

# FRA D-BLOKKA TIL VIRKELIGHETEN

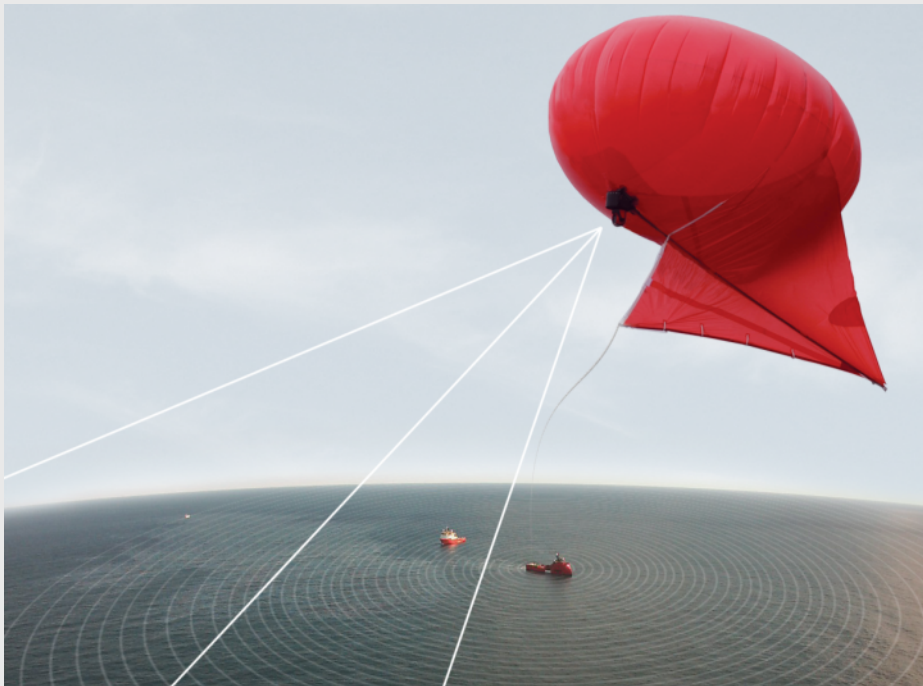
**VEGARD EVJEN HOVSTEIN**  
**MSC KYBERNETIKK 2000**  
**NAVIGASJON OG FARTØYSTYRING**



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# UNMANNED SYSTEMS FOR MARITIME OPERATIONS



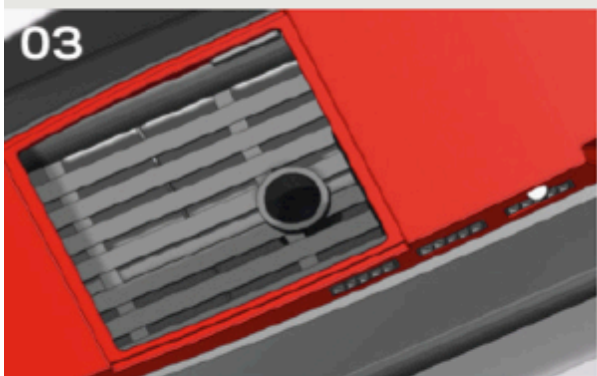
# MARINER UNMANNED SURFACE VEHICLE



# MARINER components



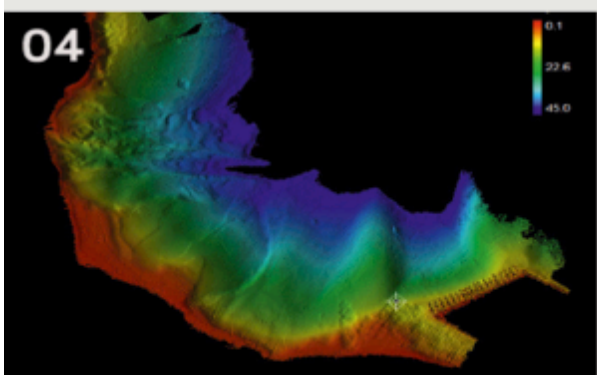
Mariner USV



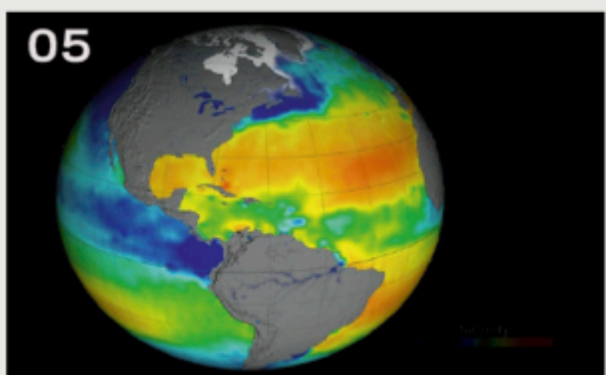
Moonpool



Vehicle Control Station



Bathymetry



Oceanography



Hydroacoustic positioning


# OCEANEYE®


## MOORED BALLON SYSTEM



# OceanEye® components



 **Weight:** 425 kg / 936 lbs (with all system components packed)

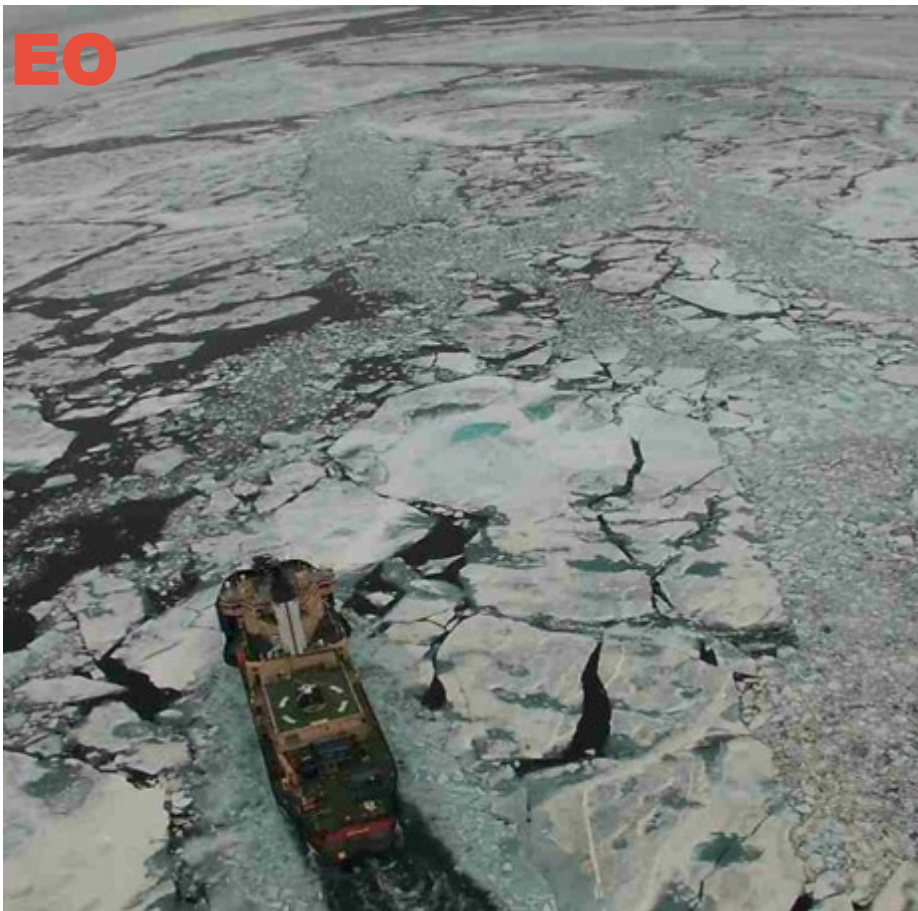
 **Length x Wide x Height:** 1.20 x 0.80 x 1.59 m / 47.3 x 31.5 x 62.6 inches

# PENGUIN MR

## UNMANNED AIRCRAFT SYSTEM



**EO**



**IR**



- Day-light camera (EO)

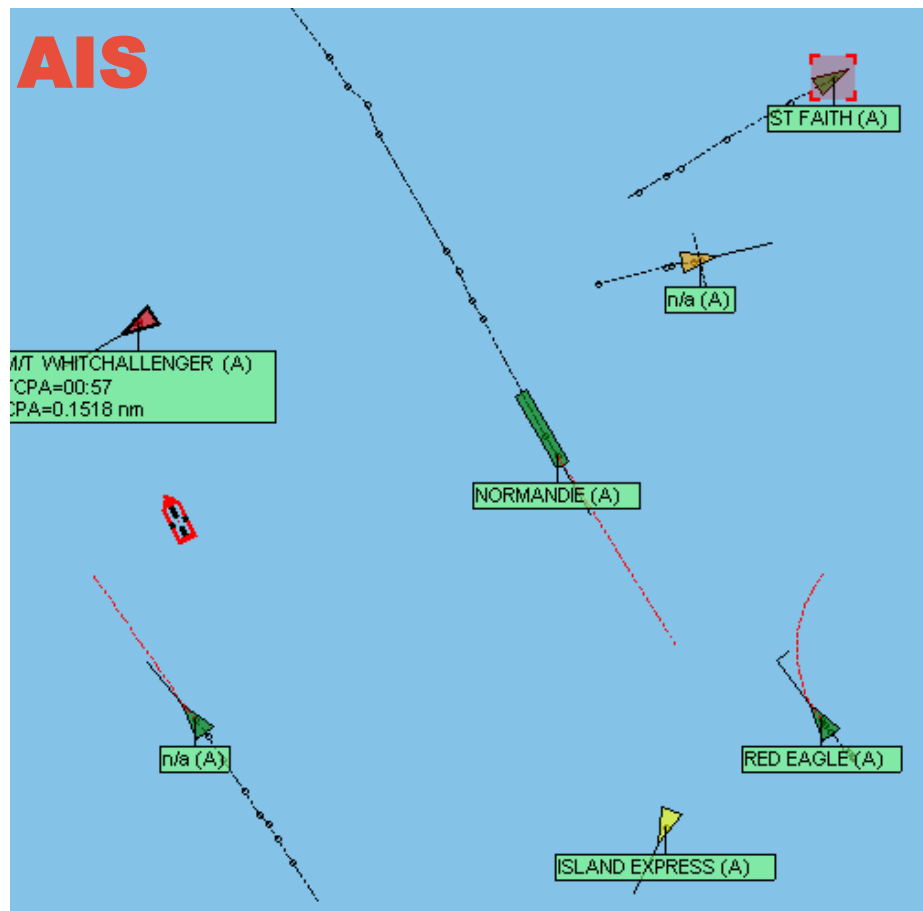
- Captures still images or video
- Intuitive and easy understandable information
- Limited by weather and darkness

- Infrared (IR)

- "Sees" the infrared spectrum day and night
- May give add-on info to EO (heat, thickness etc)
- Affected by dense fog and rain etc



# AIS



# SAR

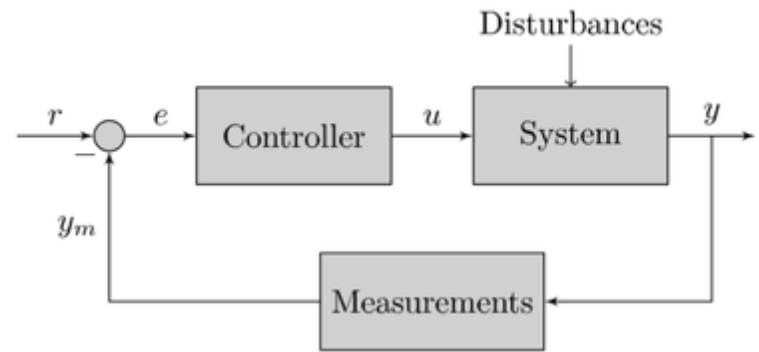
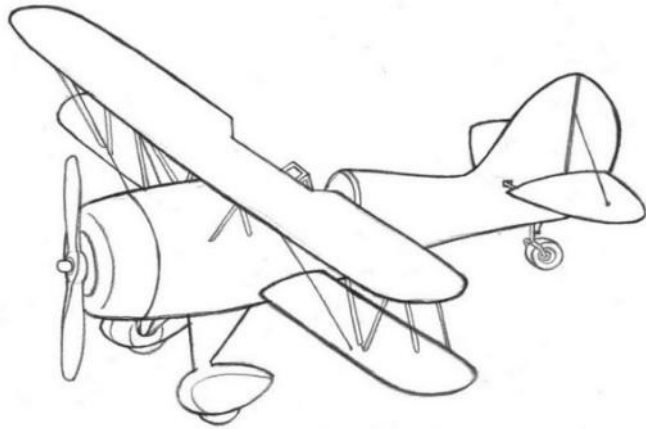


- Automatic Identification System (AIS)
  - “Sees” ships equipped with mandatory AIS
  - Intuitive and easy understandable information
  - Limited by VHF range (but better than ship)

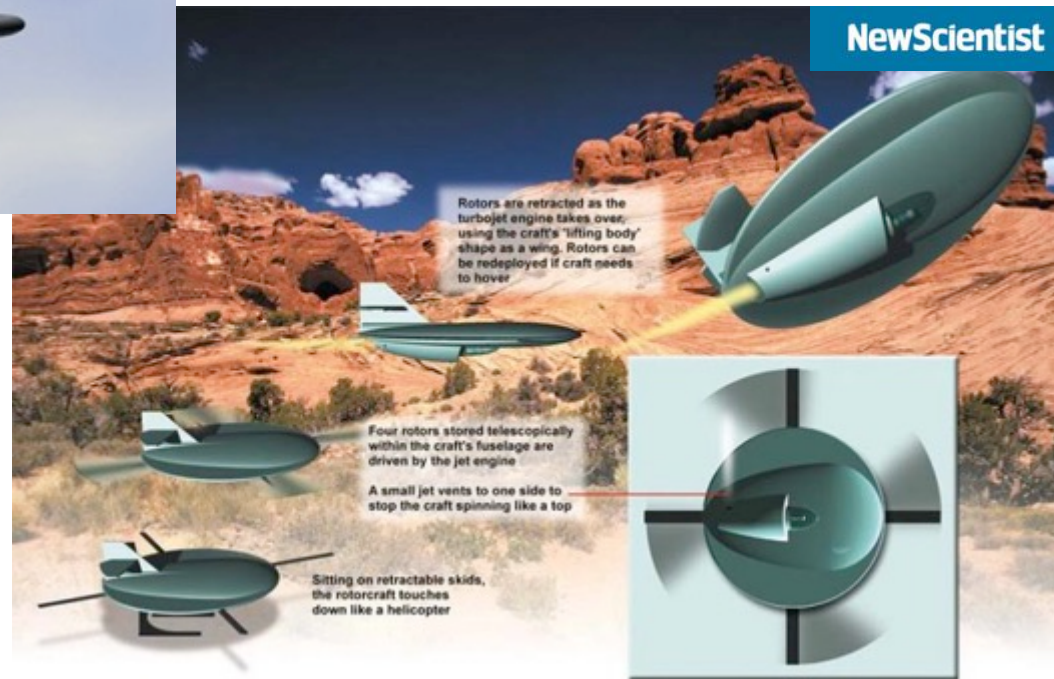
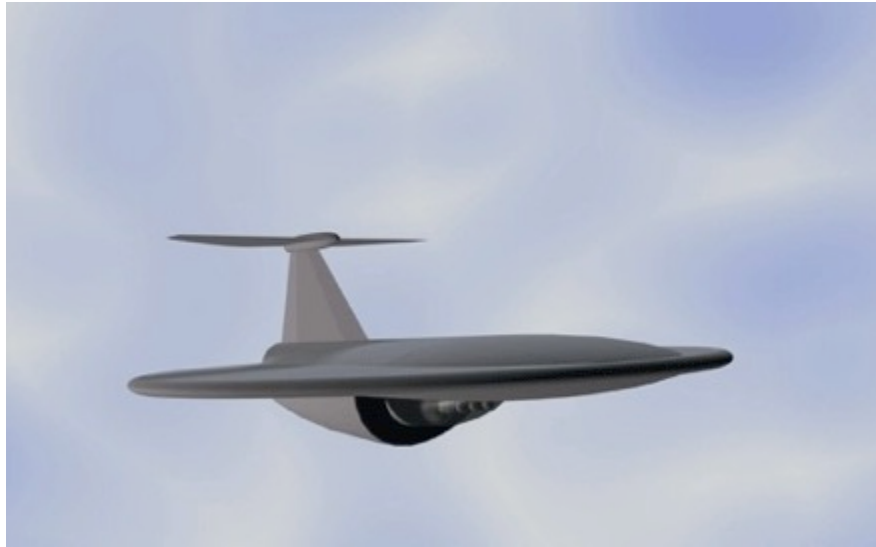
- Synthetic Aparature Radar (SAR)
  - “Sees” through fog and darkness
  - Less intuitive information
  - Small SAR (5-10kg) are coming



