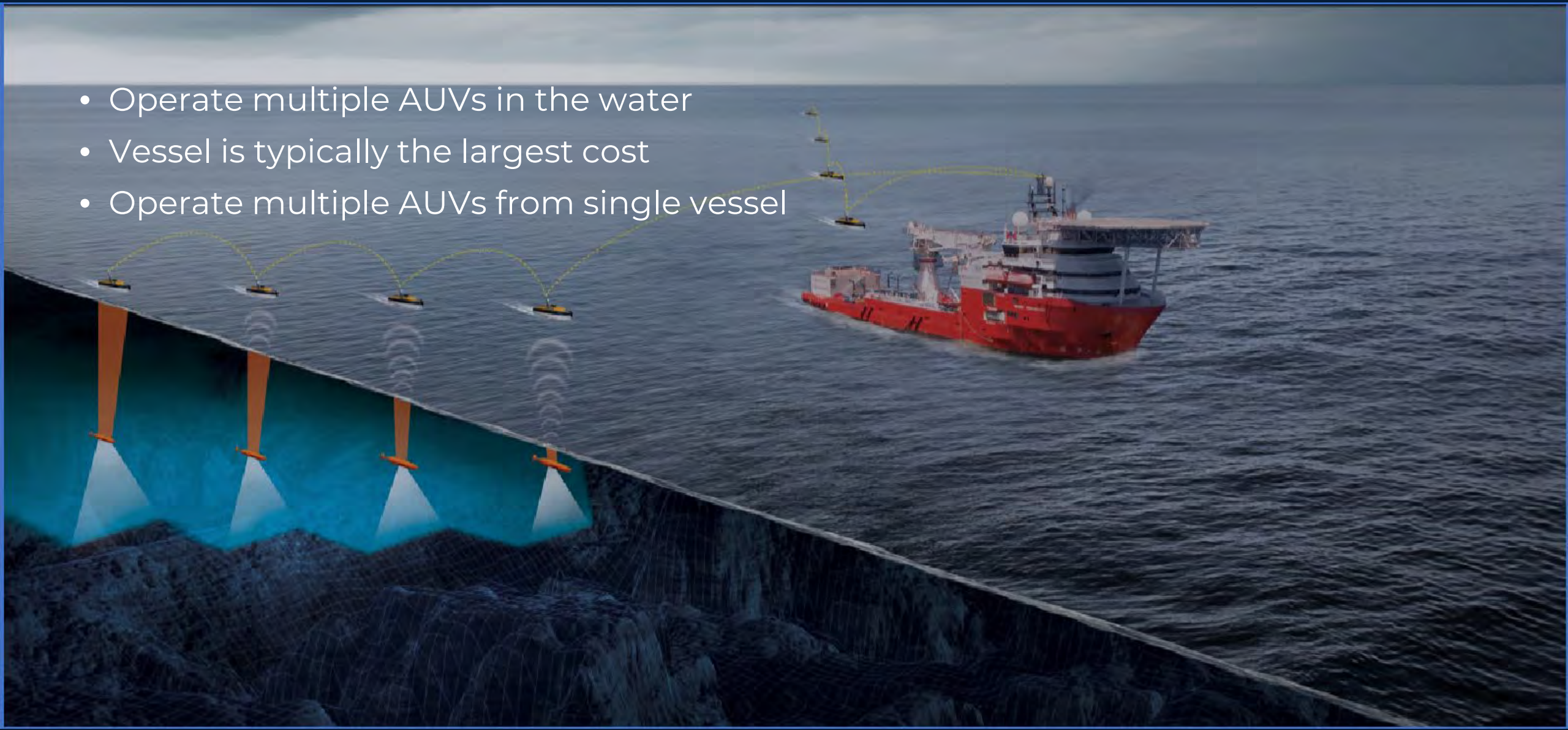
- Goal to search large areas of seafloor in high resolution, quickly
- Hull mounted sensors – wide swath at low resolution
- Get sensors closer to seafloor
- Limitations for deep-tow systems
- Untethered sensor systems (AUV)





# MULTI-AUV CONCEPT

- Operate multiple AUVs in the water
- Vessel is typically the largest cost
- Operate multiple AUVs from single vessel



# AUV / USV SYSTEMS PURCHASE (2017)


- 14 x Kongsberg AUVs 6000m rated, 48-90 hour mission capable
- HiSAS 1032, Kraken MINSAS 120, Edgetech Side Scan Sonar
- EM2040 Multi-Beam Echosounder
- Edgetech Sub-bottom profiler
- CathX 12MP Digital Color Stills Camera
- SC Magnetometer
- FLNTU Turbidity / Visibility Sensor / CTD

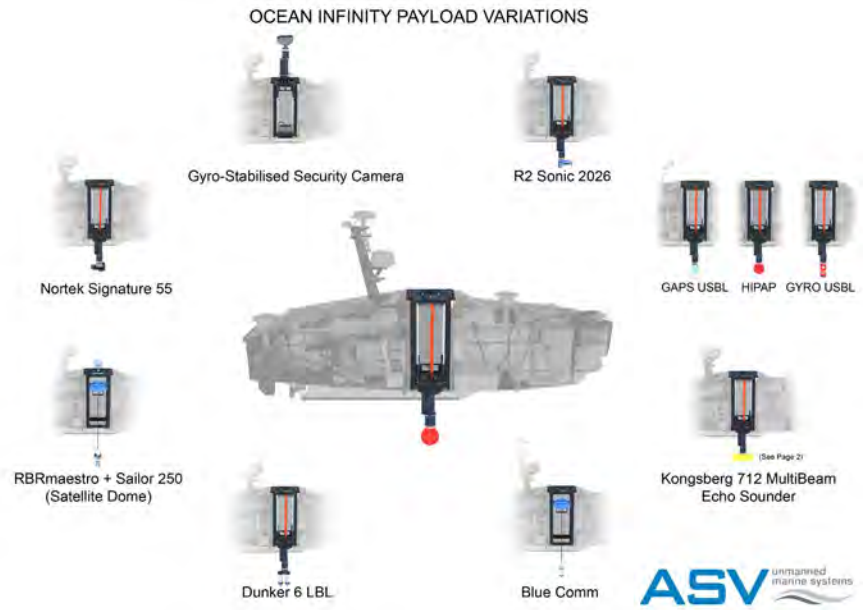
- 6 x remote surface vessels for acoustic tracking
- 150 hours endurance
- Launch recovery system from host vessel
- Sat / Radio / Wifi mesh comms
- HiPap 502 acoustic tracking of AUVs

(Ask me later about the challenges….)

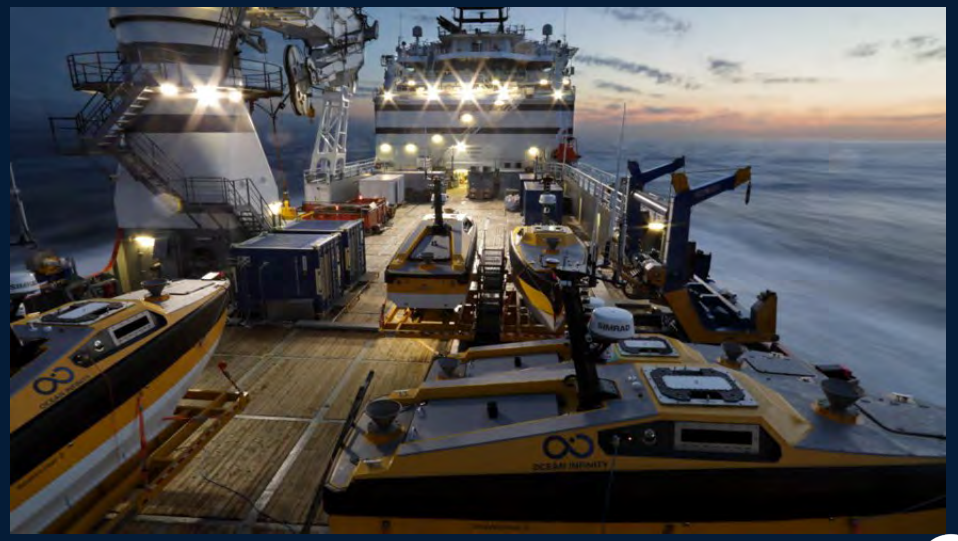
# UNMANNED SURFACE VESSEL: 8 METERS

- Endurance 150+ hours
- Persistent monitoring
- Multiple Payload Variants
  - Above and below the water line

- UUV Ops Support
- Station Keeping
- Target Following
- Independent Survey



# CONCEPT TO REALITY 2017

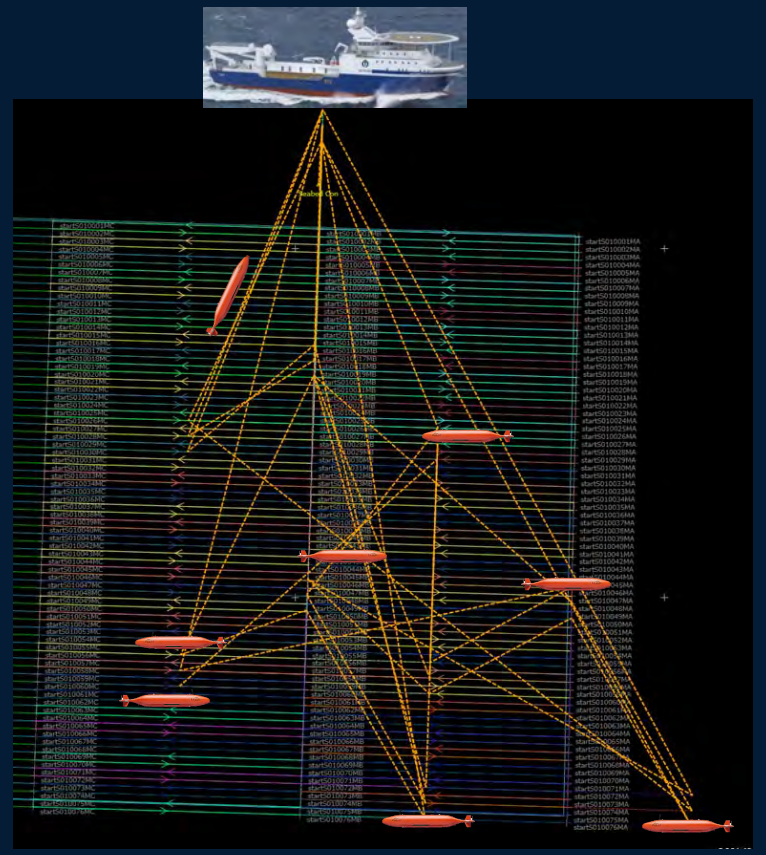


# OPERATIONAL 2018

- Deployed and operated 8 AUVs simultaneously from 1 vessel
- Covering up to 1,500km$^2$ seafloor per day in high-resolution


