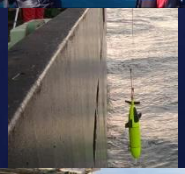
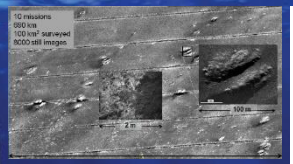
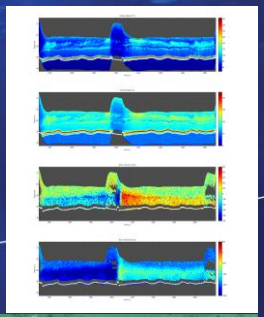
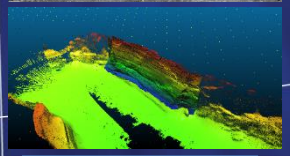
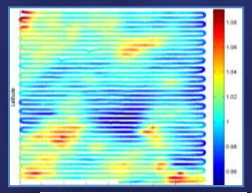




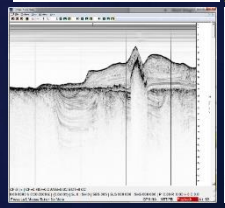
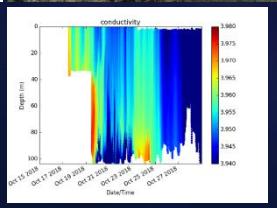






NOC NMF
MARS Updates

OFEG-TECH 05/09/19

Maaten Furlong

National Marine Facilities

- Research Ships Management
- Programme Management
- Marine Autonomous & Robotic Systems (*MARS*)
- Logistics & Warehousing
- Scientific Engineering
- Science & Project Support
- NERC National Facility for Scientific Diving

The National Marine Equipment Pool

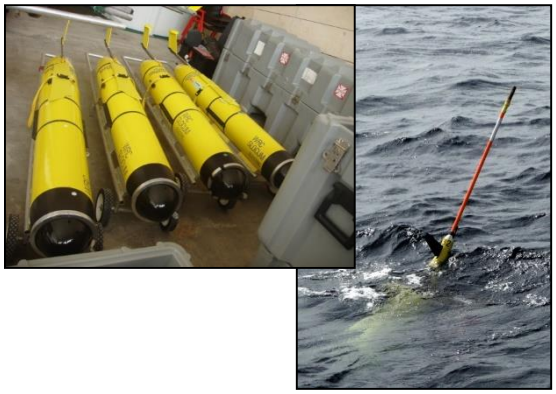
Operated by National Marine Facilities

Holds more than 10,000 instruments and systems

Is available for use by the whole of the UK marine science community

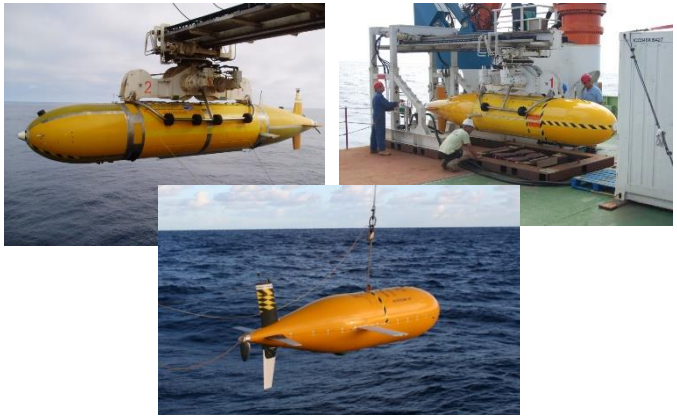
MARS Fleet & Personnel

Underwater Gliders



- Teledyne Webb Slocum (1000m) x 12
- Teledyne Webb Slocum (200m) x 10
- Kongsberg Seagliders x 9
- Uni. Washington DeepGlider x 1 + 1

AUVs



In-house developed:

- Autosub6000
- ALR6000 x 3
- *Autosub2KUI*
- *ALR1500 x 3*

ROV & Deep Tow Equipment

- Isis ROV
- HyBIS
- *MPUS*

USVs

STAFF

A mix of:

- Mechanical
- Electronics
- Software
- Systems

The MARS Team Structure

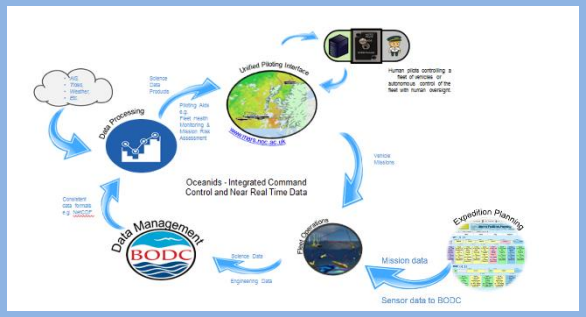
Short Range

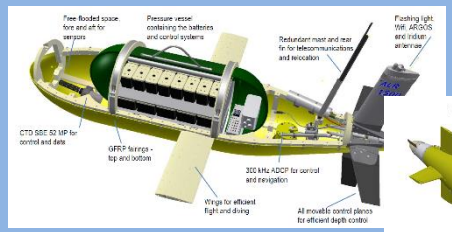
ROV team

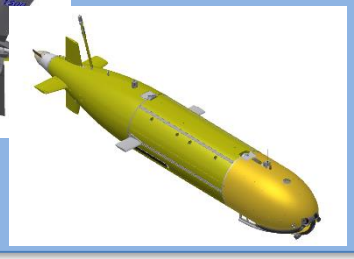
AUV team

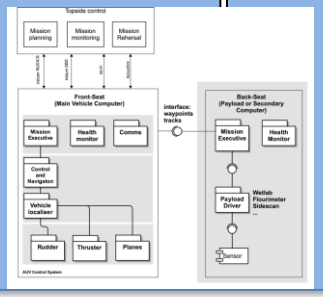
Long Range

Development









The MARS Team Structure

Short Range

Dave Turner
+5 Eng

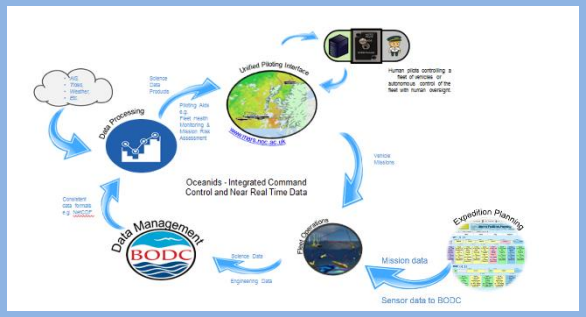
ROV team

Dan Roper
+ 5 Eng

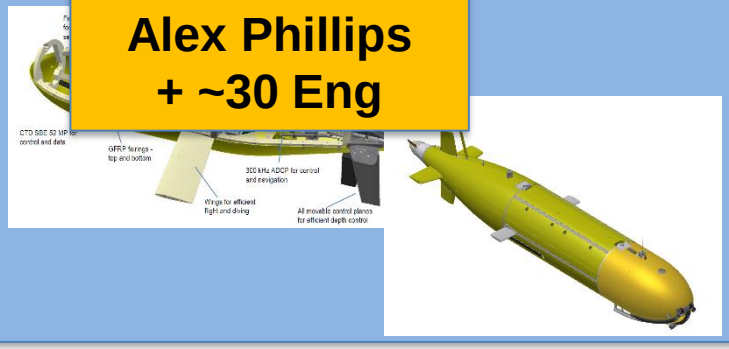
AUV team

Long Range

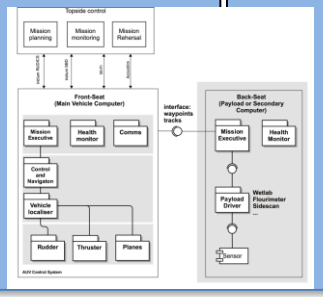
Phil Bagley
+8 Eng



Alex Phillips
+ ~30 Eng



Development



NMF Technology Roadmap

https://www.noc.ac.uk/files/documents/about/ispo/Marine_Facilities_Advisory_Board_March_2019_FINAL_2.pdf

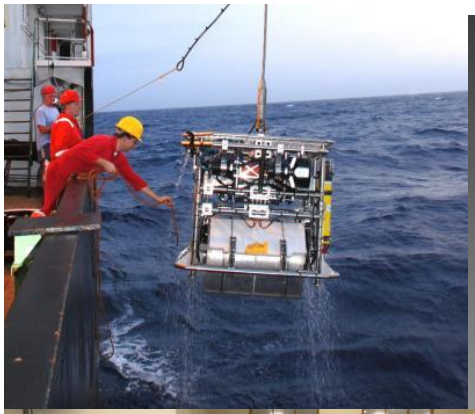
Updated annually
Reviewed by the Marine Facilities Advisory Board (MFAB)