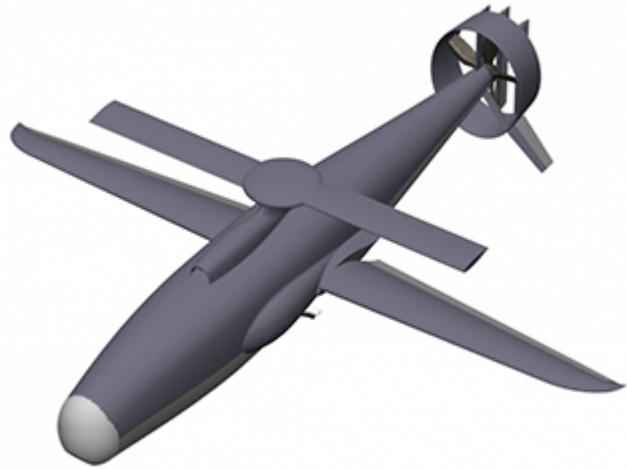


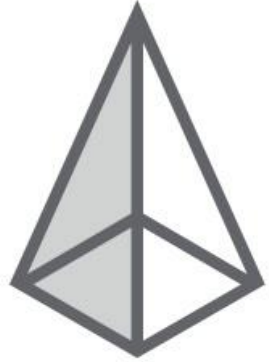


# “DISC-SHAPED SPYPLANE COULD HUNT FOR TERRORISTS”



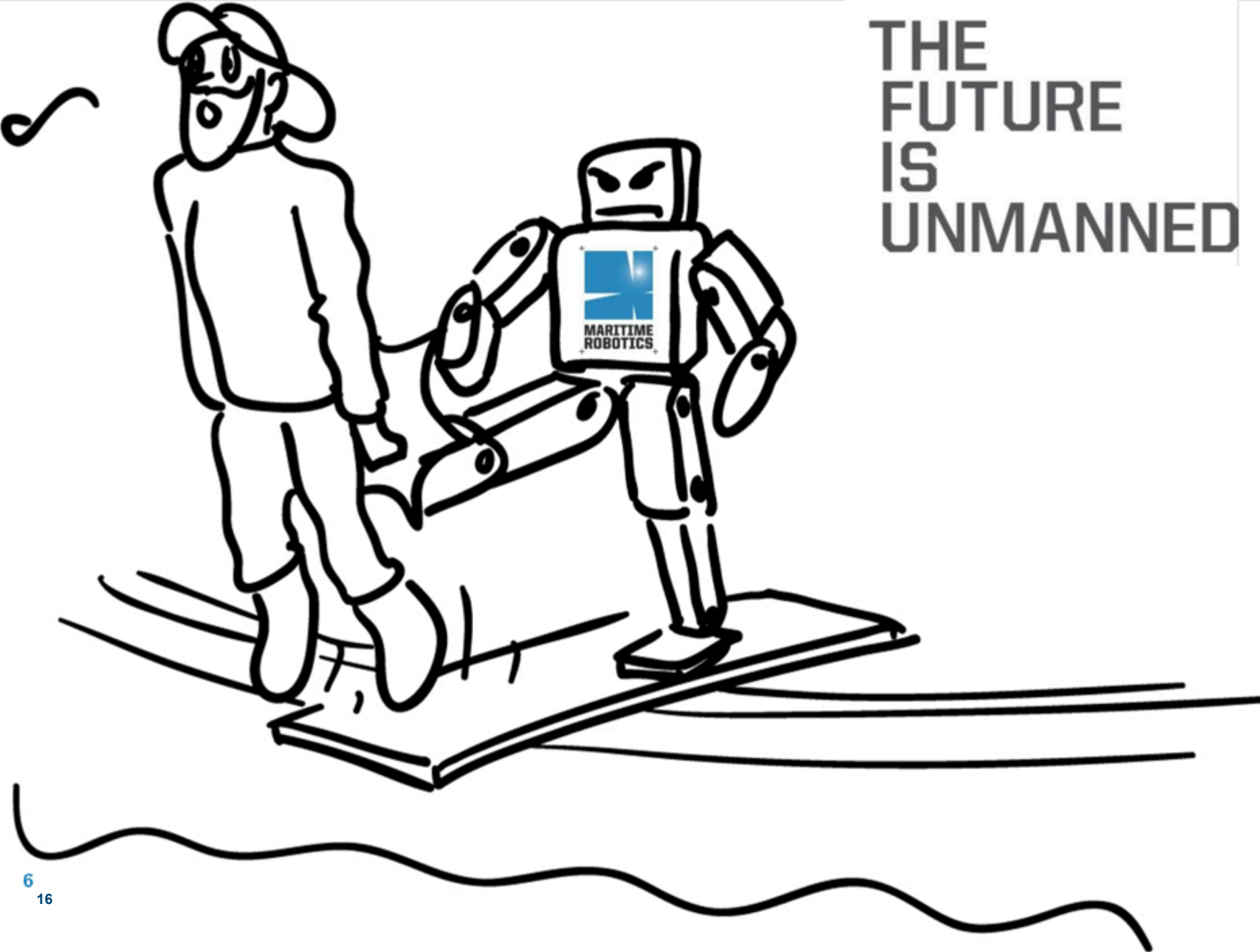
# 2004





**MARITIME  
ROBOTICS**

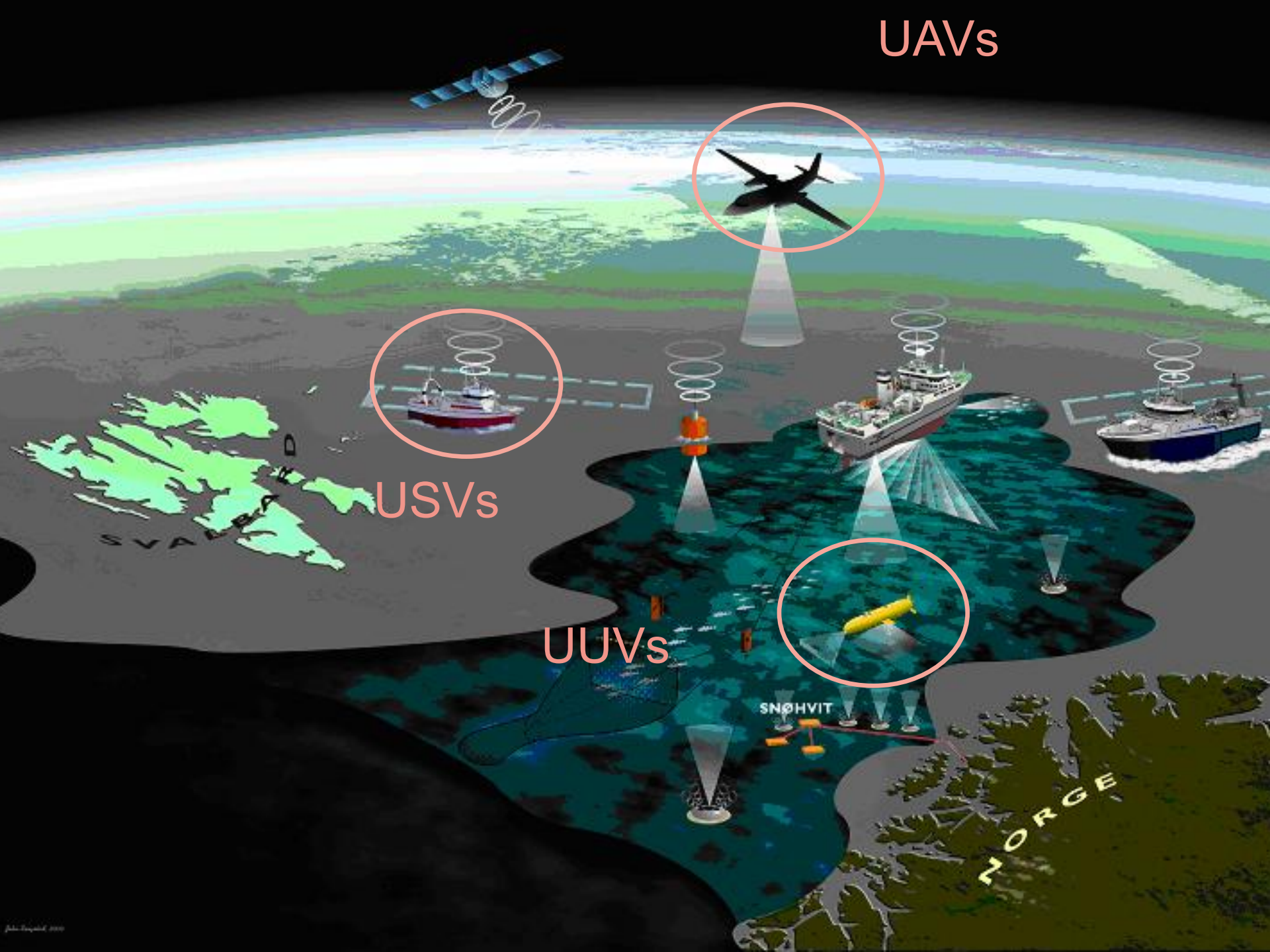
# THE FUTURE IS UNMANNED







UAVs



USVs



UUVs

SNØHVIT

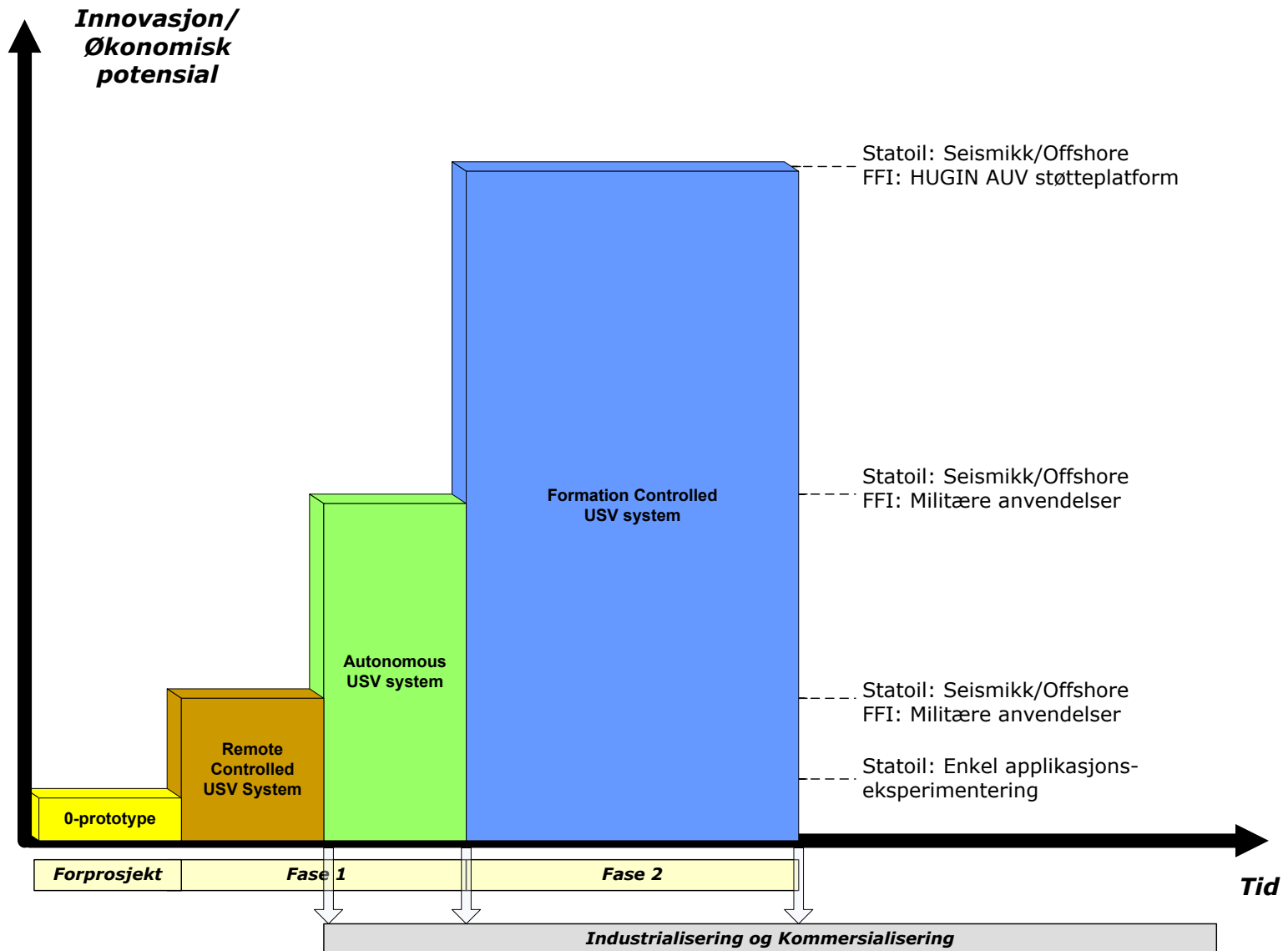
NORGE

Vanvikan/Leksvik

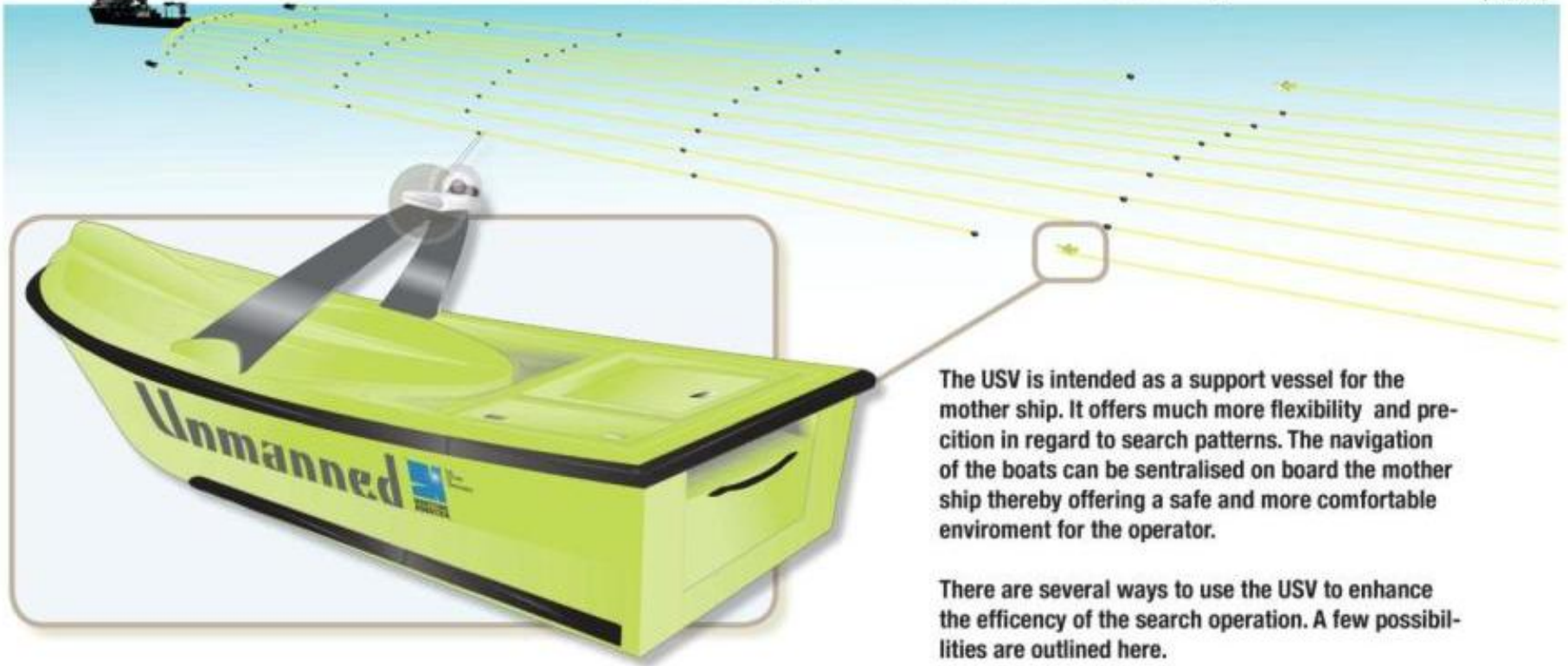


Trondheim

# HIGH VISIONS

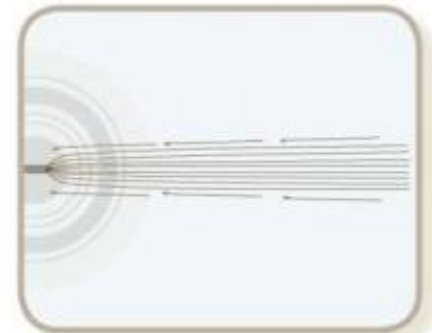
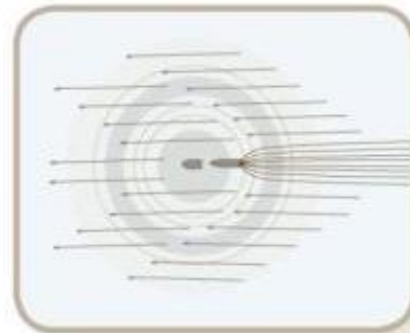


# USV supported seismic survey



The USV is intended as a support vessel for the mother ship. It offers much more flexibility and precision in regard to search patterns. The navigation of the boats can be centralised on board the mother ship thereby offering a safe and more comfortable environment for the operator.