# MULTI AUV MISSION PLANNING

# MULTI AUV MISSION PLANNING

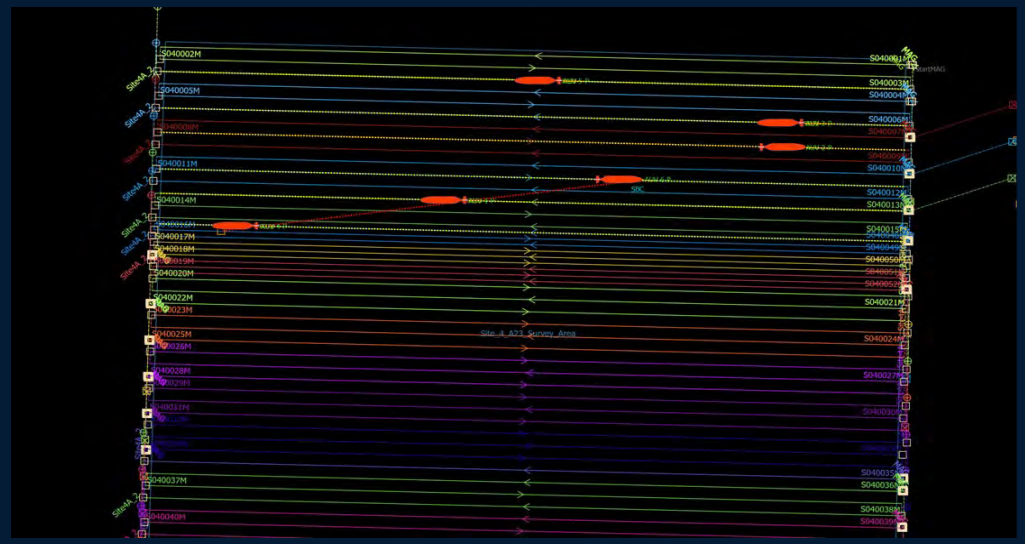


## Challenges

- Management of multiple AUV in the water
- Launch and recovery bottlenecking
- Sensor interference (crosstalk)
- Positioning accuracy (0.01% DT)

## Solutions

- Developed custom mission planning software with dynamic input “Infinity View”
- Optimizes intelligent launch staggering and line planning
- Designs sparse seabed acoustic arrays to improve positioning accuracy

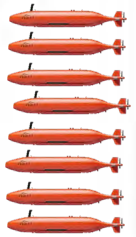


# MULTI-AUV SEARCH FOR MH370

- MH370 Missing March 2014
- Centred along BTO 7th Arc
- ATSB Search 2015-17
- Ocean Infinity search Feb 2018

**Ocean Infinity Search Area**

4.5 months of operations
1 Vessel - 8 AUVs
- ✓ 125,134km² (36,483nm²)
- ✓ Up to 1500sq Km/ Day
- ✓ Man Hours 225,000
- ✓ Fuel 2,500 tonnes
- ✓ Emissions
- ✓ 11 tonnes CO2



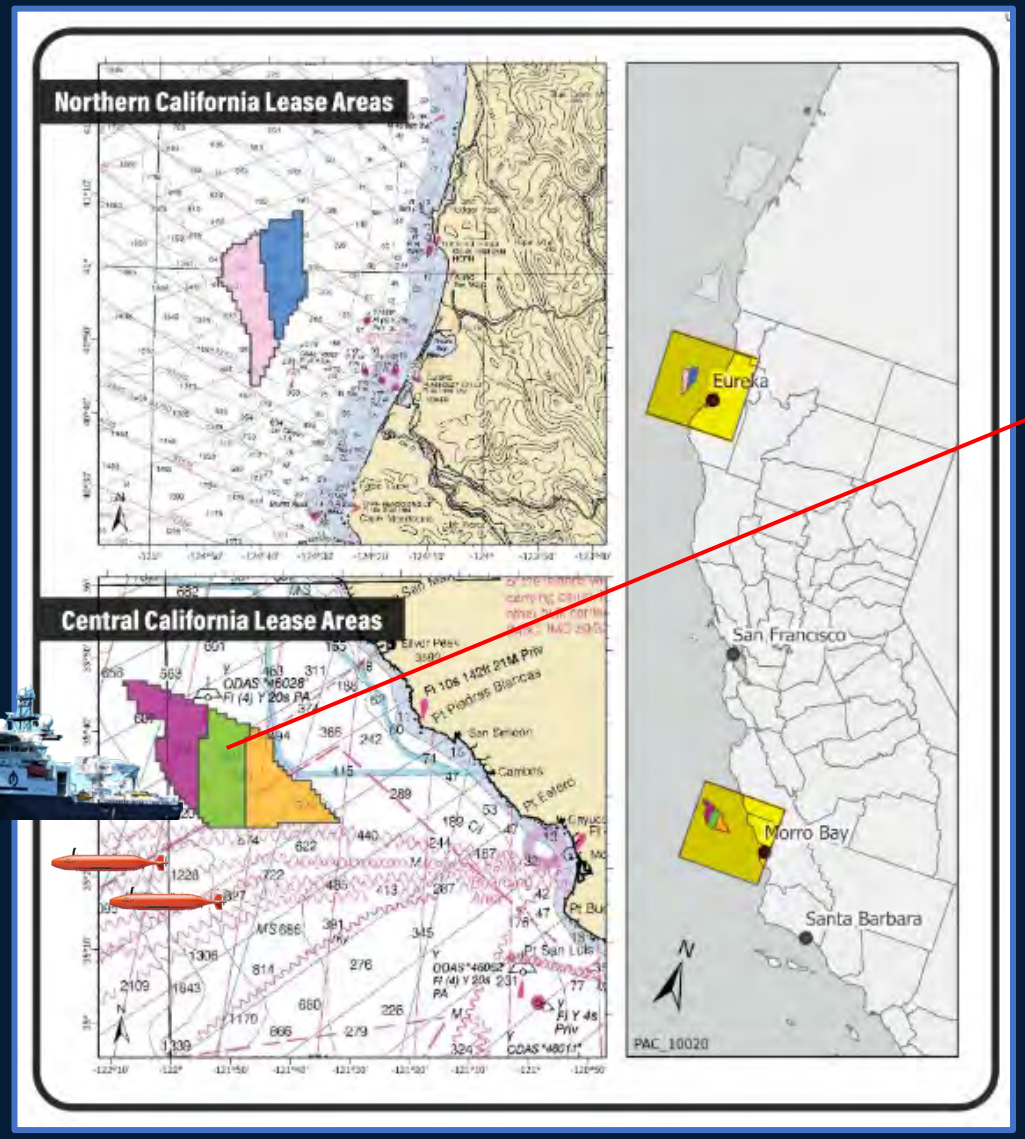
**ATSB Search Area**

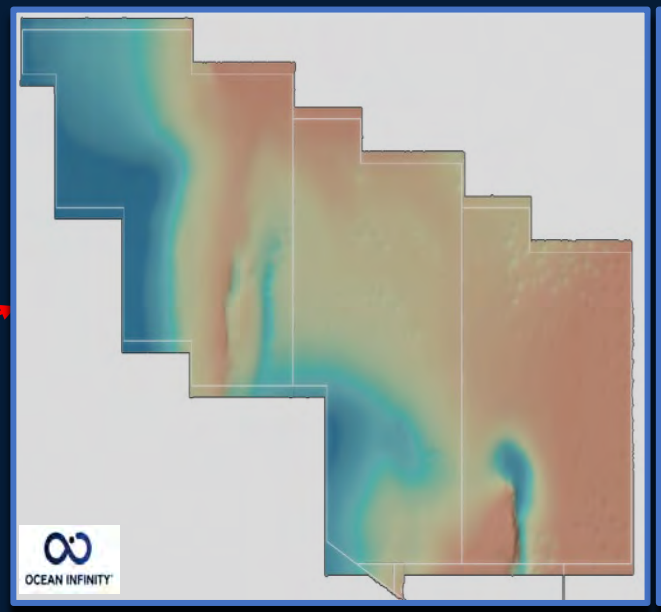
27 months of operations
3 Deep-tow Vessels and 1 AUV Vessel
- ✓ 121,502km² (35,425nm²)
- ✓ Man Hours 550,000 (Est)
- ✓ Fuel 12,250 Tonnes
- ✓ Emissions – 39 Tonnes CO2

# MULTI-AUV SEARCH FOR LOST SUBMARINE

- Nov 2017 ARA San Juan submarine went missing during a routine patrol off the coast of Argentina
- 44 service personnel lost including Argentina's first female submarine officer
- 60-day multi-AUV search 2018
- Sub found 900mwd in November 2018