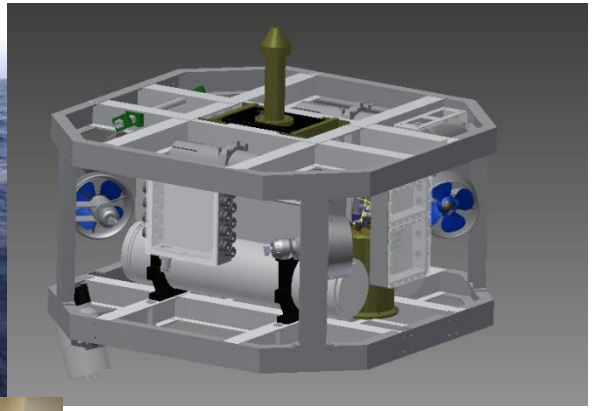
- Split into sections by capability eg.
  - Remotely operate platforms
  - High power MAS
  - Low power MAS
  - Etc.
- Each section split into
  - Current capabilities
  - Science drivers
  - Future capabilities - What we are working on
  - Aspirations – What we intend to work on

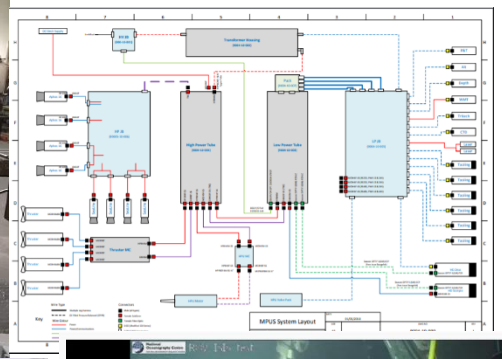
Attempts to capture science pull and technology push

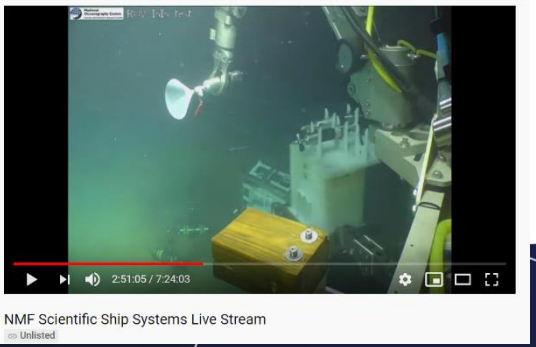
ROV Team – Leader Dave Turner
Modular Payload Underwater System Updates

HyBIS Command Module Upgrade (MPUS)









Objectives:

- *Improve manoeuvrability*
- *Increase payload capacity*
- *Improve reliability and maintainability of the system*

Status:

- *Physical design complete*
- *Parts being manufactured & assembled*
- *Software design underway*
- *Prelimnary testing next years*
- *Trials 2020 / 2021 depending on programme*

Enhancements:

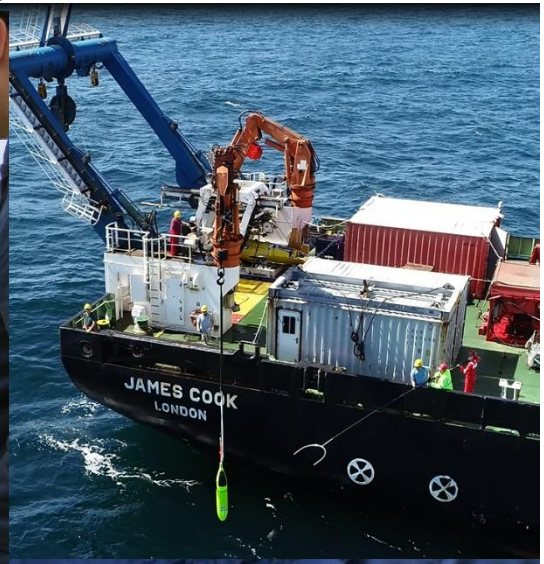
- *Heave comp on the deep tow*
- *Video streaming*