There are several ways to use the USV to enhance the efficiency of the search operation. A few possibilities are outlined here.





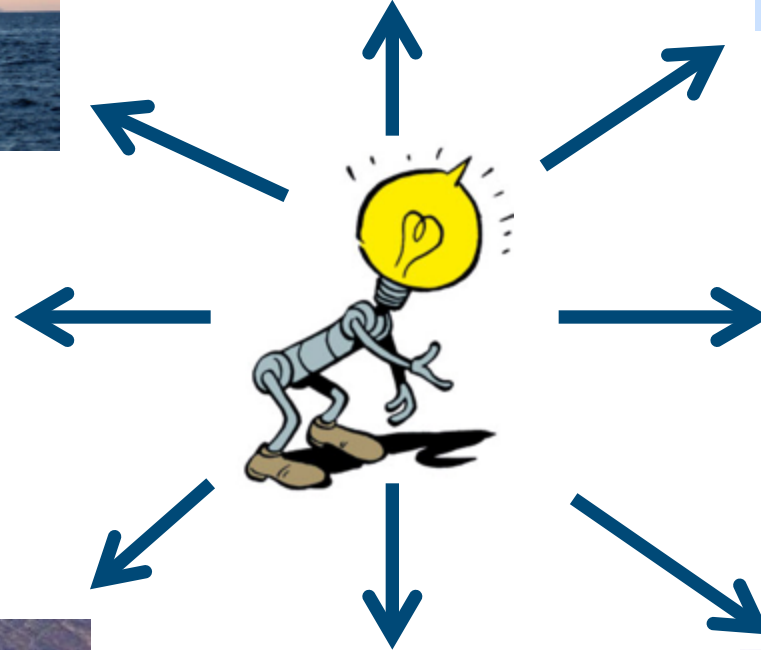
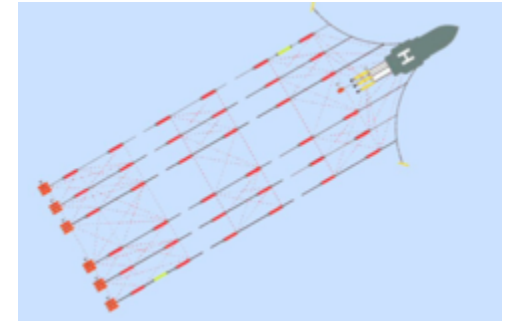


MPK

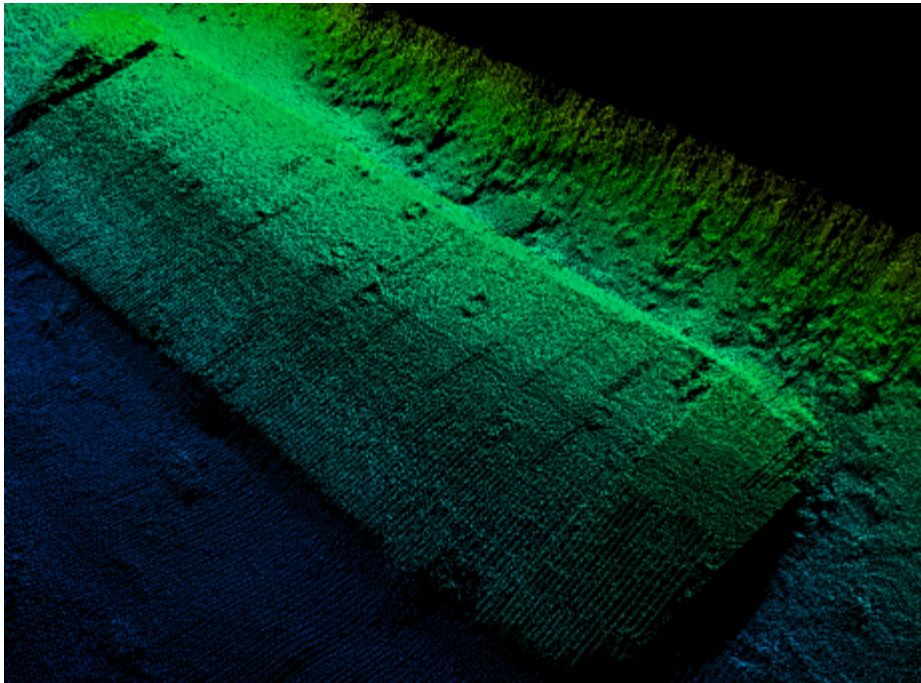
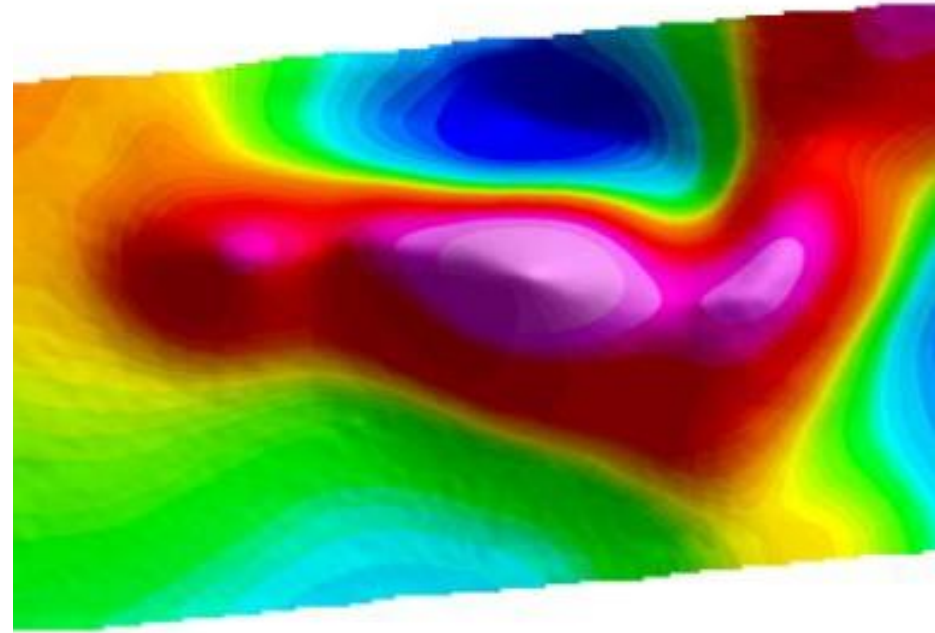




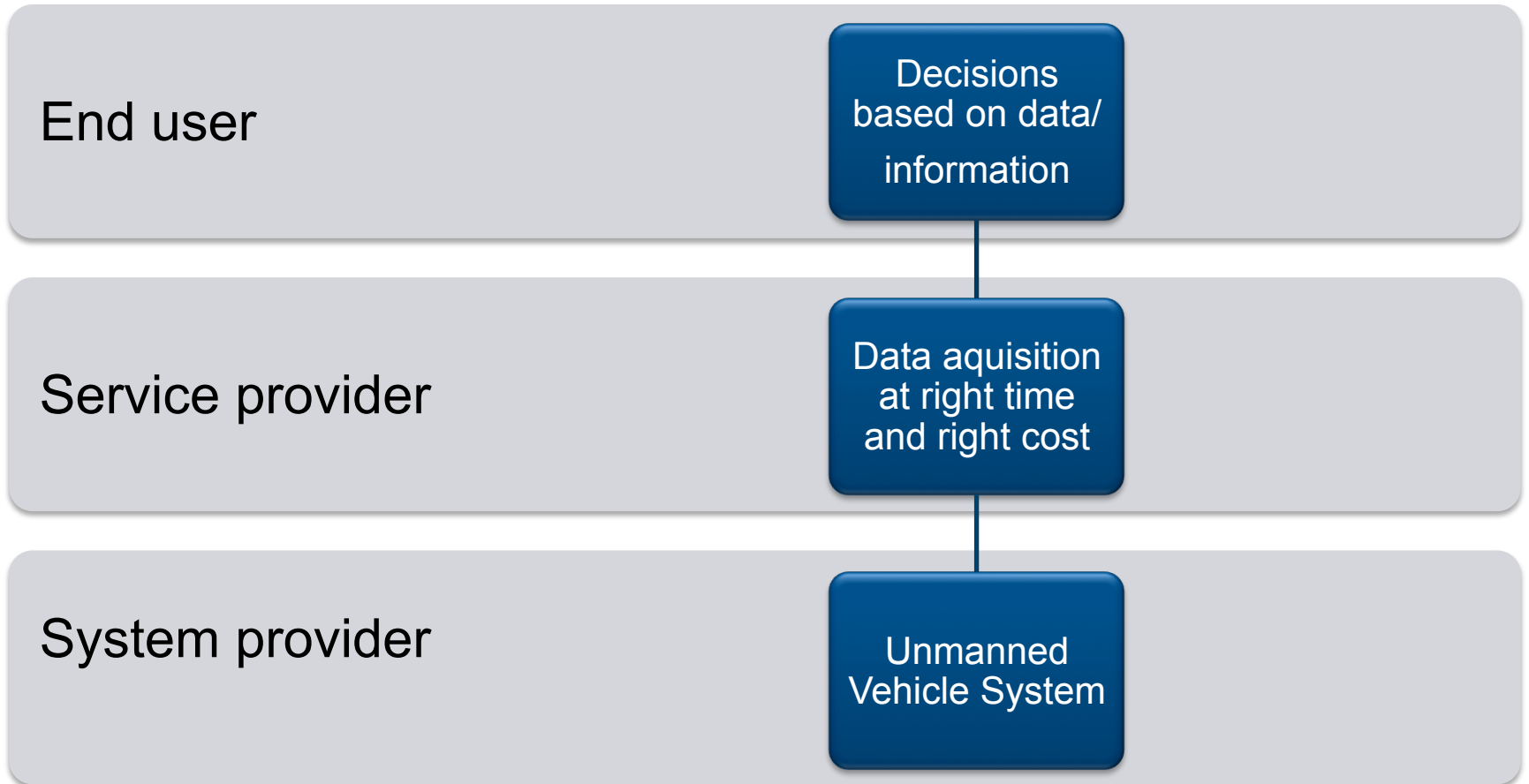
# WHERE IS THE MARKET?



**COST EFFECTIVE &  
SAFE  
DATA AQUISITION  
WITH  
UNMANNED  
SYSTEMS**



# MARKET LEVELS





**MARITIME  
ROBOTICS**

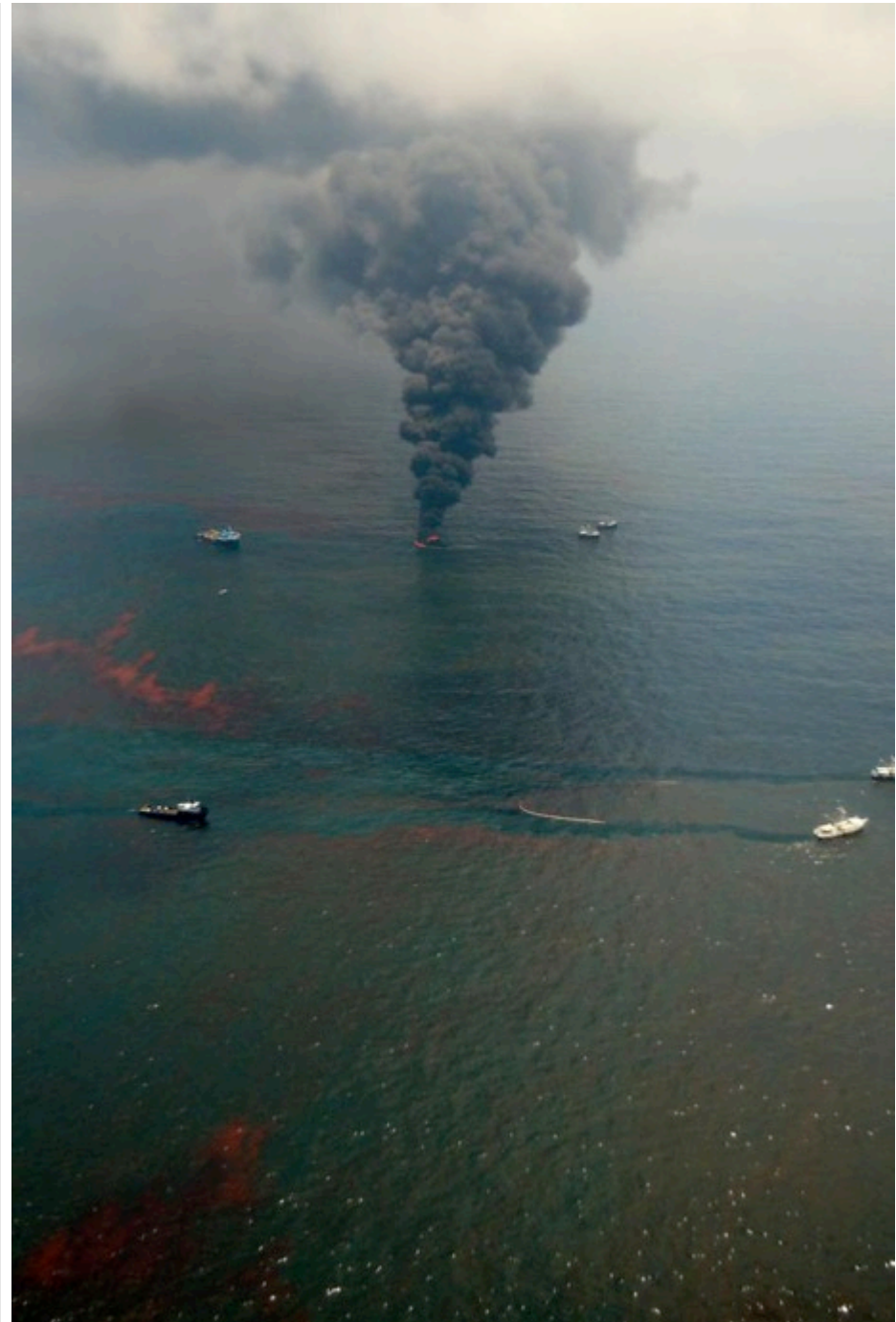






# MOTIVATION

- An aerial observation system that:
  - Assist and even sometimes replace observations from aircraft or helicopters
  - Be a deployable surface based capacity where aircraft solutions are not an alternative
  - Have a capability for persistent operation for days and weeks
- Deepwater Horizon 2011
  - Never enough aerial surveillance capacity