# MULTI-AUV GEOPHYSICAL US WEST COAST WIND FARM SURVEY

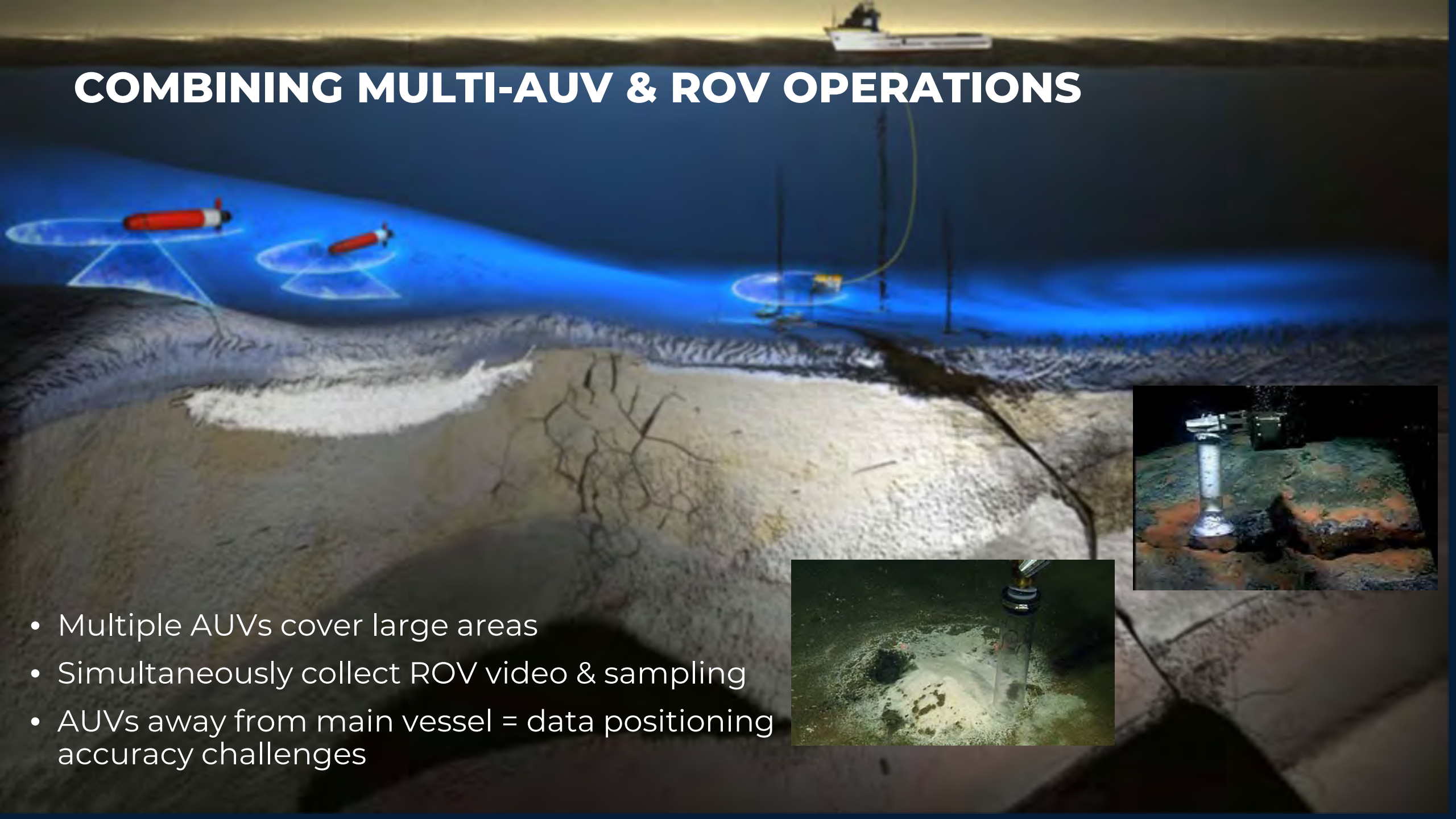




- Multi-AUV Geophysical Site Investigation (2024)
- Survey Area = 324 km$^2$
- 2 x AUVs
- Faster data delivery, less CO2 emissions

# COMBINING MULTI-AUV & ROV OPERATIONS



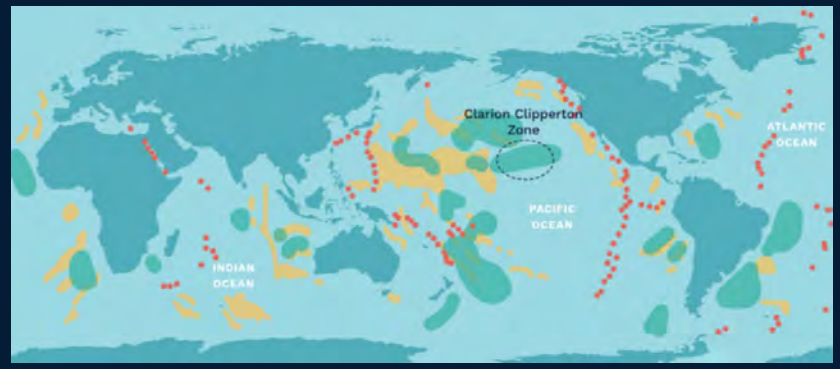


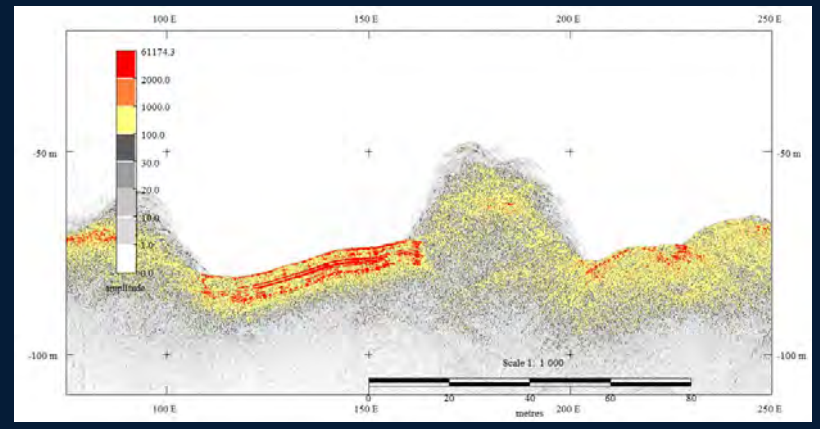


- Multiple AUVs cover large areas
- Simultaneously collect ROV video & sampling
- AUVs away from main vessel = data positioning accuracy challenges

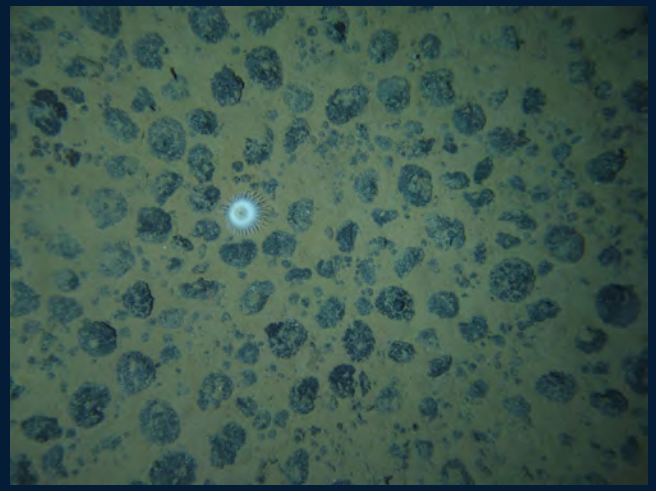
# MULTI-AUVS DEEPWATER MINERALS

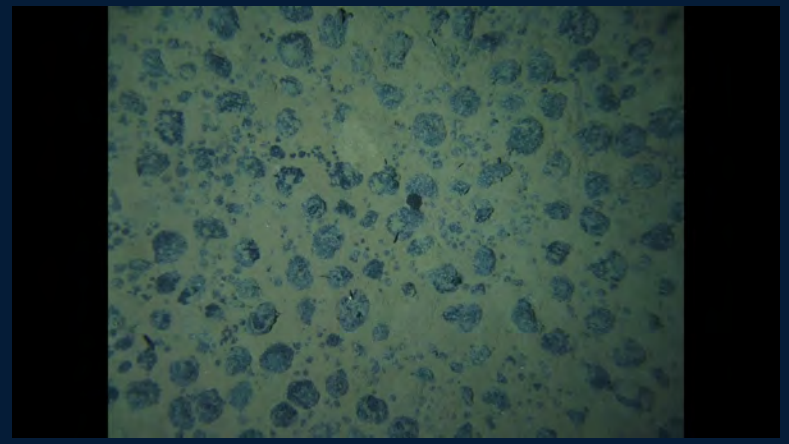
- Polymetallic Nodules: AUV + ROV + box coring + water sampling
- Resource Assessment + Document Environmental Baselines
- Massive Sulfides: AUV + SAS + magnetic sensors to delineate deposits

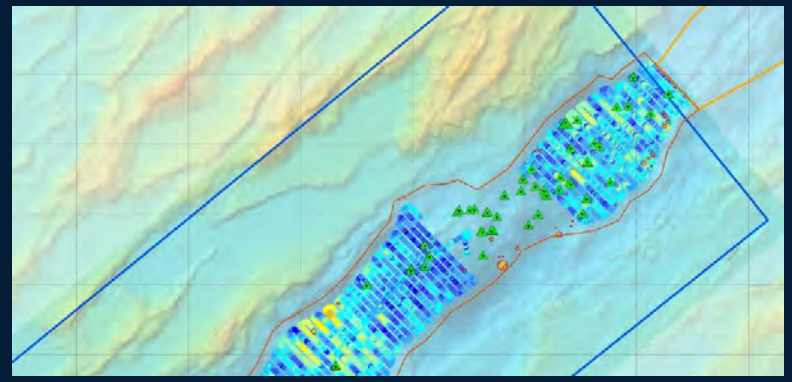



Source: Denny, A. J. Ocean Tech (2015)