NERC SCIENCE OF THE ENVIRONMENT

Long Range Team – Leader Phil Bagley
Updates

Deep Glider

- Commissioned
- Triialled on JC166
- Issue with PV identified



In house glider calibration

- Slocum CT
- Seaglider CT

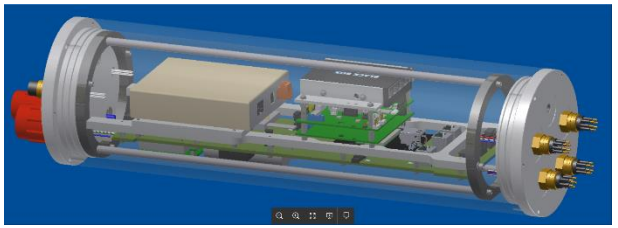
AUV Team – Dan Roper
Updates

New/ Control Containers

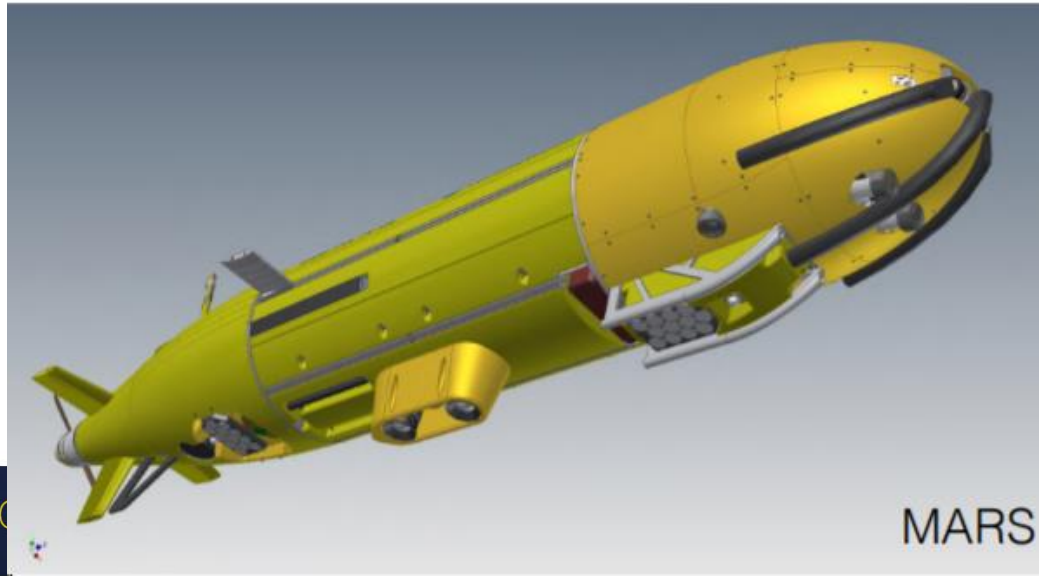
- Control centre for vehicle
- Full system level spares
- Hardware Vehicle Simulator

Mid-Life Refit

- Updated power control tube
- Upgraded logger tube
- Updated navigation tube



BioCAM Integration



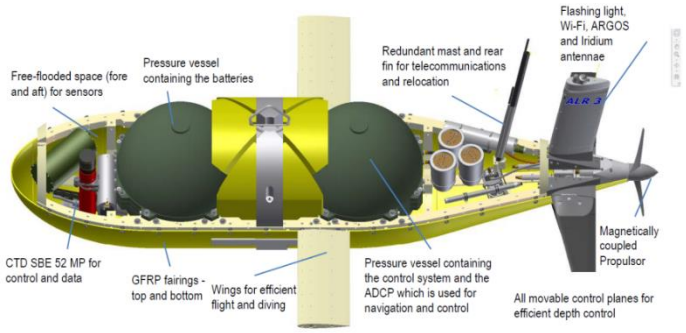
ALR1500 (ALR6000 derivative)