Recording

Power save

Hide

Zero eye

Roll stabilizer

Stabilize

Screenshot

Settings

Exit

Altitude <sup>m</sup>  
210.4

Voltage <sup>v</sup>  
11.5

Current <sup>A</sup>  
1





Link  Battery  Gust  GNSS: Fixed

101.0m

Tablet  11:43

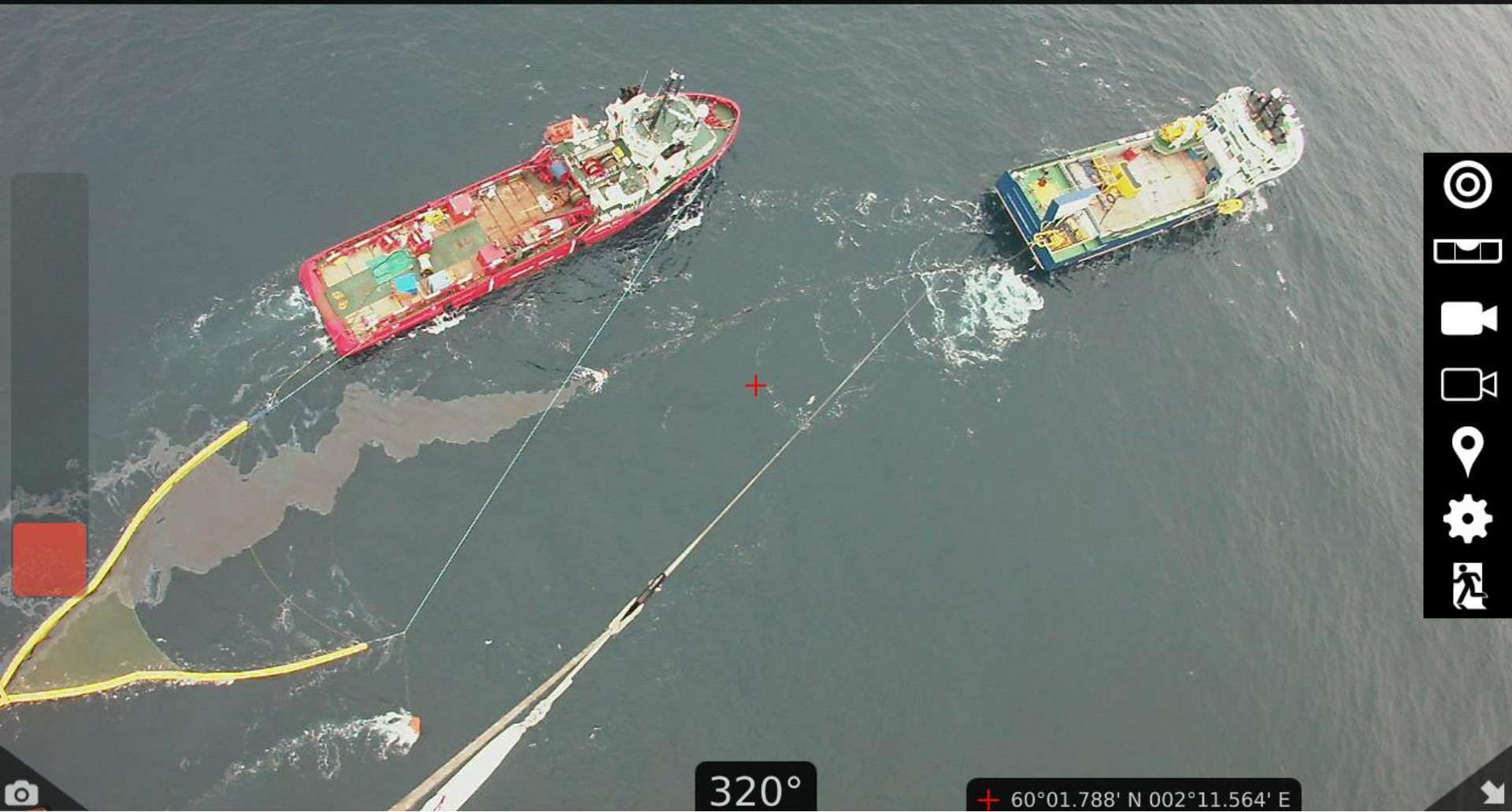


DATE:

Link  N/A Battery  Gust  GNSS: Fixed

128.0m

Tension  N/A VT battery  11:33



- 
- 
- 
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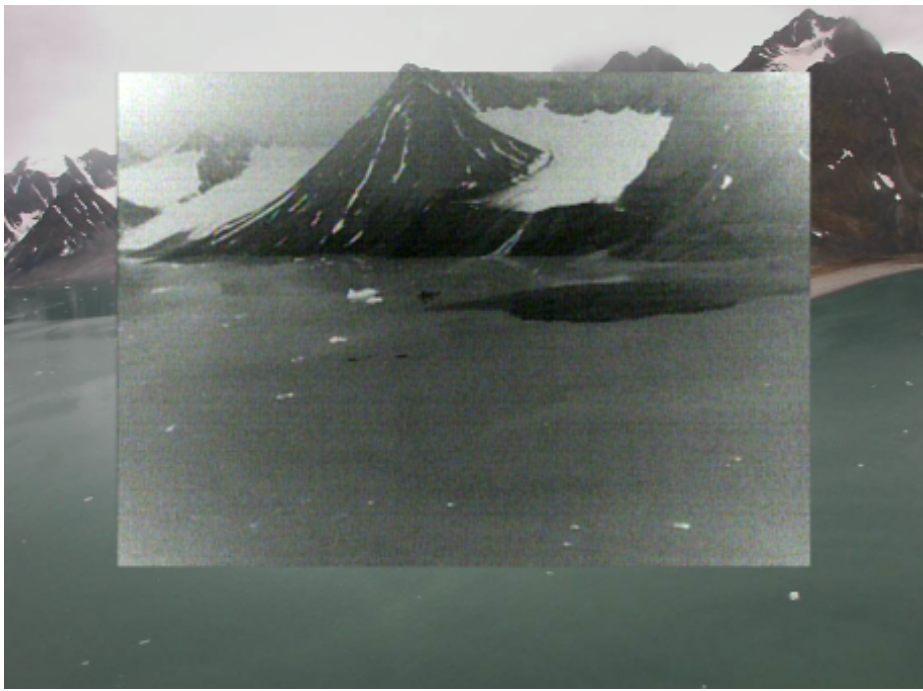
320°

+ 60°01.788' N 002°11.564' E

DATE:









**THE FOLLOWING COMPANIES  
HAVE SUPPORTED THE OCEANEYE™  
PRODUCT DEVELOPMENT**

# VALUE PROPOSITION

- Lower cost
  - Replaces aircraft or helicopter
  - Less complex systems
  - Requires little training
  - Accesible for the ship itself
  - Very deployable
  - Long endurance operations
- Improved HSE
  - No crew onboard
  - Night operations
  - Harsh weather operations
  - Smaller environmental footprint





**MARITIME  
ROBOTICS**

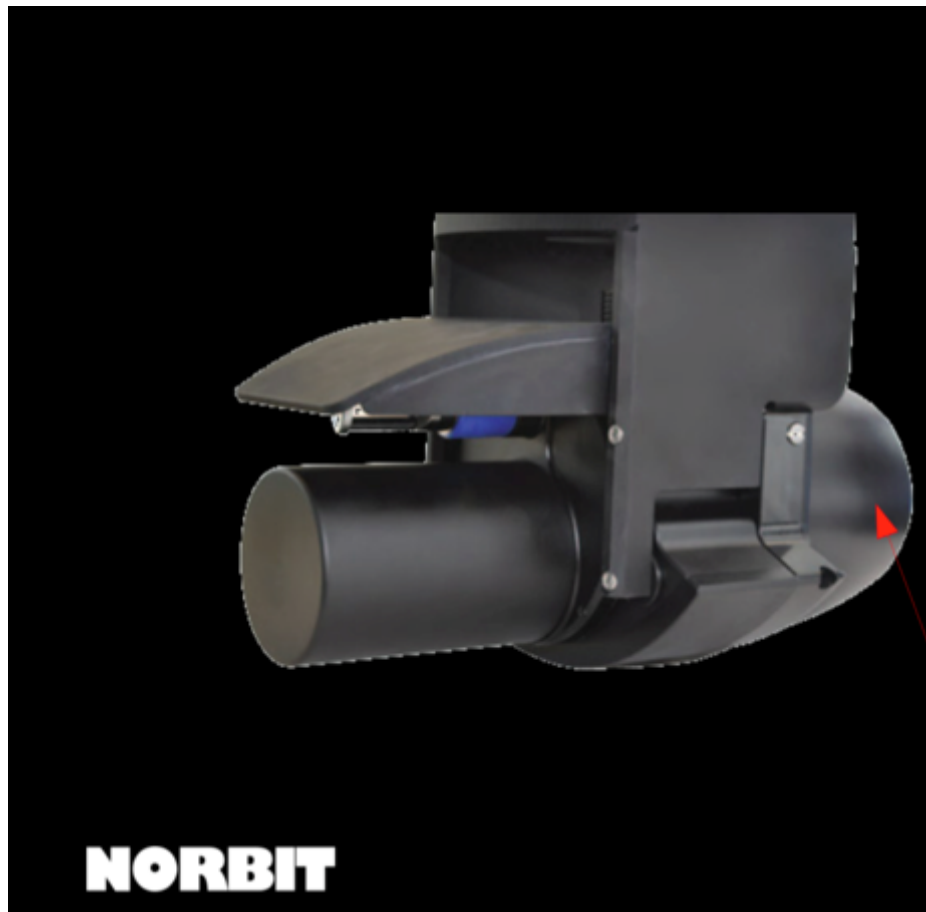


# MR USV

- Proven USV technology platform in a projects with different customers/partners:
  - Specto Remote
  - Norwegian Navy
  - Norwegian Armed Forces
  - Current RnD project with the following partners:
    - NOFO
    - Norwegian Meteorological Institute
    - Insitute for Marine Research, Bergen, Norway
  
- USV PGS
  - Mariner 560 built and delivered in 2011
  - Petroleum Geo-Services (PGS)
    - One of the worlds three largest seismic survey companies
    - RnD platform for application experiments for improved efficiency in seismic operations
  
- Patented technology
  - Formation control of multiple USVs
  - EU patent and US patent



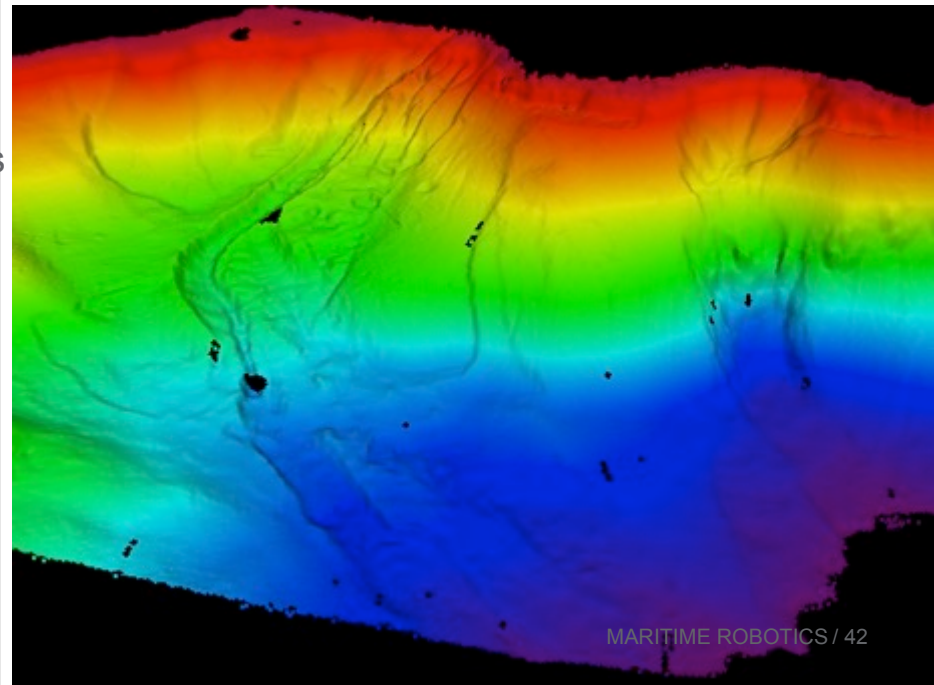
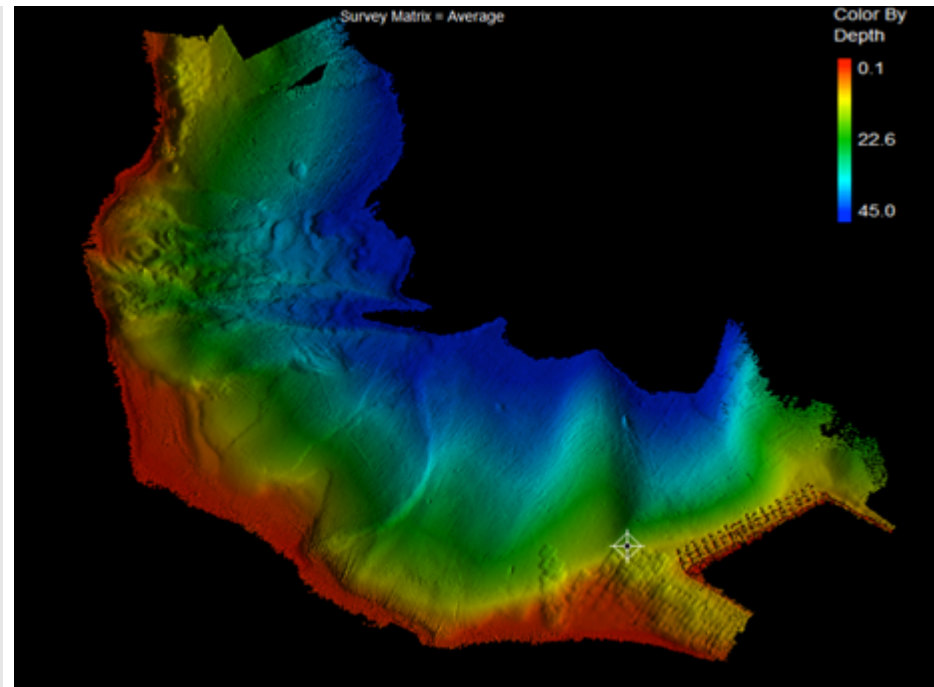