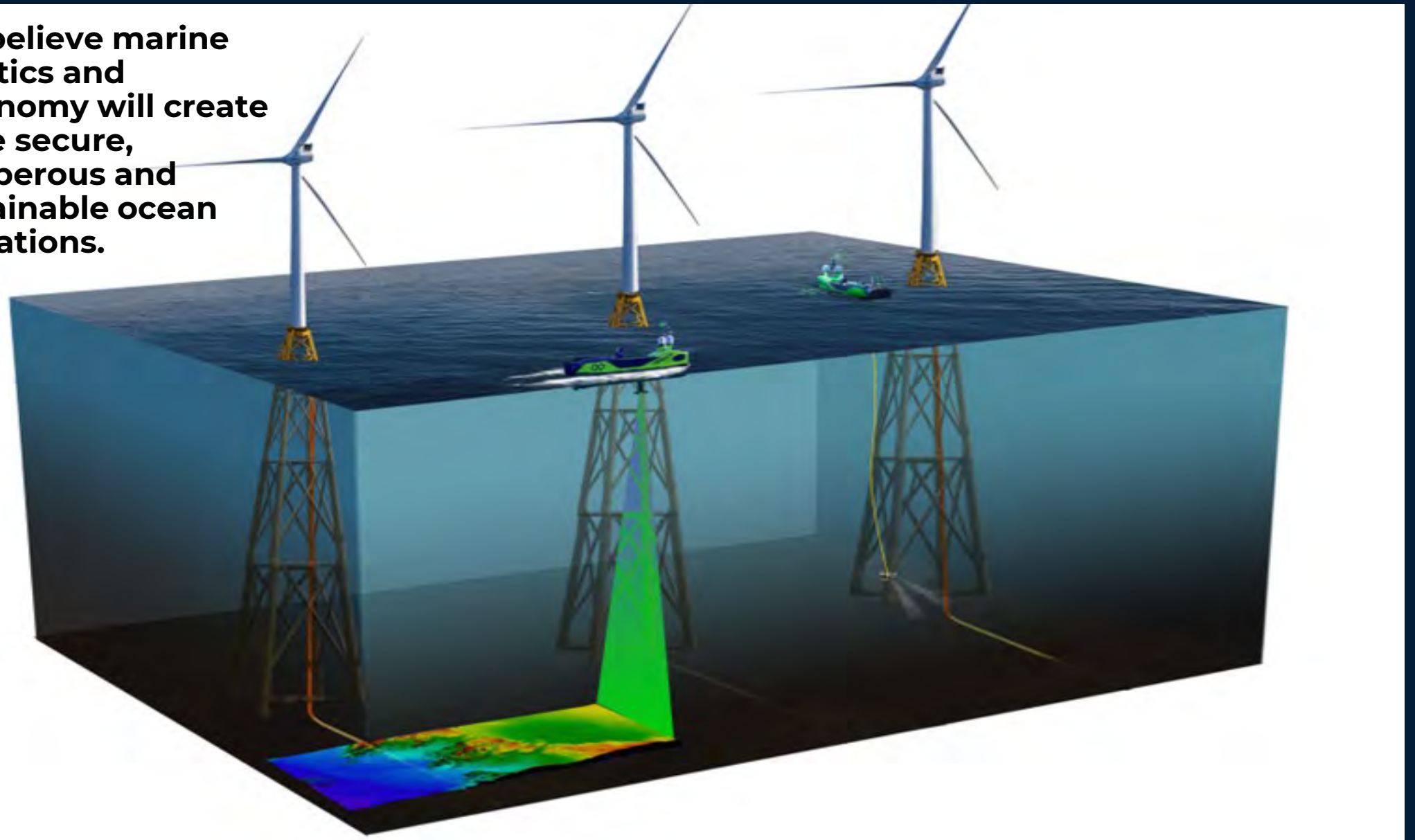




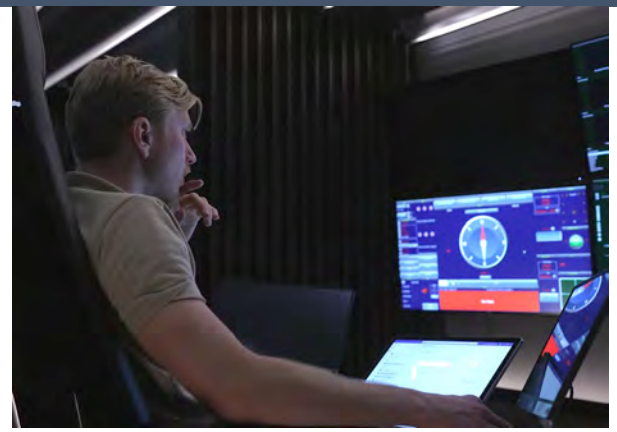


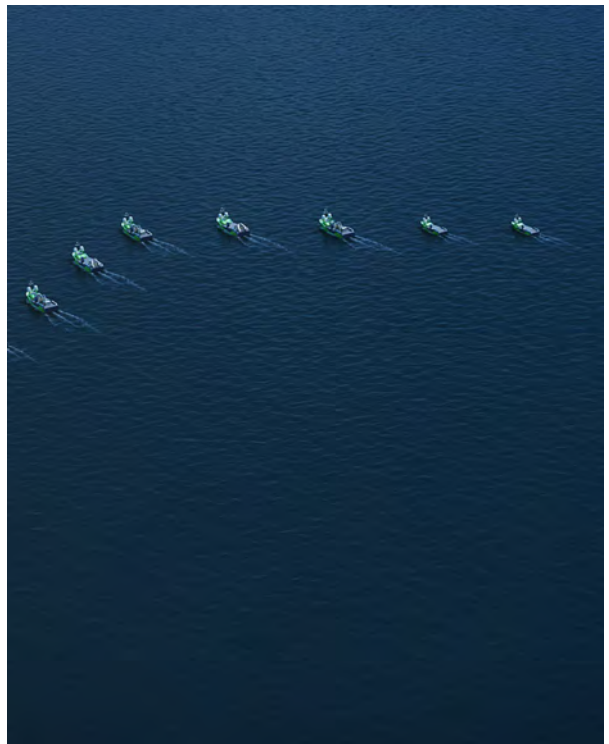
# THE FUTURE: A ROBOTIC REMOTE CONTROLLED VESSEL FLEET

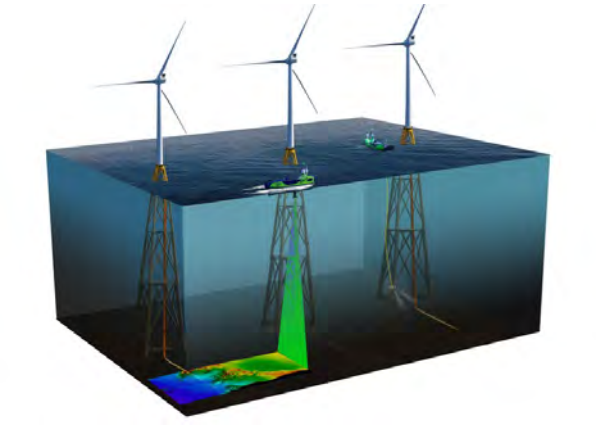
**We believe marine robotics and autonomy will create more secure, prosperous and sustainable ocean operations.**



# UNCREWED AND LEAN-CREWED VESSELS “ARMADA”



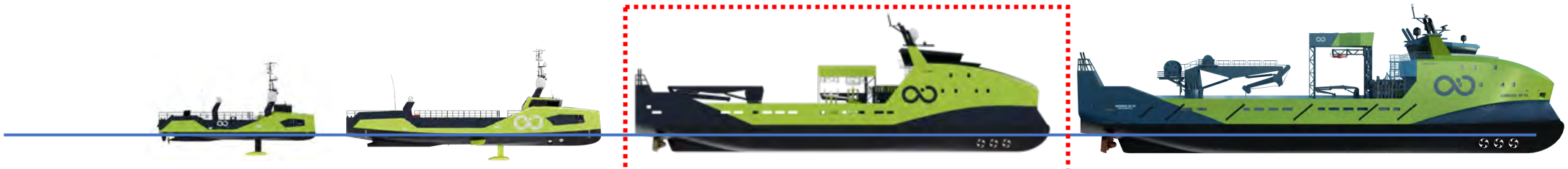


“Armada” will consist of a fleet of 23 robotic ships, comprising 21m, 36m, 78m and 85m

Why Remotely Controlled Vessels?

- Reduce Personnel Offshore
- Reduce Vessel $CO_2$ Emissions
- Automation at scale creates value:
  - less crew changes
  - next generation crew onshore control centers
  - combined expertise in control centers for multiple remote vessels

# Armada Remote Controlled Fleet



| Series Name | Armada 21 | Armada 36 | Armada 78 | Armada 86 |
|---|---|---|---|---|
| Number off | 4 | 5 | 8 | 6 |
| Length (m) | 21 | 36 | ~78 | 86 |
| Beam (m) | 6.9 | 11.4 | ~15 | 16.5 |
| Sensor Depth | 3 | 3.6 | 6m+ | 6m+ |
| Propulsion type | DP1, Diesel electric battery hybrid | DP2, Diesel electric battery hybrid | DP2, Diesel electric battery hybrid – Ammonia Fuel Cell | DP2, Diesel electric battery hybrid – Ammonia Fuel Cell |
| Endurance at cruise speed (days) | 25 | 35 | 60+ | 60+ |
| Moonpool size (m) | 2.5 x 1.5 | 8 x 3 | Two 9 x 4 | Two 9 x 4.5 |
| Regulatory regime | DNV classed hull, MCA workboat code<br>DNV unmanned | Classed IMO (Non-SOLAS, MARPOL)<br>DNV unmanned | Classed IMO (SOLAS, MARPOL) | Classed IMO (SOLAS, MARPOL) |
| Services | Survey<br>Hydrographic & Geophysical & Light ROV | Survey<br>Hydrographic, Geophysical and Light ROV<br>Inspection | Geophysical and Geotechnical<br>Inspection, Maintenance, and Repair | Geophysical and Geotechnical<br>Inspection, Maintenance, and Repair |
| Other Payloads | Towed Survey, ROVs | CPT, Towed Survey, ROVs, AUVs, Drone Inspection | CPT, Seabed Drills, Towed Survey, ROVs, AUVs, Drone Inspection | 50te, subsea crane, ROVs, AUVs, Drone Inspection |

**No Crew Delivery 2026**

**Optional Crew Delivery 2025**

**Lean-Crewed 8 in Service in 2024**

**Lean-Crewed 6 in Service in 2025**

# Hardware: Fleet

## Surface and sub-surface


Long duration, high endurance remote operations in complex, energetic sea-states from the coast to the deep.