Project Lead - Stephen McPhail

Goals

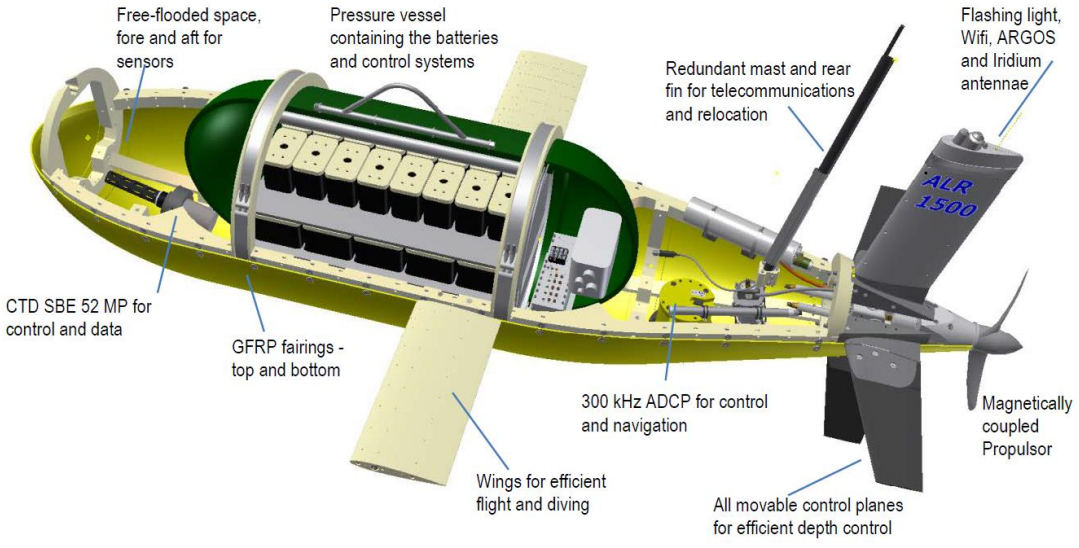
- *Develop the capability to operate under ice for extended periods and transarctic crossings*
- *To extend the range of ALR6000 by increasing the battery payload (2.5x for ALR1500)*
- *Update the ALR6000 control systems to prevent hardware and software obsolescence issues*
- *Iceberg avoidance sonar, & rechargeable batteries*