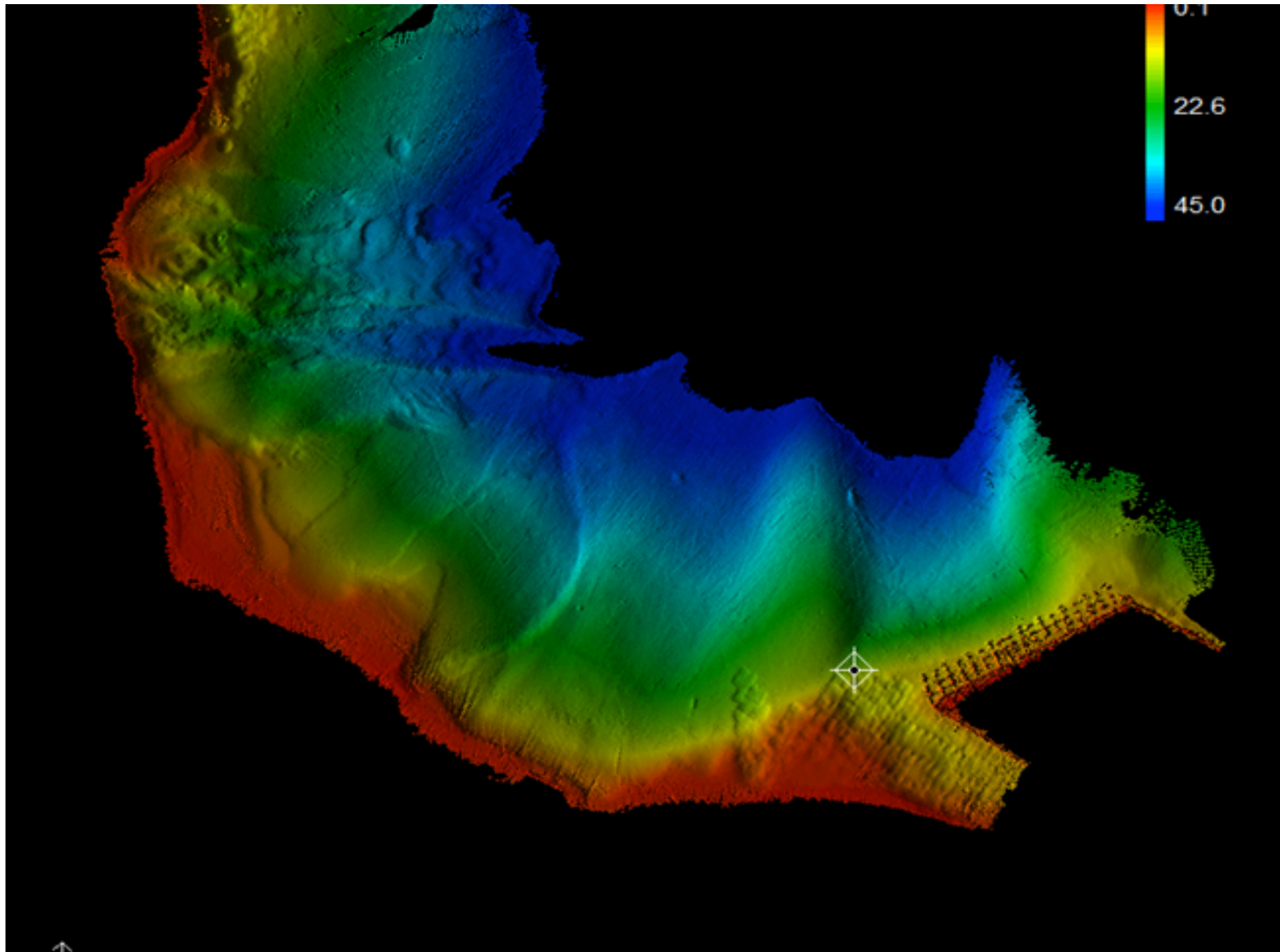


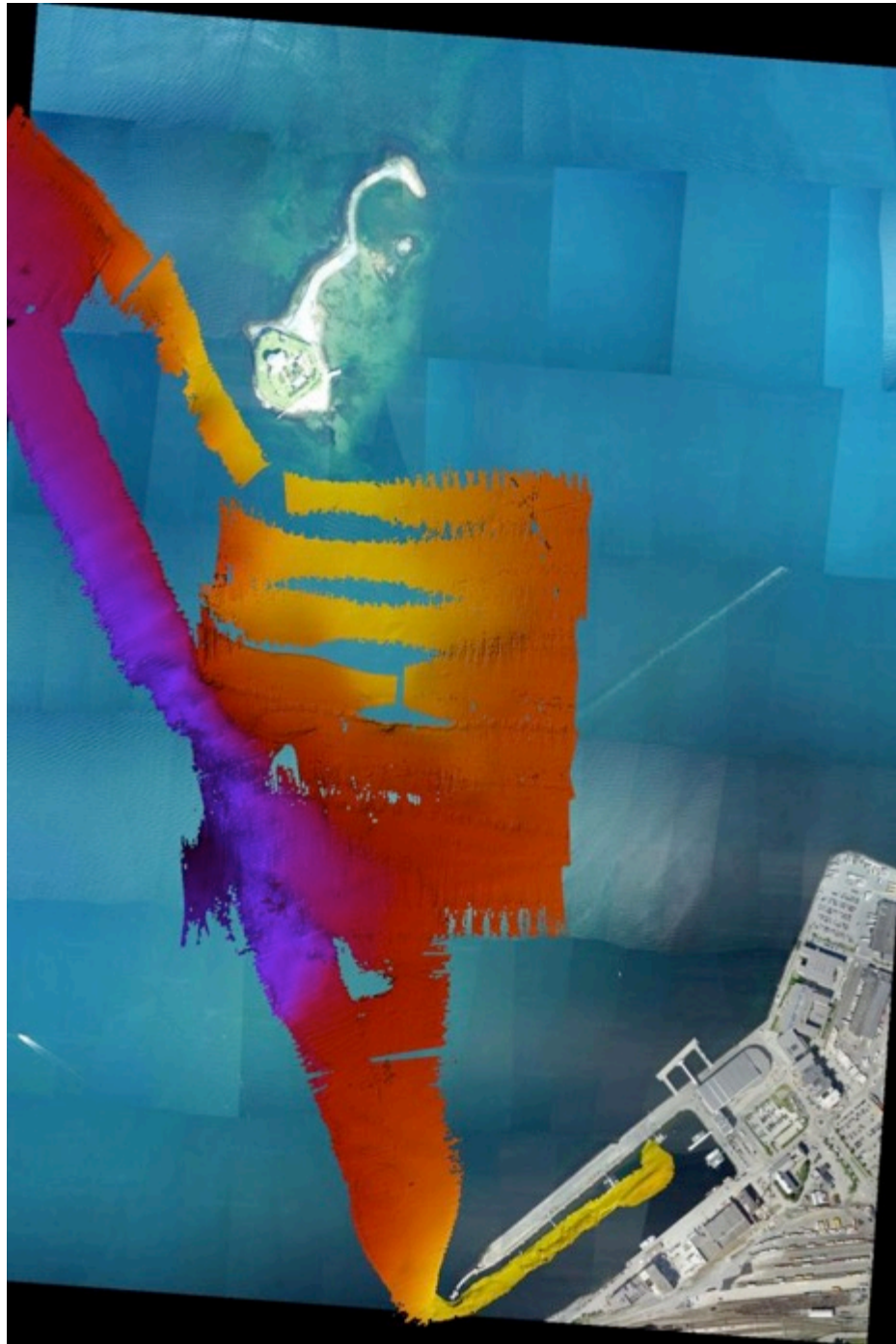
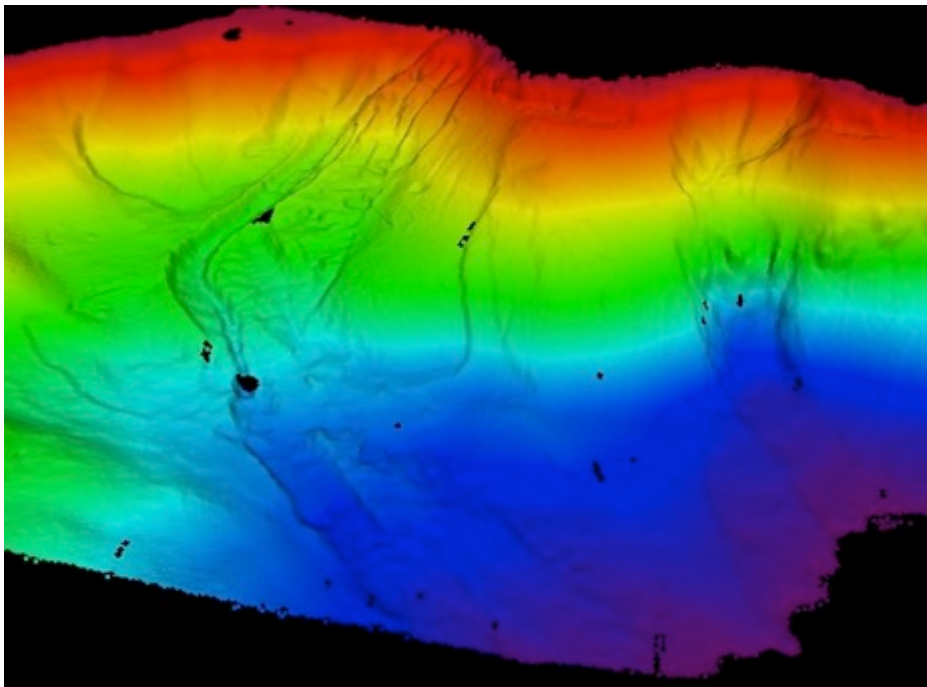
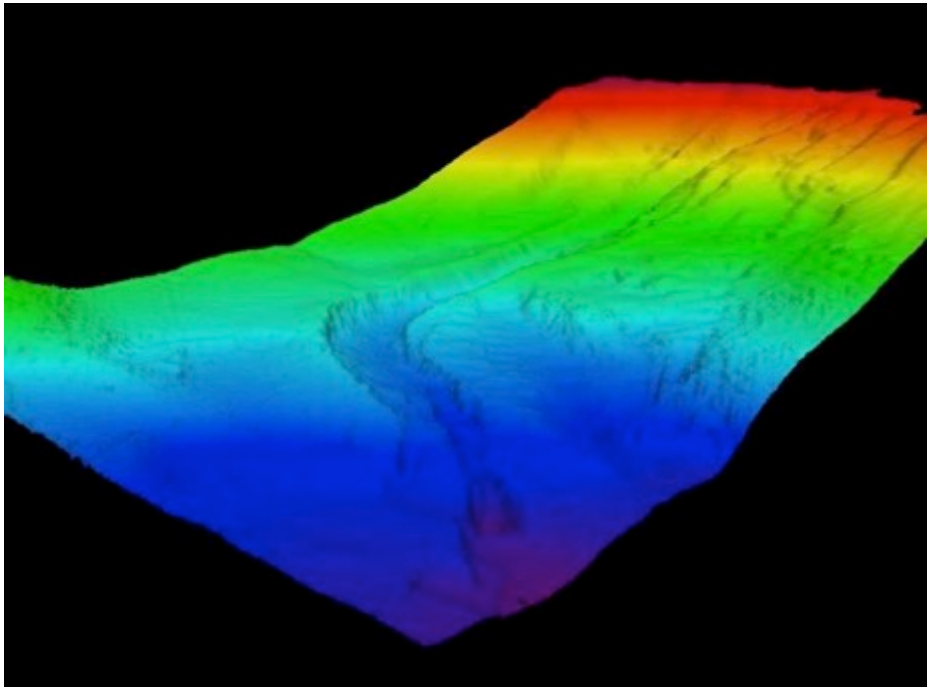
## Seabed mapping with unmanned surface vehicles

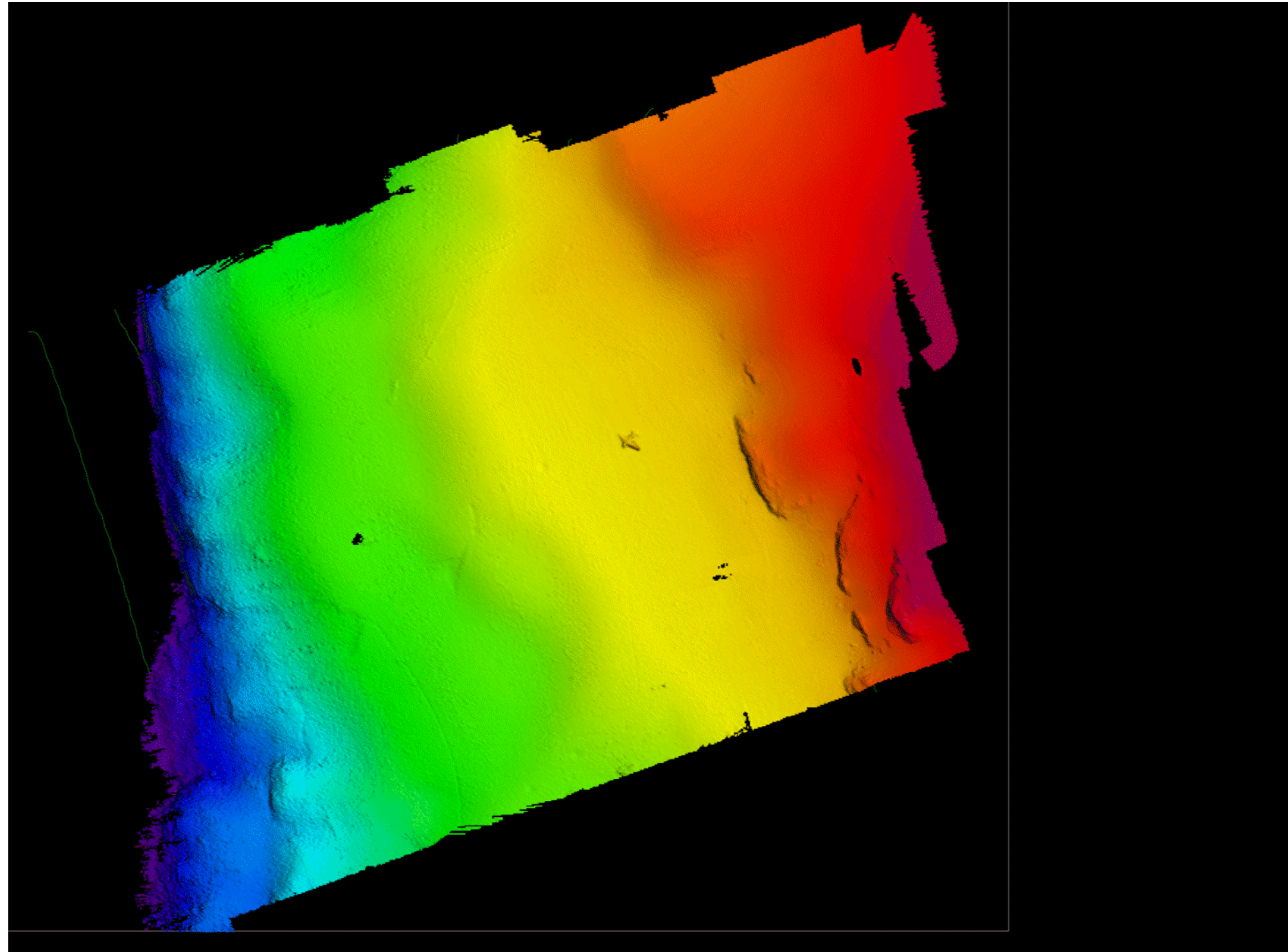
# TEST SURVEY TRONDHEIMSFJORD WINTER 2014