Single and multi-asset AUV and ROV deployments, deep and shallow geotechnical and towed geophysical projects.

**25x** lean/uncrewed, robotic surface vessels

**35x** robotic and autonomous undersea vehicles

**Large – Lean Crewed Armada A78 and A86**
8 x A78 and 6 x A86 'lean-crewed' robotic vessels

**Medium – USV Armada A36**
Ultra lean or uncrewed A36

**Small – USV A8 and Drix**
Uncrewed A8 and Drix USVs

**Sub-surface**
New build eWROVs
Expanded AUV fleet

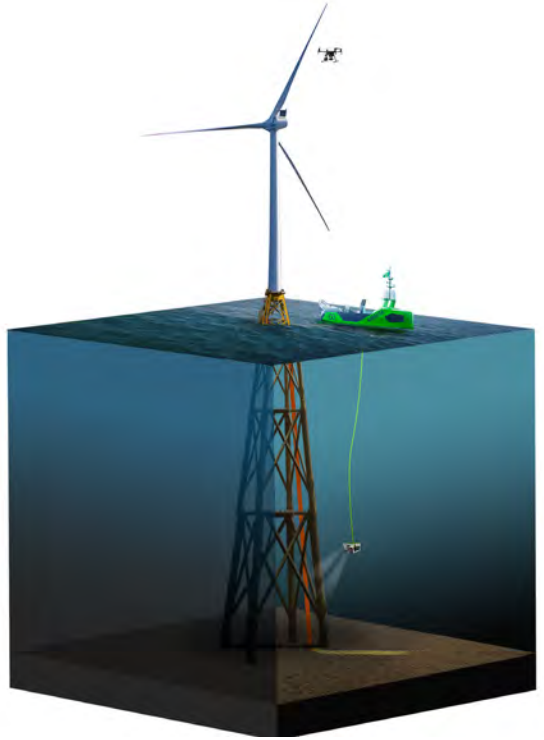
**Geotechnical**
Range of remote operated CPTs and Sonic Vibrocorers

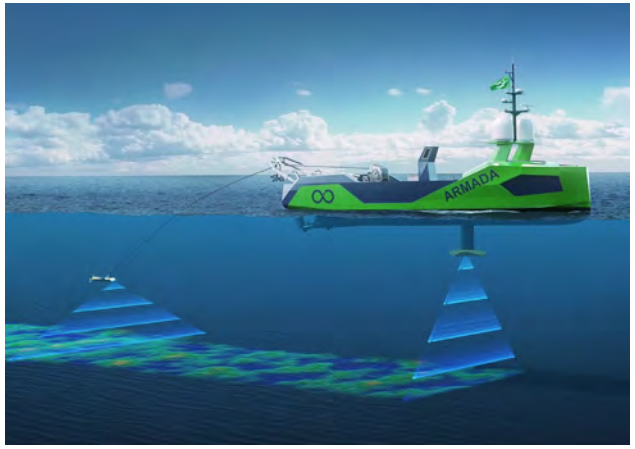
**Deep Geotechnical**
Remote Operated Seabed coring 'Ocean Drill'

**Facilities:**
Advanced geotechnical laboratory.
Global Operation Centres

**Cyber Security and IT Platform:**
Secure and responsible IT infrastructure

# ARMADA A21 AND A36 (UNCREWED)





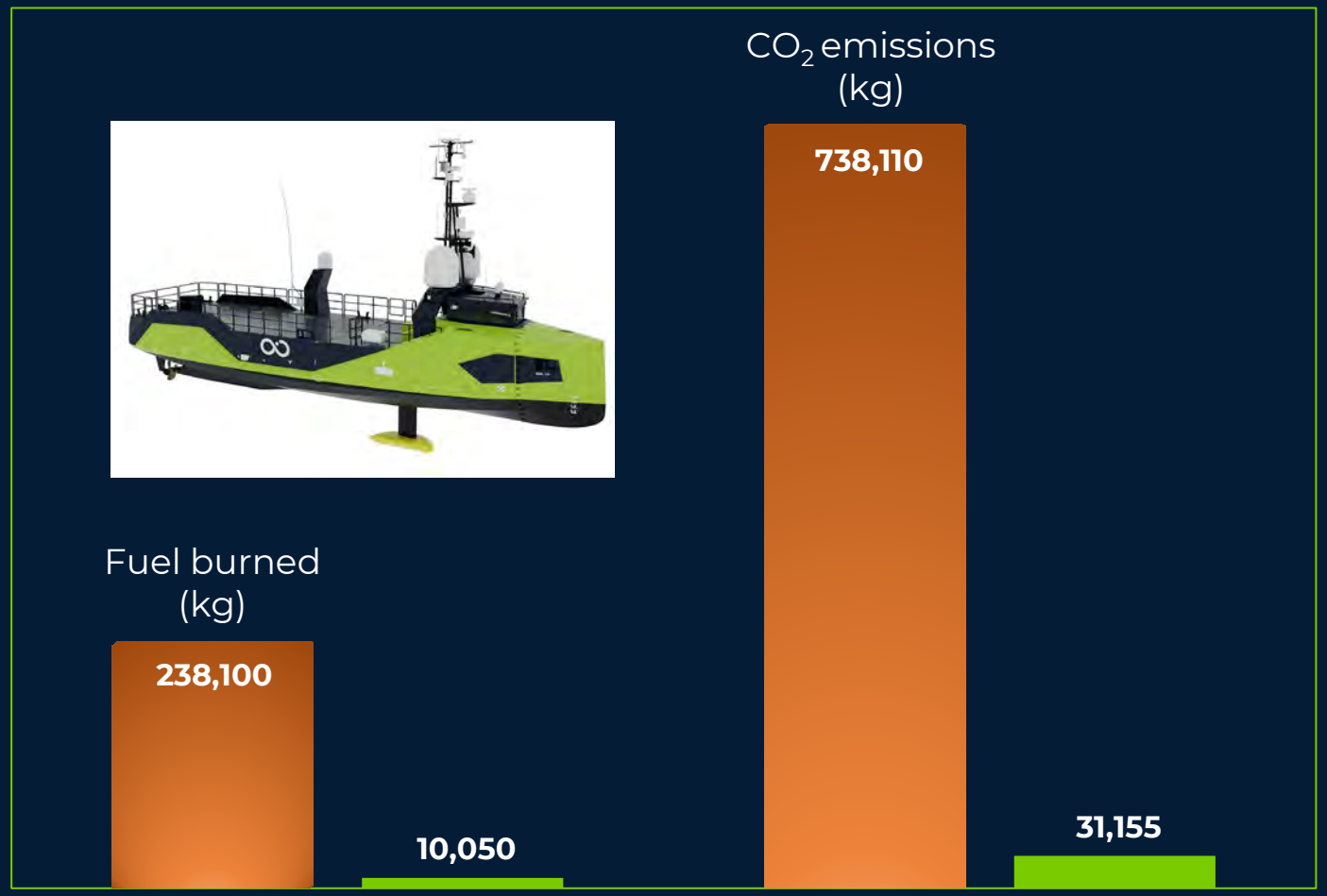

Armada A21 (21 meters): 4 vessels (2026)

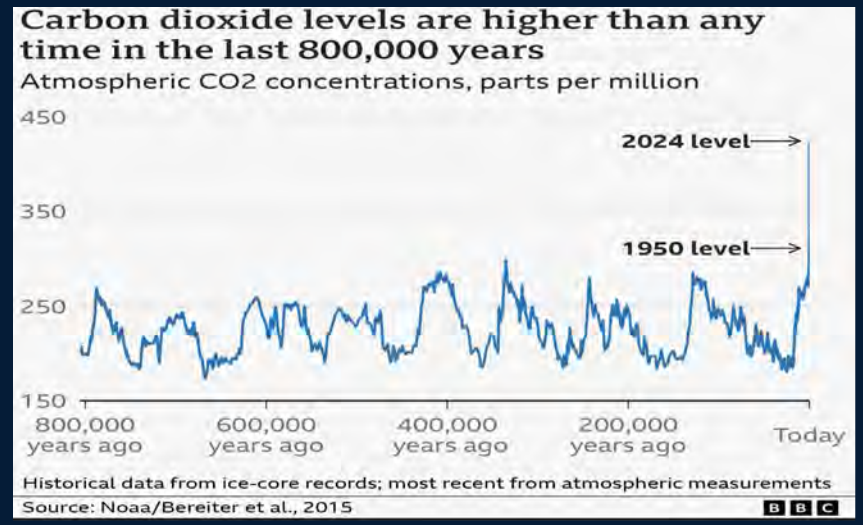
Armada A36 (36 meters): 5 vessels (2025)

- Hydrographic and Geophysical Survey
- Gondola Instrument System
- Light WROV
- Towed Sensor (stern/moonpool)
- Uncrewed, will have manual steerage for port ops

# FUEL ECONOMY REMOTE VESSELS

Typical 21-day offshore campaign



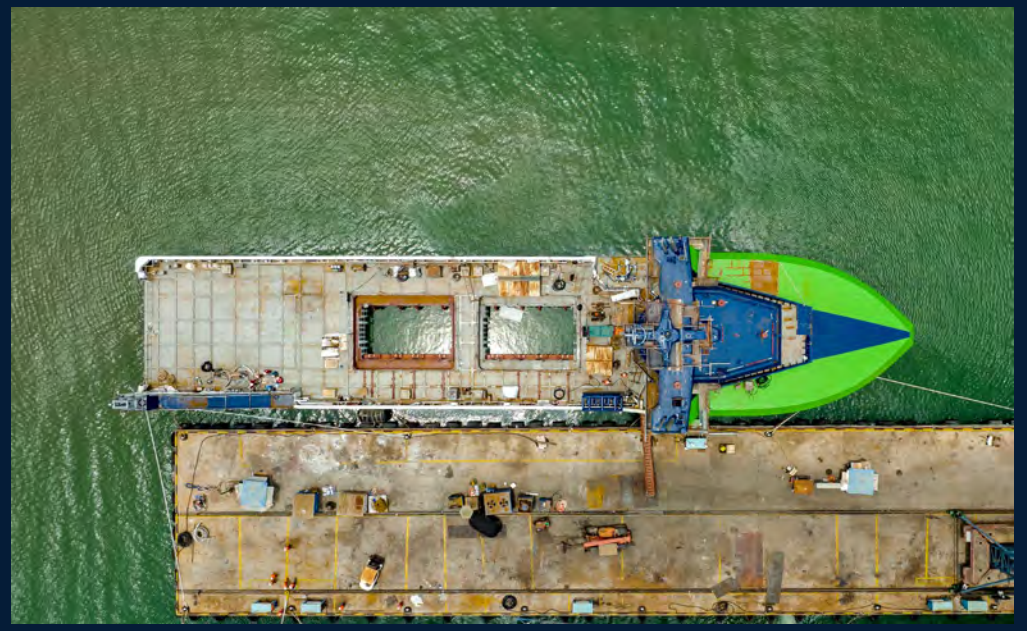




A36 vessel up to **90% reduction in $CO_2$ emissions** when compared to conventional vessels.

➔ Armada 78m and 86m will be “ammonia fuel cell” ready by 2026

# FIRST ARMADA 78M (A78) BUILT AT VIETNAM (DEC 2021)

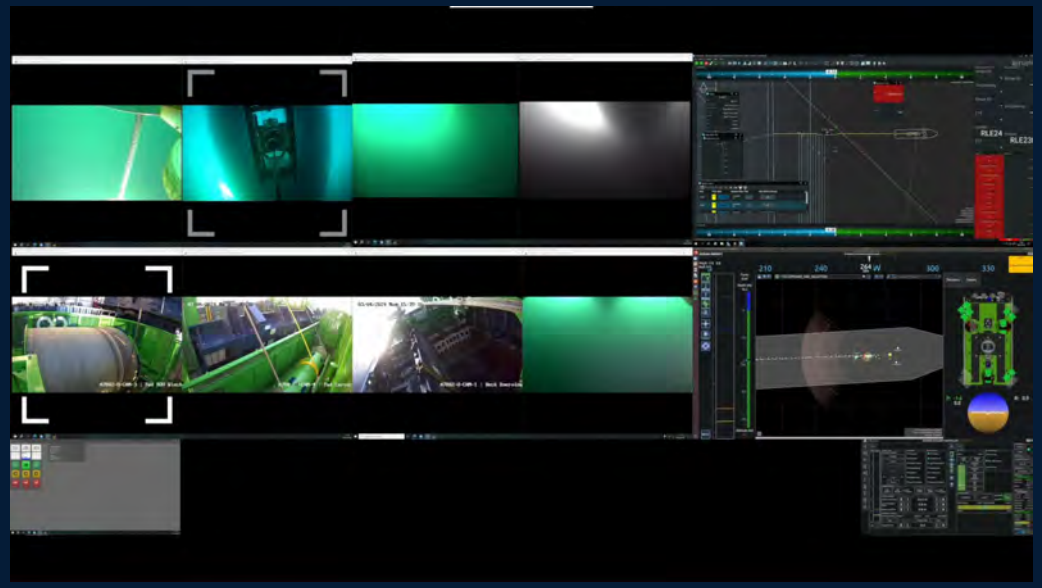
# FIRST A78 FLOATED FROM VIETNAM YARD (APRIL 2022)

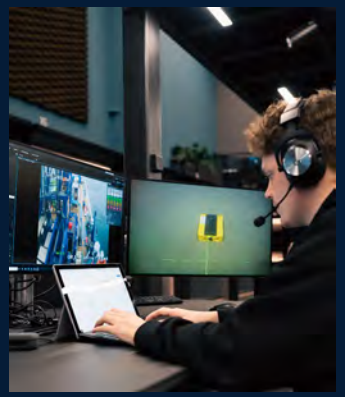


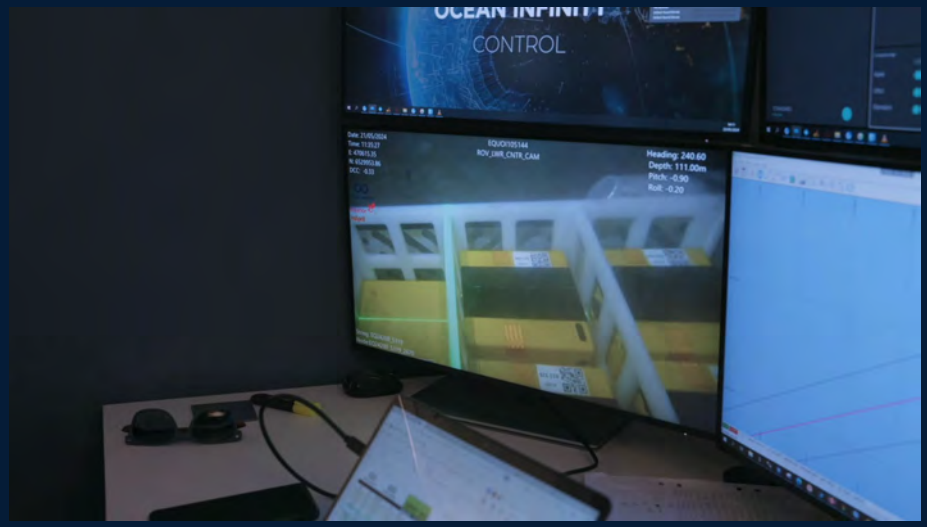
# CONSTRUCTION OF A78 FLEET (2022)


**A78 all 8 vessels delivered in 2024**

# ARMADA 78 METER – ROV CONFIGURATION (2024)

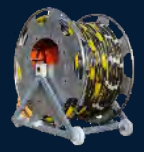







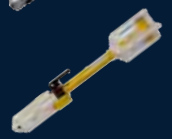
# ARMADA 78 METER - GEOPHYSICAL SURVEY CONFIGURATION (2024)