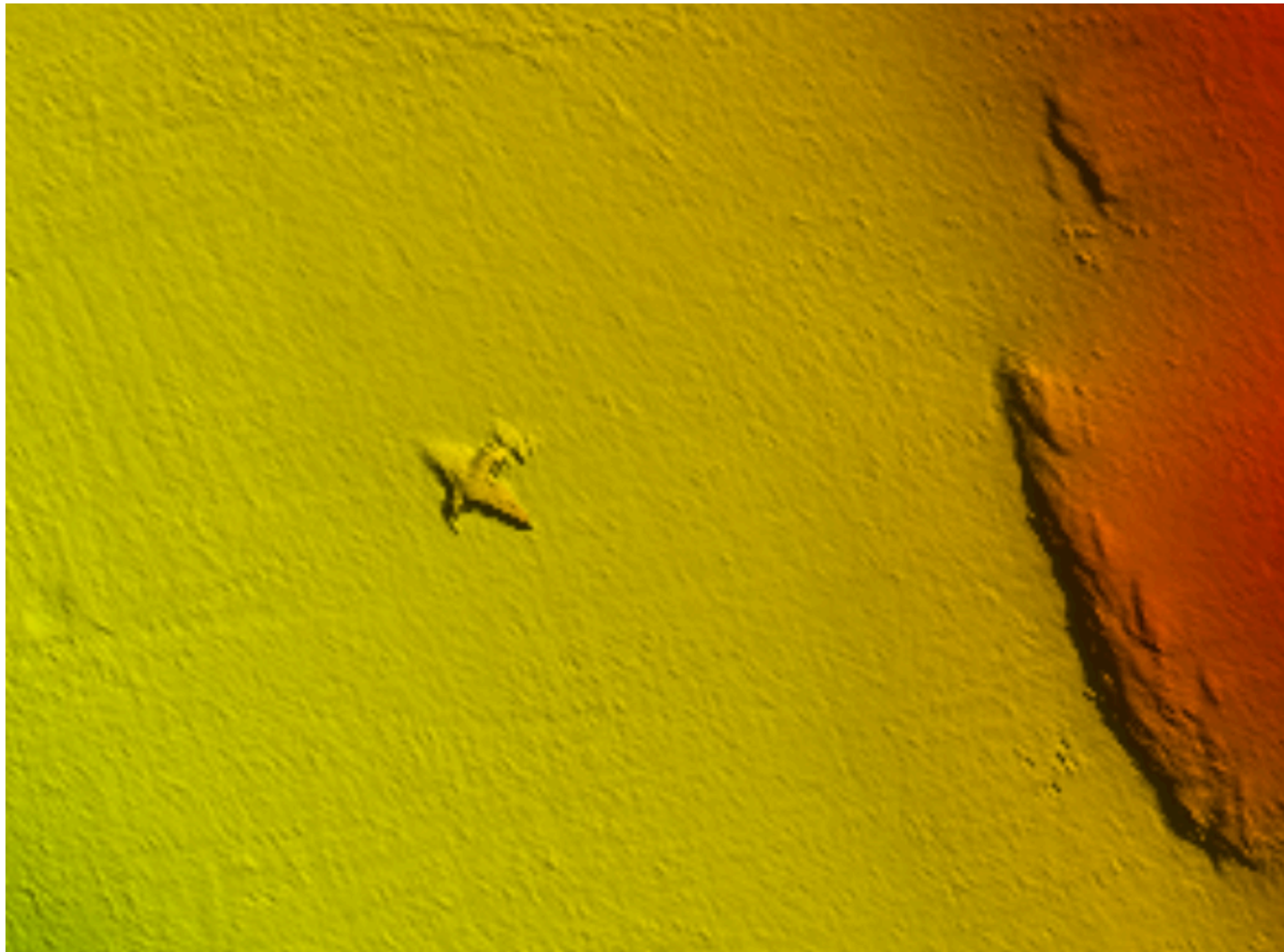
- Project performed by
  - Seahorse Geomatics, US (Survey mngment)
  - Maritime Robotics (USV)
  - NORBIT Subsea (Multibeam echosounder)
- Main results:
  - Stable high quality data aquisition
  - Especially suitable for shallow water operations
  - Good potential for further development of commercial concept



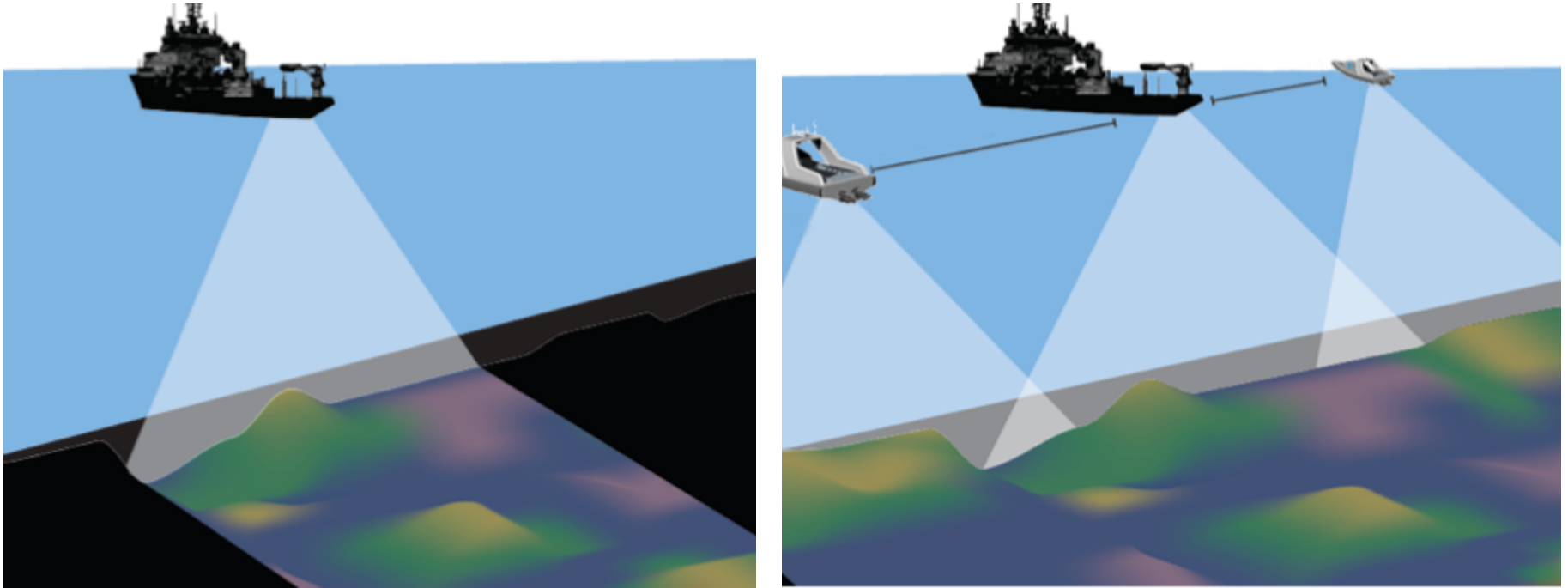








# CASE STUDY – SEABED MAPPING



The capability of the main survey vessel has been augmented with a fleet of USVs, thus saving both time and money





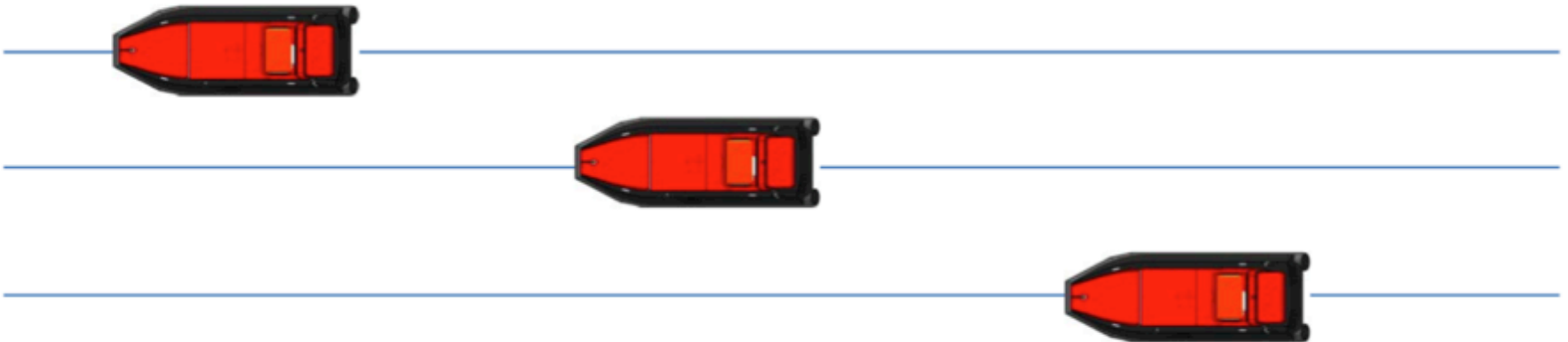
# VALUE PROPOSITION

- Lower cost

- Mother ship can be aided by small USV
- Potential for multivehicle operations
- Long endurance missions

- Improved HSE

- No crew onboard
- Shallow water operations
- Night operations
- Smaller environmental footprint





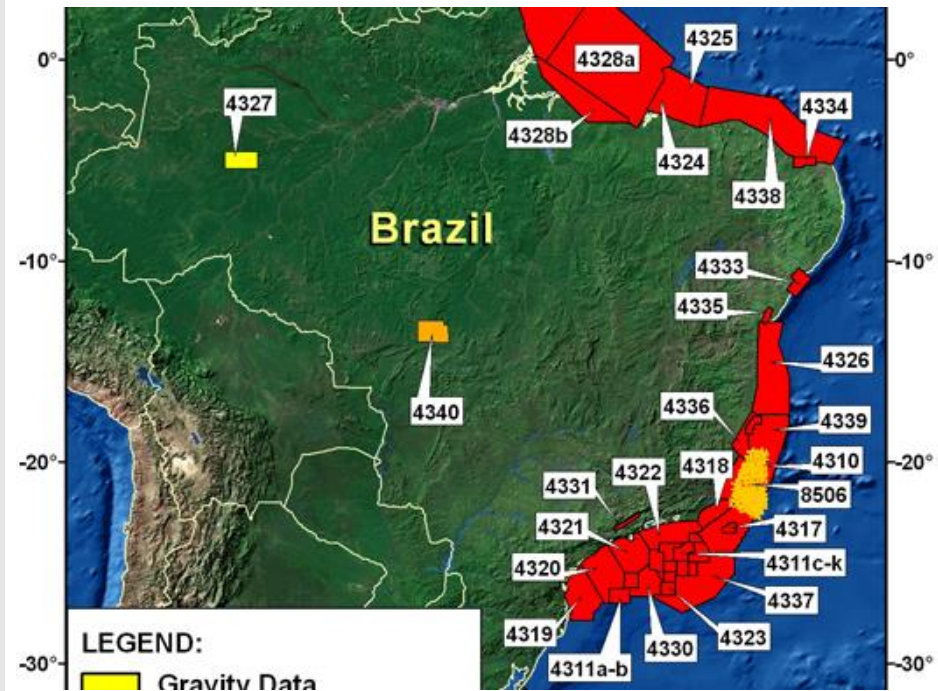
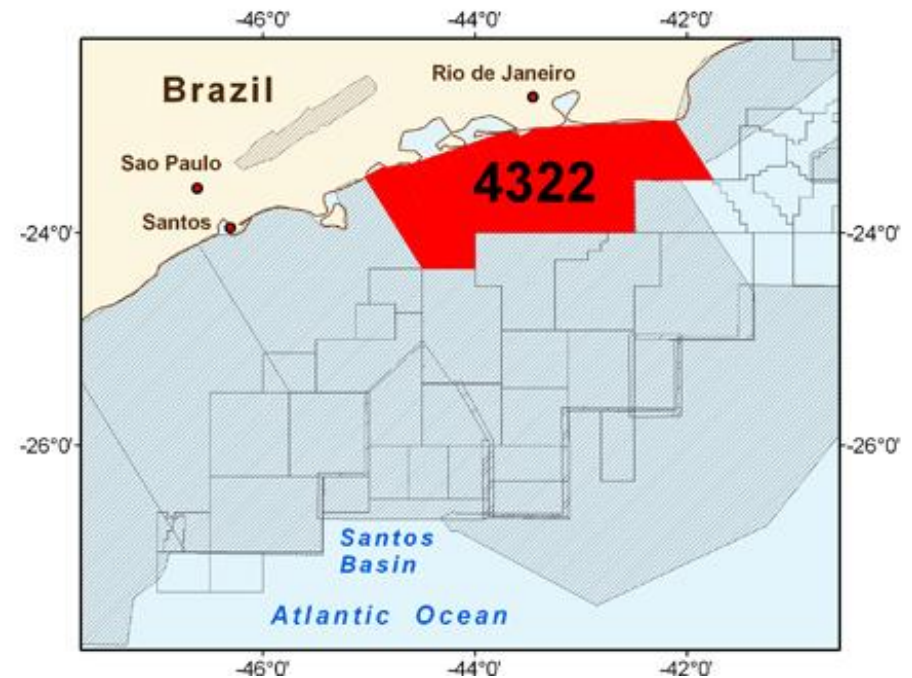
**MARITIME  
ROBOTICS**





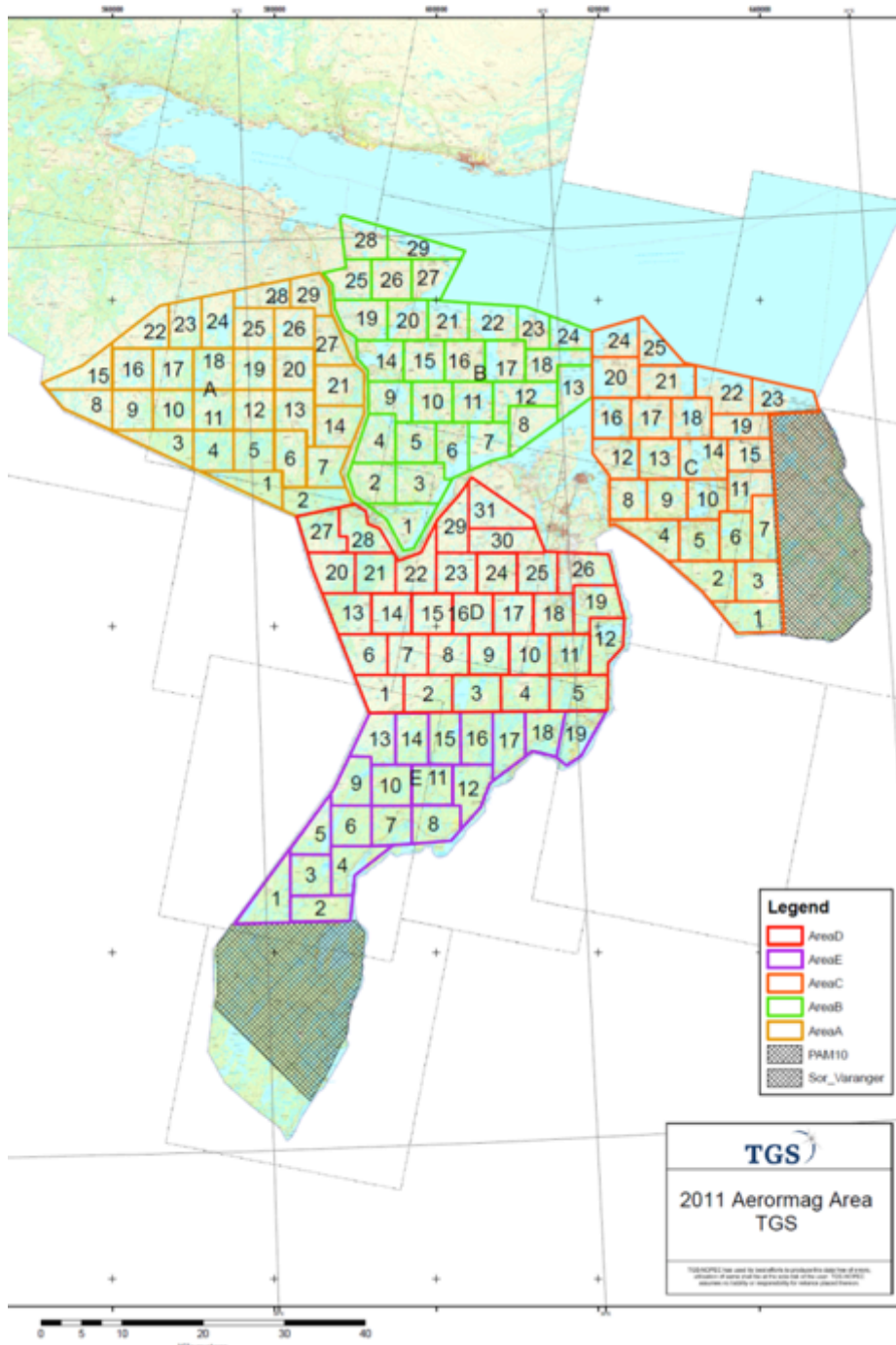
# UAS AEROMAG

- An **aeromagnetic survey** is a common type of geophysical survey to map the mineral content of the earth and is carried out using a magnetometer aboard an aircraft.
- Such as:
  - Mineral exploration
    - Magnetometric surveys can define magnetic anomalies which represent a mineral ore
    - Direct measurements of Iron, magnetite, hematite, kimberlite etc -> indirect indication for gold, diamonds etc.
  - Oil and gas exploration
    - Magnetic surveying can give additional information about the underlying geology and in some environments evidence of leakage from traps. Magnetometers are also used in oil exploration to show locations of geologic features that would make drilling impractical, and other features that give geophysicists a more complete picture.

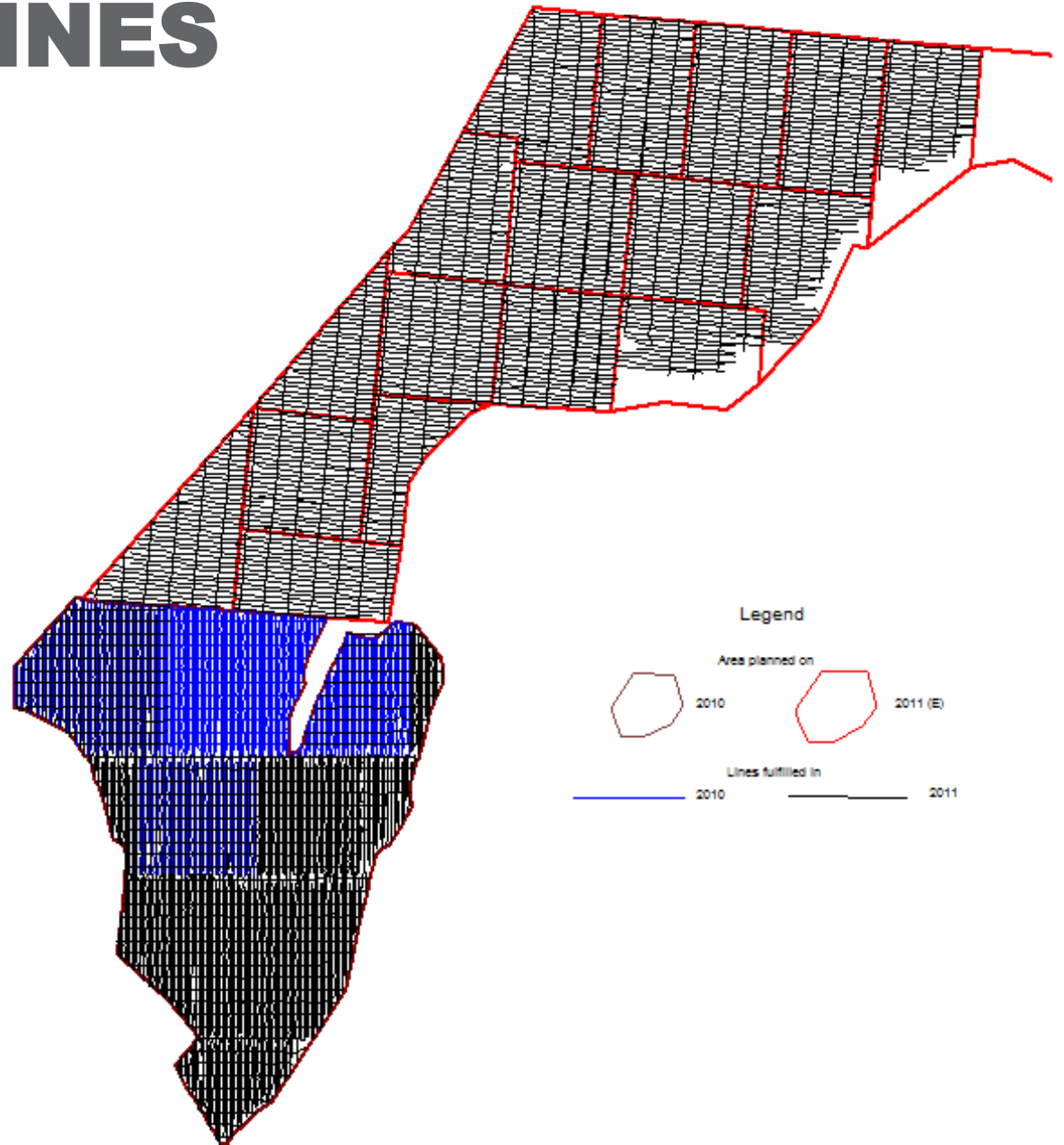


# REFERENCE KIMBERLITT SURVEY 2010-2011

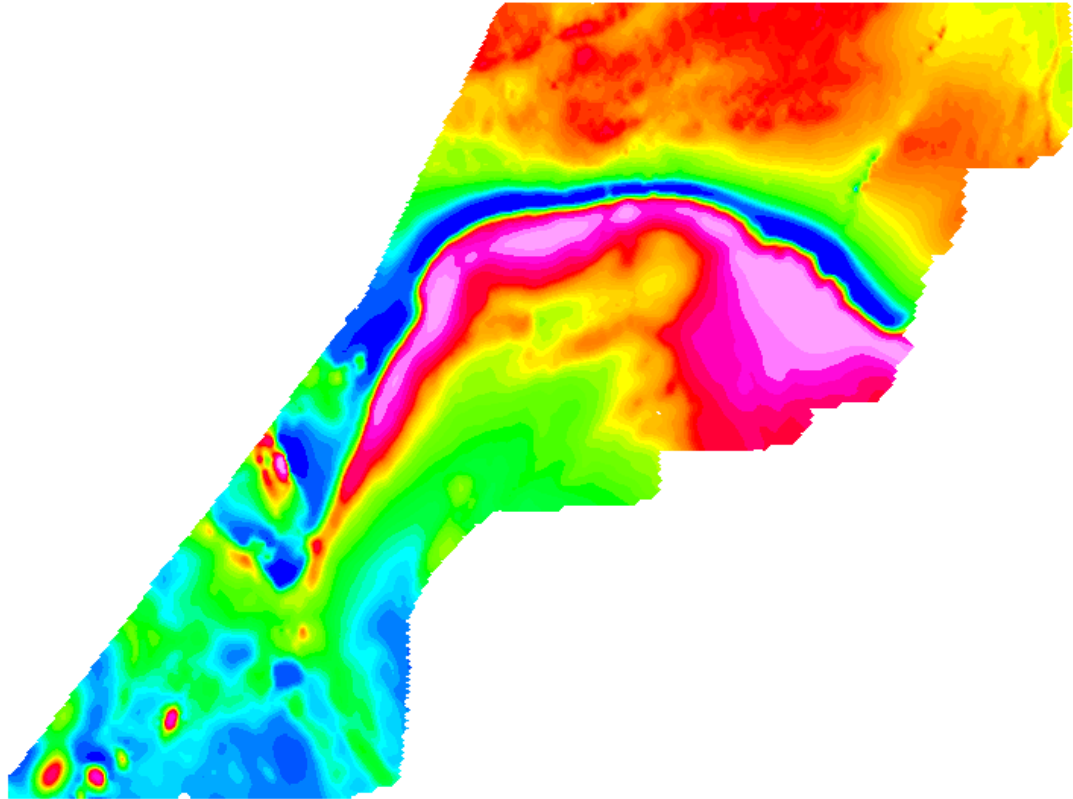
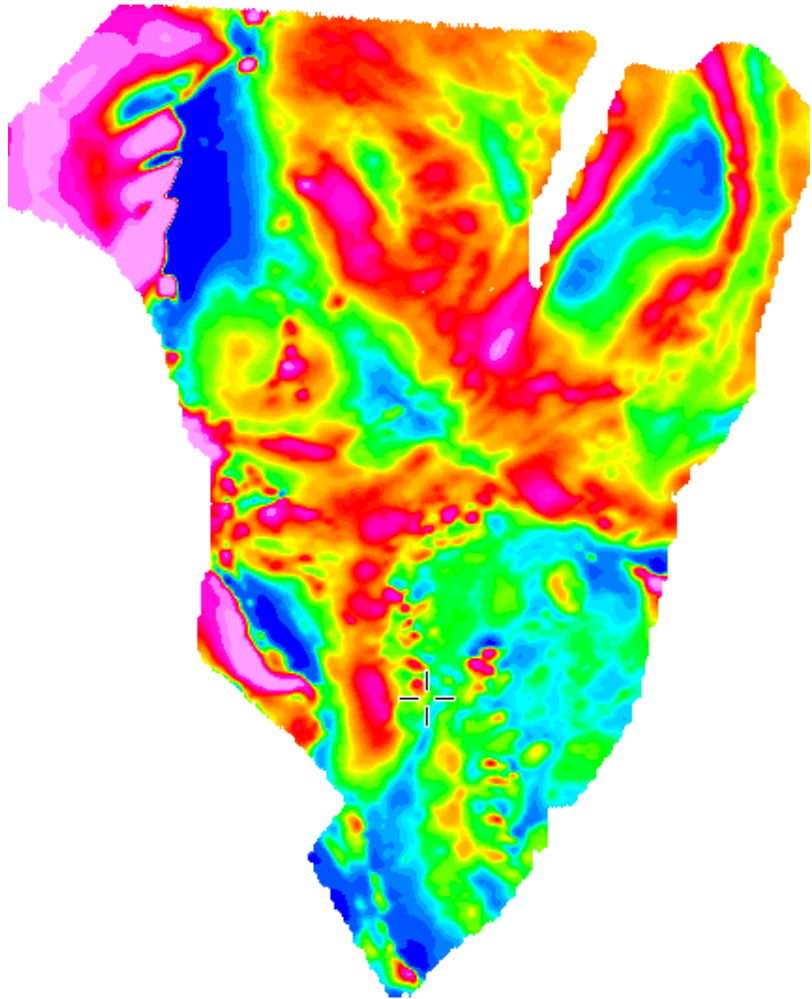
- East-Finmark, Northern Norway
- Project-leader: TGS NOPEC ASA
- Results:
  - Customer claimed that the data provided was of very high resolution and good quality
  - Good anomaly mapping allows concentrated drilling / soil sampling
  - Client very pleased with data quality
  - Very positive feedback from the civil aviation authorities (CAA) involved in the project. (Norway, Finland and Russia)