Back deck



2D/3D UHRS

SSS

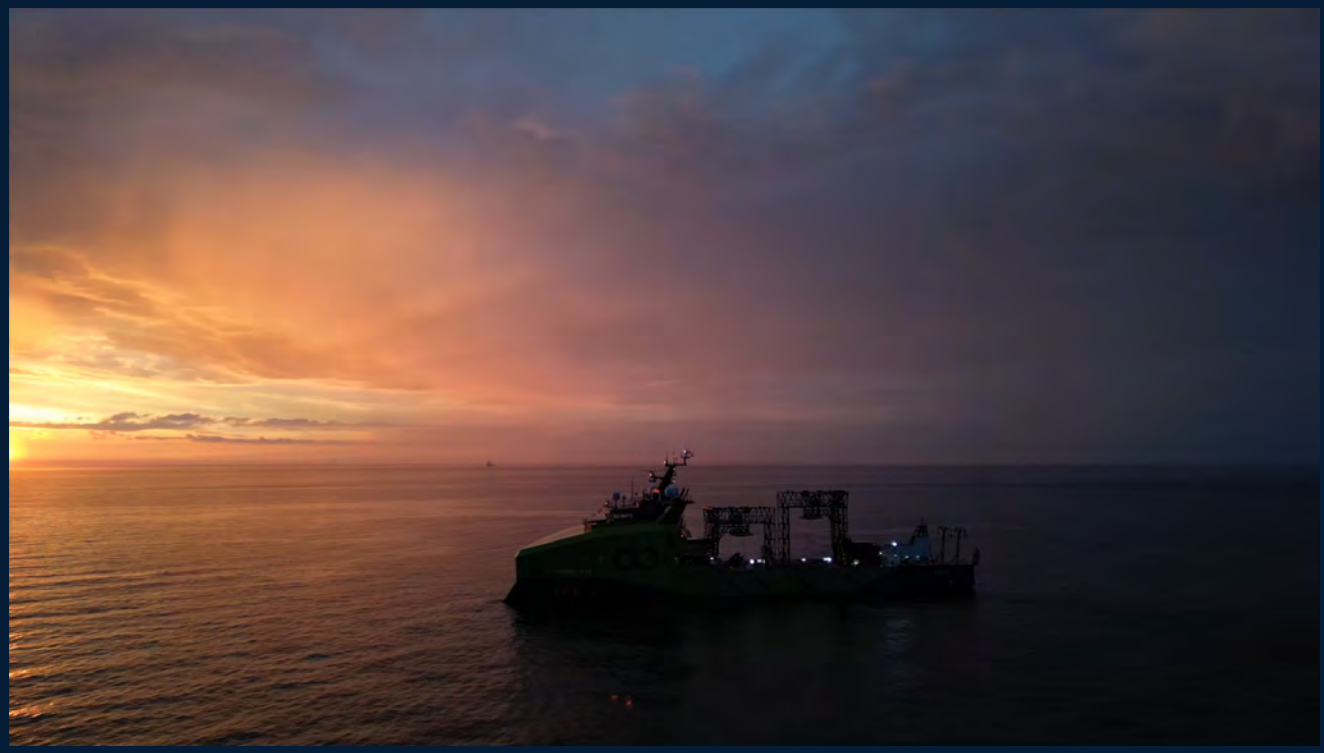


MAG

Moonpool

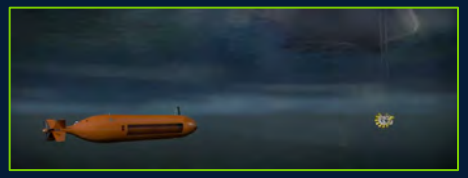
SONIC CORER

INFINITY CPT-100



AUVs

On-demand



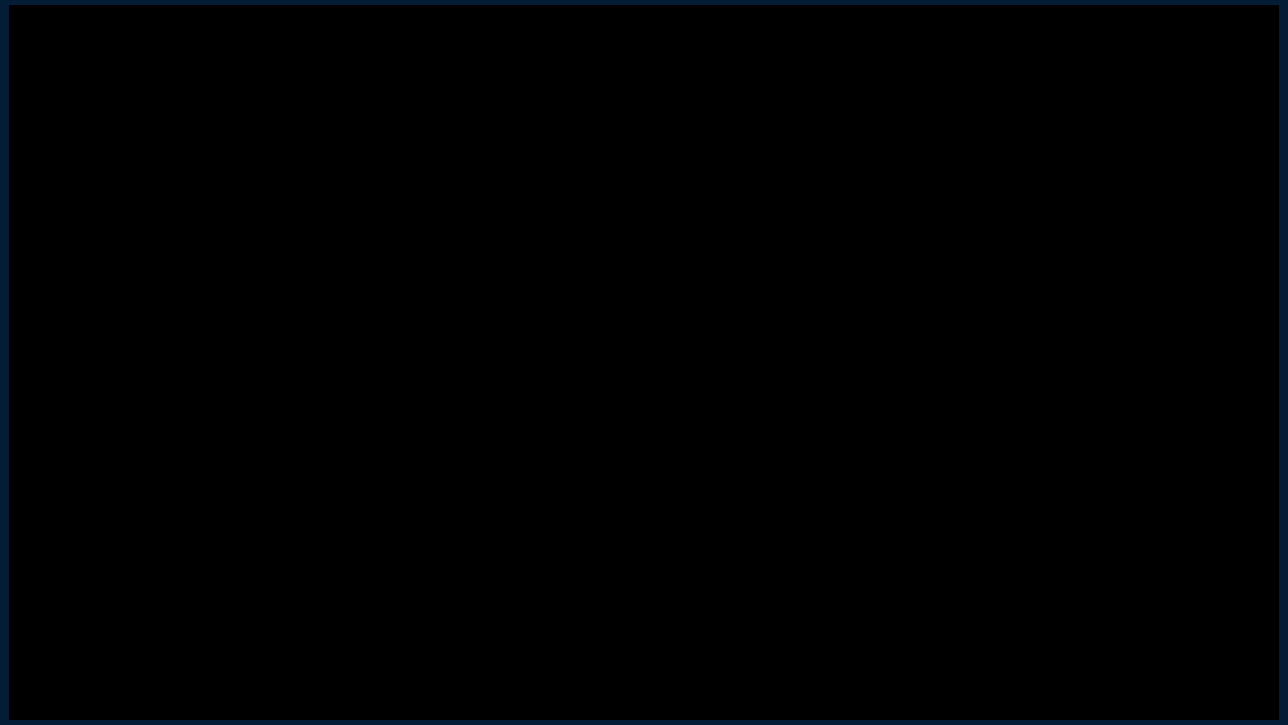
SHALLOW MBES

SBP

Gondola

# ARMADA 86 METER – GEOTECHNICAL DRILLING CONFIGURATION (2026)


- The first lean crewed geotechnical survey vessel in history
- Seabed drilling system sample to 120m below mudline
- Application in wind farm and energy field development
- Commercial use early 2026



# REMOTE VESSEL CONTROL

Our Remote Control Centers connect onshore human operators with offshore robotic platforms.

## Next Generation Marine Operations

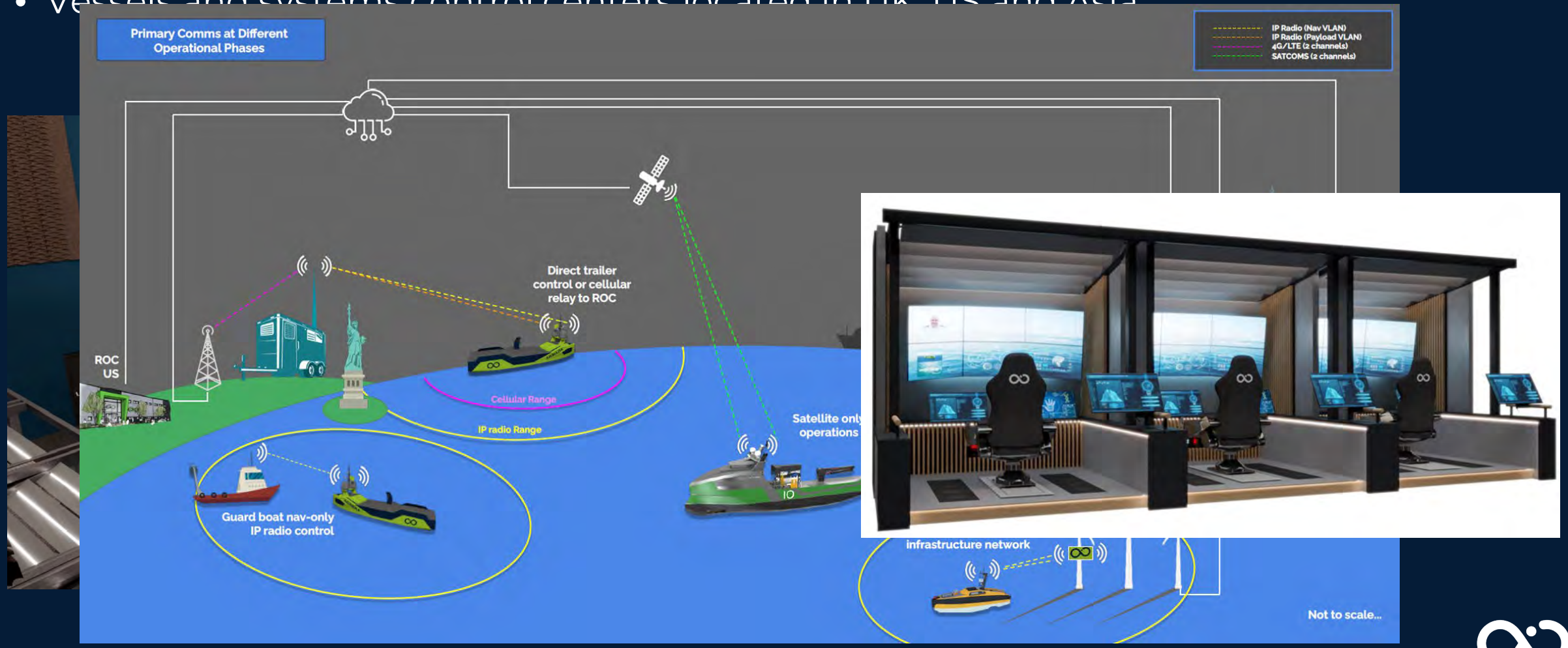
From custom operator consoles, our mariners and data acquisition specialists will safely and efficiently harvest vast quantities of ocean data.

## Safe Navigation

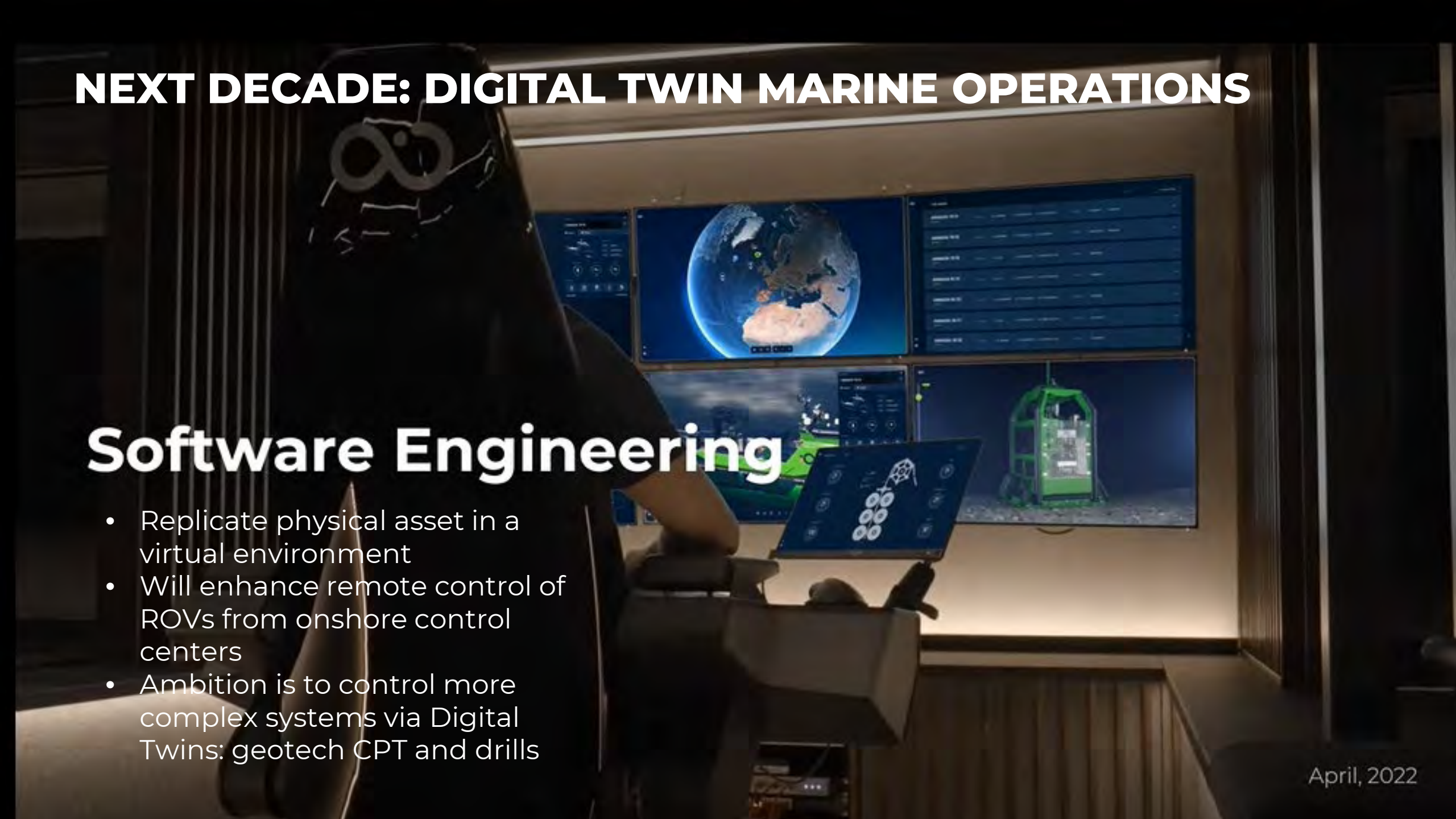
Our Remote Control Centre will comply with maritime regulations and safety rules. They will set the standard for a new way of working in marine operations.