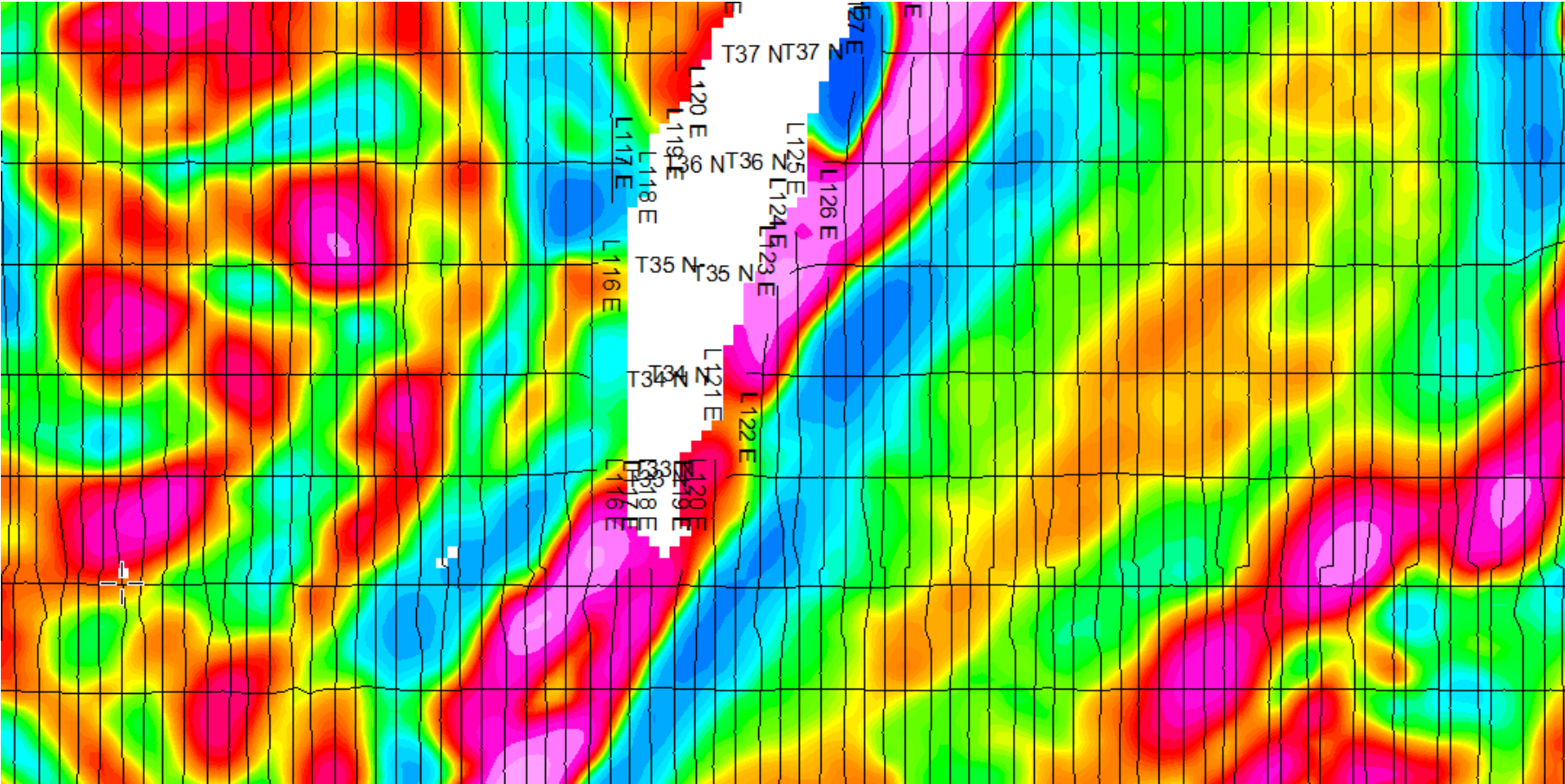
# SURVEY LINES



# DATA EXAMPLES



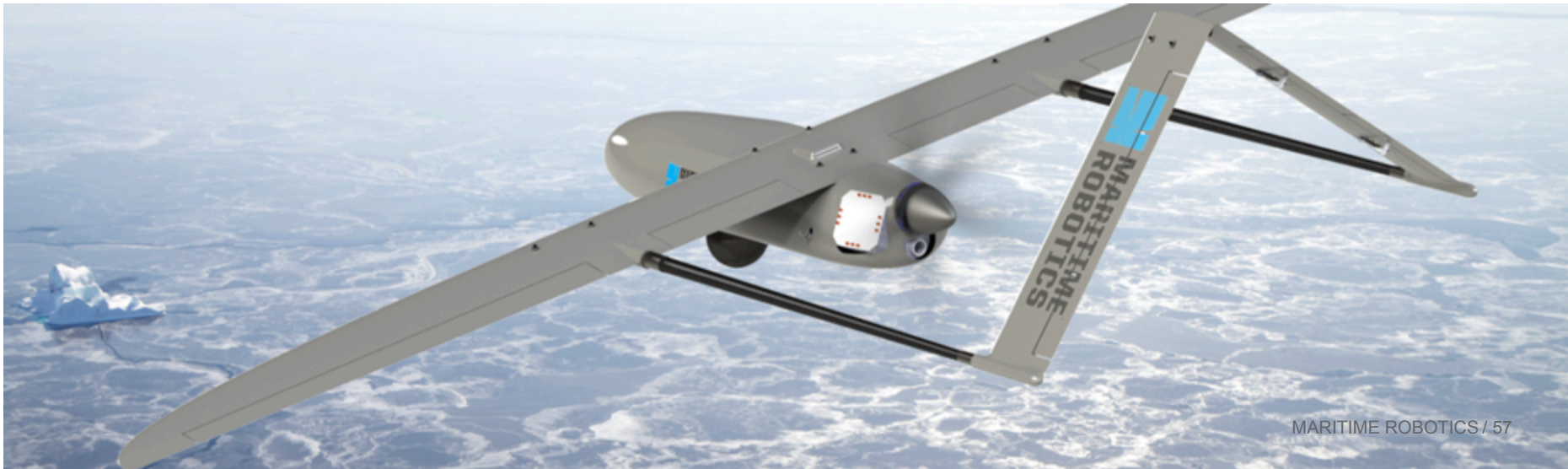
# DATA EXAMPLES





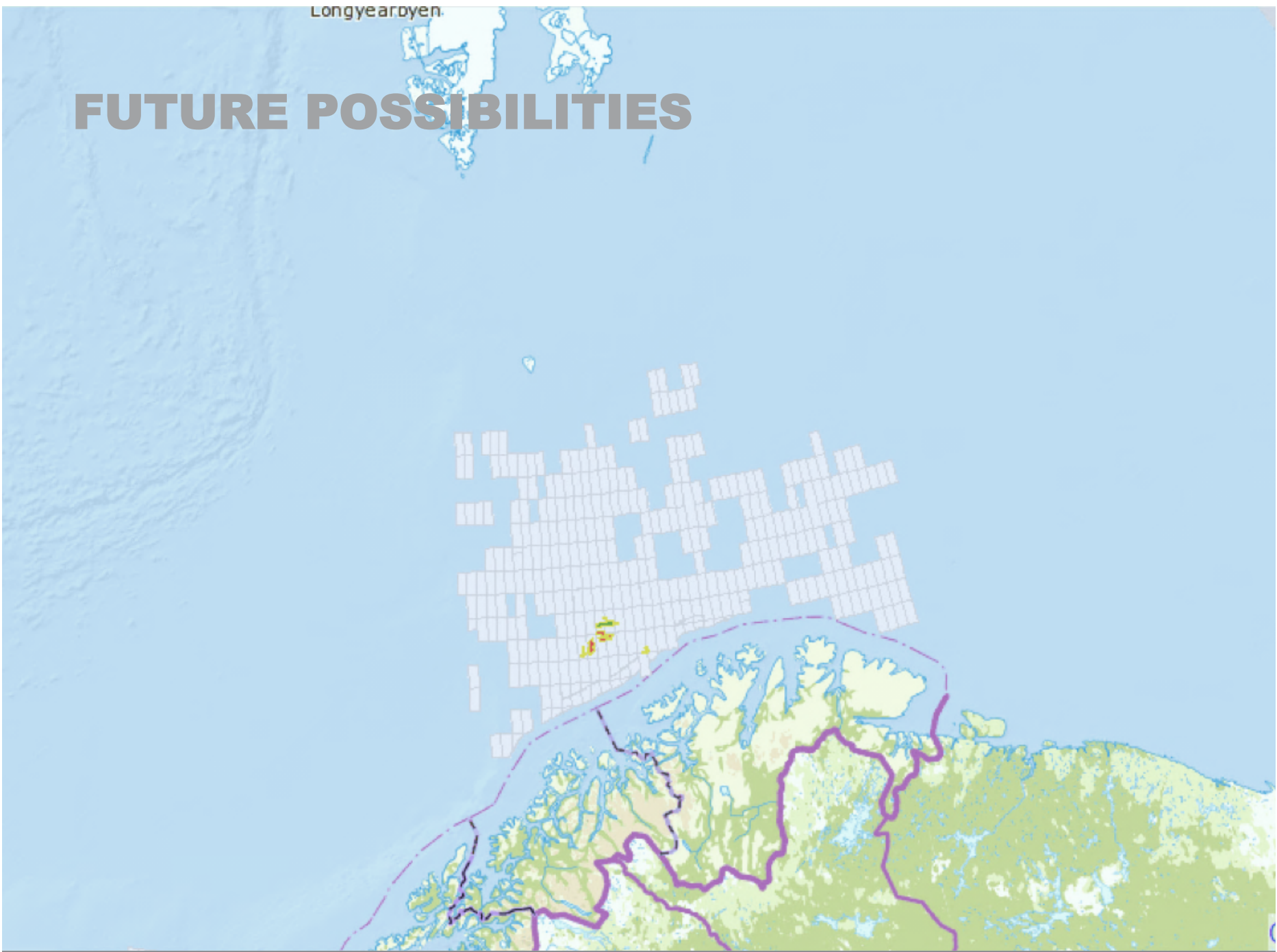
# VALUE PROPOSITION

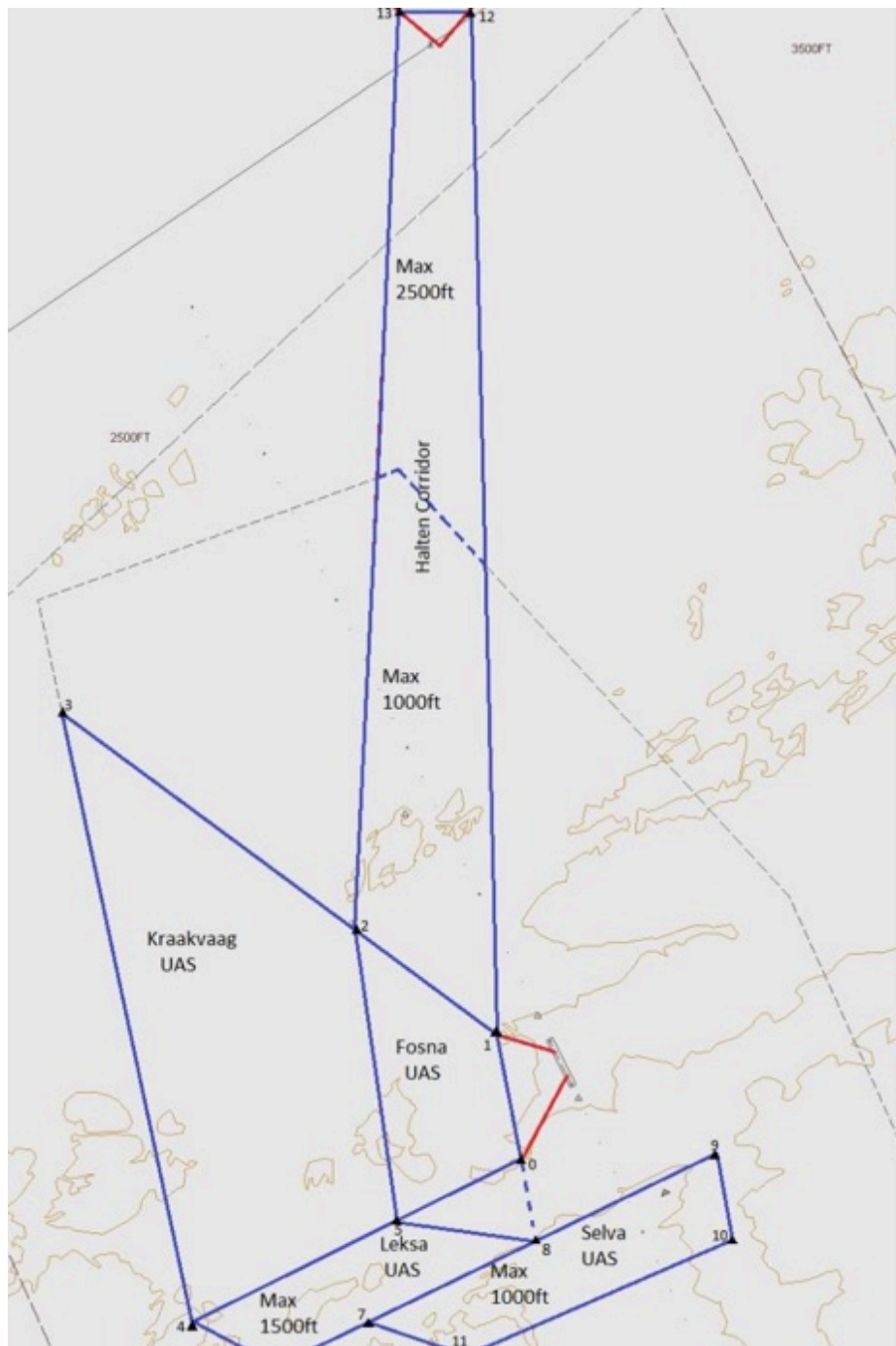
- Lower cost
  - Reduced crew costs
  - Less complex systems
  - Lower material costs than manned aircrafts
  - More accesible and deployable
  - Multivehicle operations
  - Long endurance operations
- Improved HSE
  - No crew onboard
  - Smaller environmental footprint
  - Night operations



Longyearbyen.

# FUTURE POSSIBILITIES





# UAS AIR REGULATIONS

- An UAS is a flying object affected by national/international civil aviation laws
- **Today's regulation**
  - **Visual Line of Sight (VLOS)** operations is allowed below 500feet and performed by a licensed UAS operator
  - **Beyond Line of Sight (BLOS)** operations is only allowed within a **segregated** airspace and performed by a specially BLOS licensed UAS operator
- **Possibility for use of UAS in BLOS operations**
  - Defined missions can apply to the Civil Aviation Authorities for a **segregated airspace**
  - The Civil Aviation Authorities may define special operations as a **“state operation”**

# **VLOS UAS TEST BASE**



**EGGEMOEN AVIATION AND TECHNOLOGY PARK**

# BLOS UAS TEST BASE



## AGDENES AERODROME, BREIVIKA

# PENGUIN MR

## **Specifications:**

Wing span:	3.3 m
Length:	2.27 m
Empty weight:	12 kg
MTOW:	21 kg
Powerplant:	2-stroke, 2,5hp
Typical payload weight:	3-4kg
Fuel capacity:	7,5 litre
Launch	Runway/catapult

## **Performance:**

Cruise speed:	28 m/s
Max endurance:	10-24h*

*\*24h endurance requires fuel-injection engine*

## **Typical application and payload:**

Maritime surveillance

- Stabilized pan/tilt video/infrared camera
- AIS receiver





















AP On Flying NONE ABORT Engine On

Status Lights RPM ALT IAS ATT SYS GPS LINK COMM TER SPC Aero T. DMan On SBAS/INS 1:25:20

Navigation and control icons: Home, Back, Forward, Up, Down, Search, Map, Terrain, 3D, 2D, Local Remote

S/N: 2842  
TAS: 28.6 [m/s]  
IAS: 28.1 [m/s]  
BALT: 434.4 [m]  
ALT: 451.1 [m]  
FUEL: 1.6 [kg]  
RSSI: -86.0  
ACK: 99.0  
VLTG: 12.3 [v]  
GSPD: 27.5 [m/s]









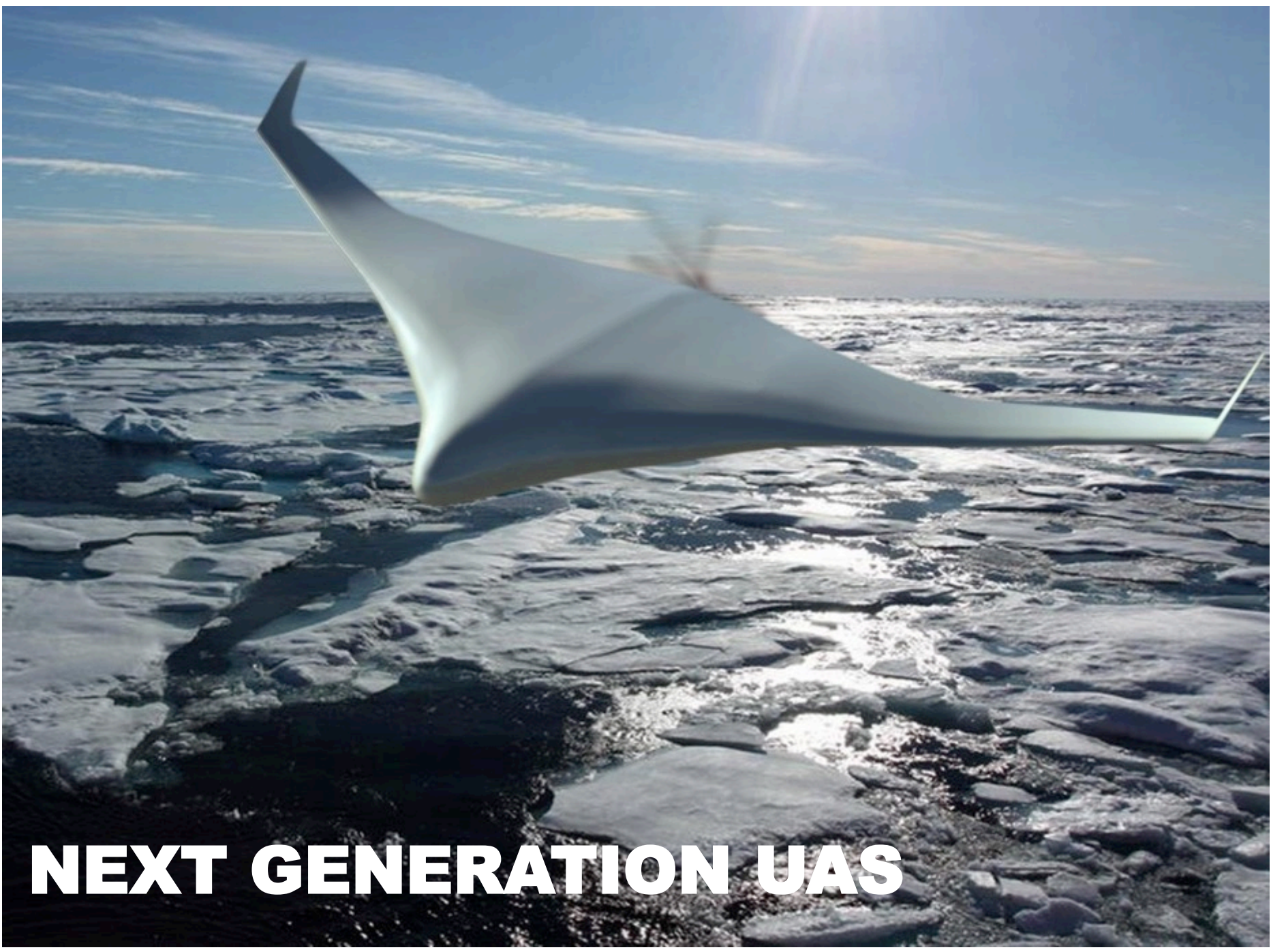




# CHALLENGES

## SEEN FROM OUR PERSPECTIVE

- Legislations
  - A formal and psychological barrier
- Communication
  - Communication (more than line-of-sight) is the main barrier for long distance operation (availability, robustness and/or price)
- Concepts of operation
  - Crew qualification and training
  - Crew set-up for long endurance operations
- Environmental adaption
  - Robust propulsion systems
  - Robut surfaces (icing etc)
  - Operations from ships
- "Sense-and-avoid"
  - What is required??
  - What can we provide??



**NEXT GENERATION UAS**

2013-2022

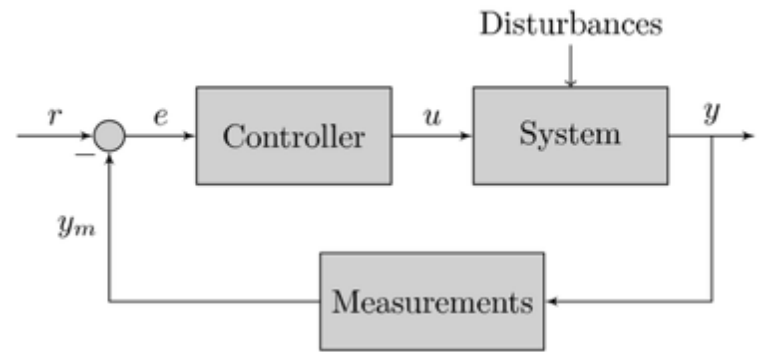
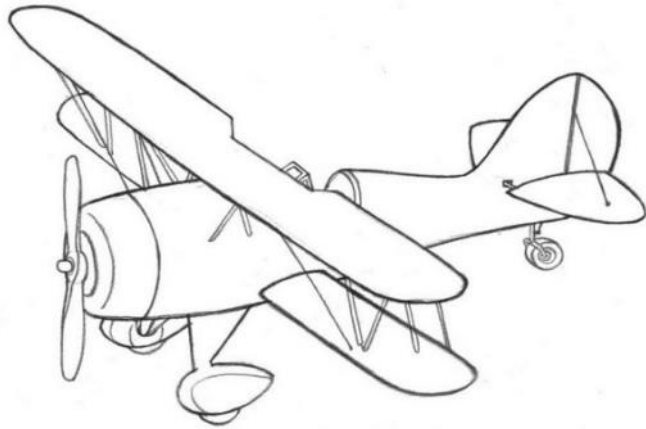
# Centre for Autonomous Marine Operations and Systems





**MARITIME  
ROBOTICS**







# **THANK YOU FOR YOUR ATTENTION**



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