# REMOTE VESSEL CONTROL

- Communications and security critical for uncrewed and lean crewed vessels
- Vessels and systems control centers located in UK, US and Asia



# NEXT DECADE: DIGITAL TWIN MARINE OPERATIONS

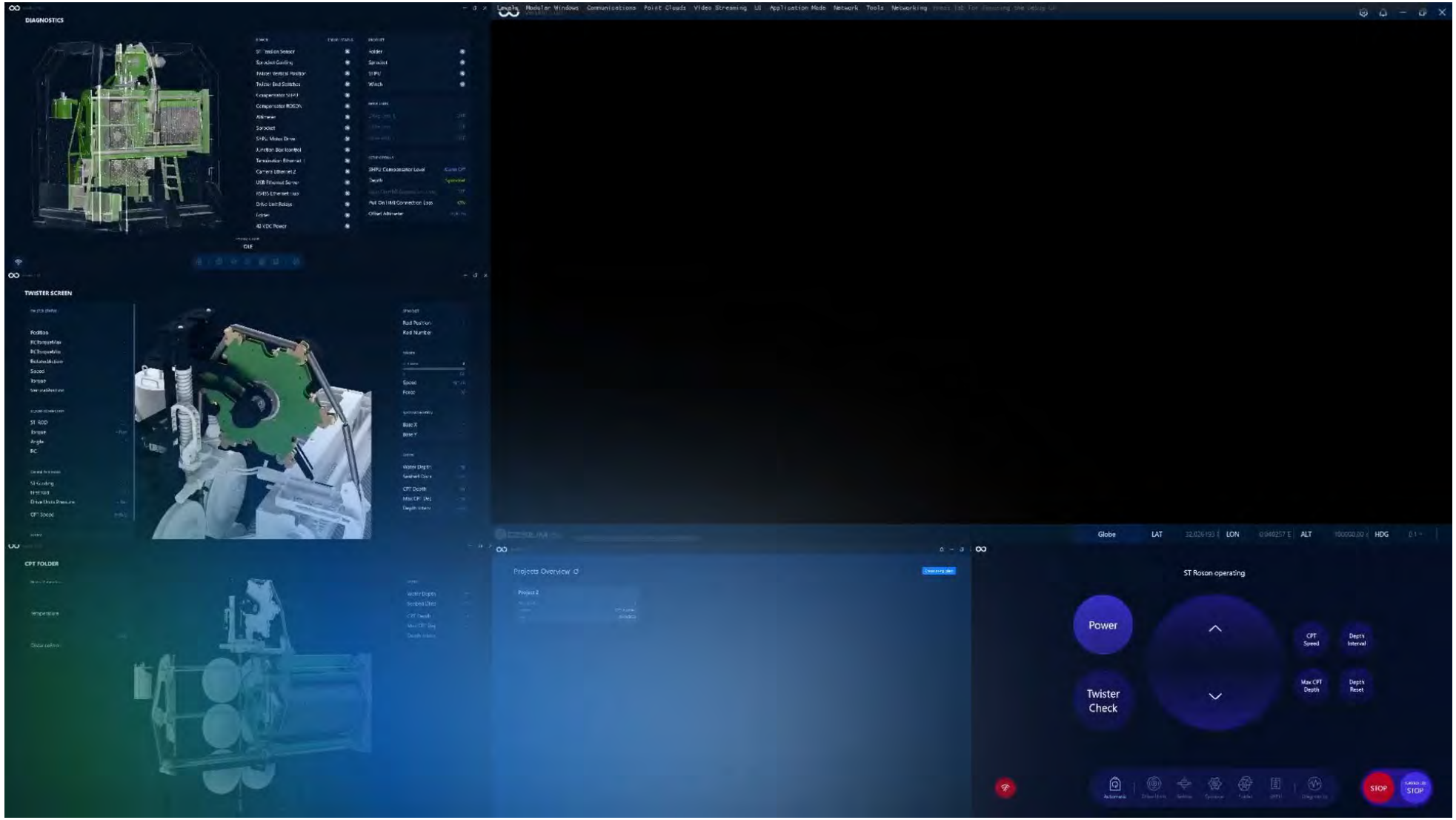


## Software Engineering

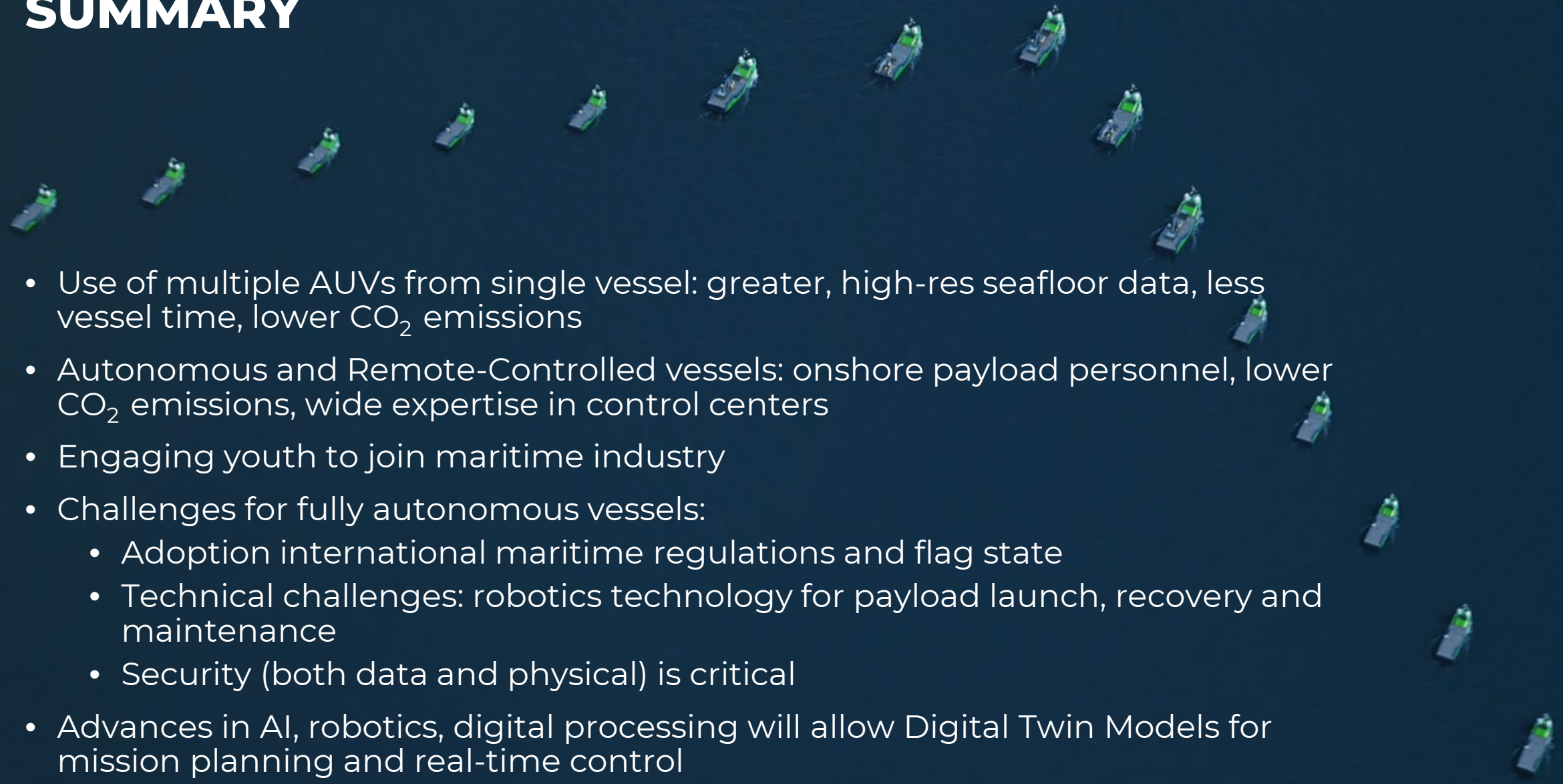
- Replicate physical asset in a virtual environment
- Will enhance remote control of ROVs from onshore control centers
- Ambition is to control more complex systems via Digital Twins: geotech CPT and drills

April, 2022

# Coupling physical and digital operations.



# SUMMARY



- Use of multiple AUVs from single vessel: greater, high-res seafloor data, less vessel time, lower $CO_2$ emissions
- Autonomous and Remote-Controlled vessels: onshore payload personnel, lower $CO_2$ emissions, wide expertise in control centers
- Engaging youth to join maritime industry
- Challenges for fully autonomous vessels:
  - Adoption international maritime regulations and flag state
  - Technical challenges: robotics technology for payload launch, recovery and maintenance
  - Security (both data and physical) is critical
- Advances in AI, robotics, digital processing will allow Digital Twin Models for mission planning and real-time control
- Full autonomy of large offshore vessels is within sight!

**Thank You!**

**Questions?**