ALR6000

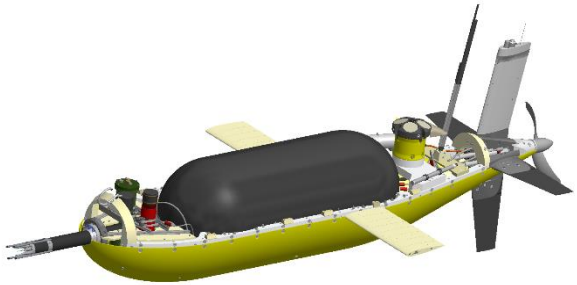


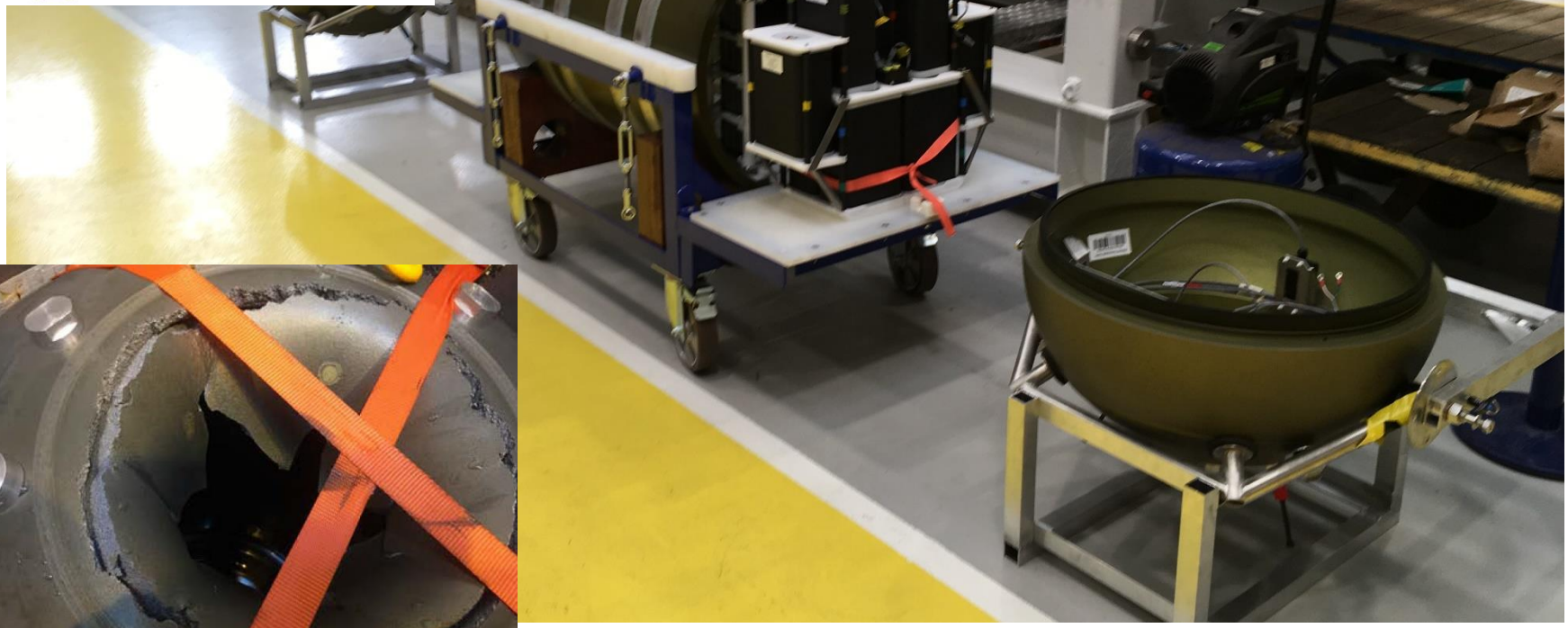
ALR1500

- **1** x Pressure vessel
- **95** kWhrs Primary LTC batteries
- **1500m** depth rated
- Mass ≈ 800 kg
- Length ≈ 3.5 m
- Top Speed ≈ 1 m/s
- Max Range ≈ **6000 km**



ALR1500 Build – Not without its challenges



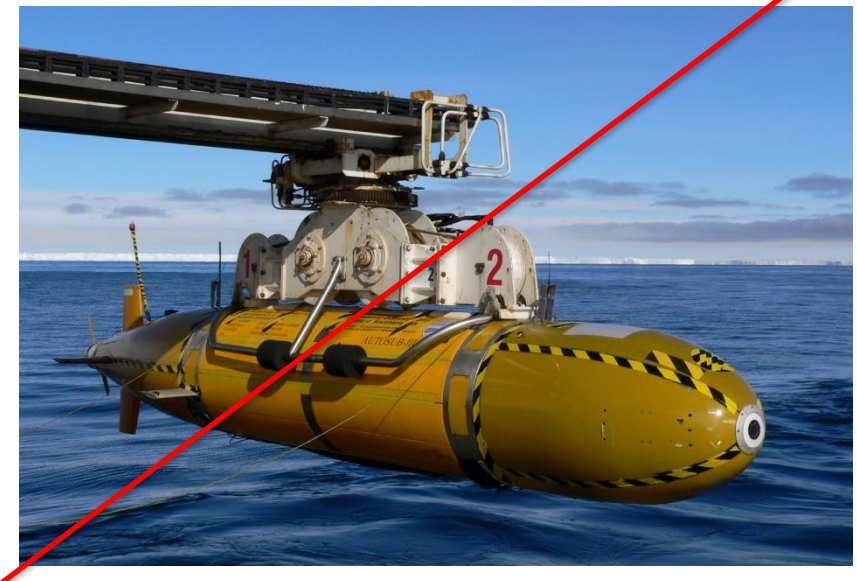


ALR1500 Status

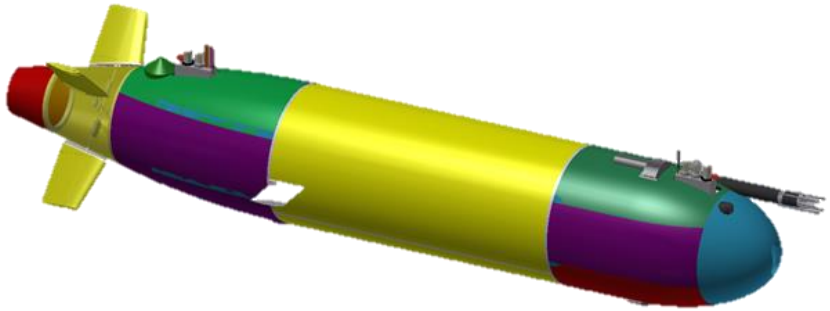
- Vehicles built
- Preliminary trials complete
- Long distance proving trials early 2020
- Under-ice capabilities being developer
- Transition into operations 2021

Autosub2000 Under Ice (A2KUI)

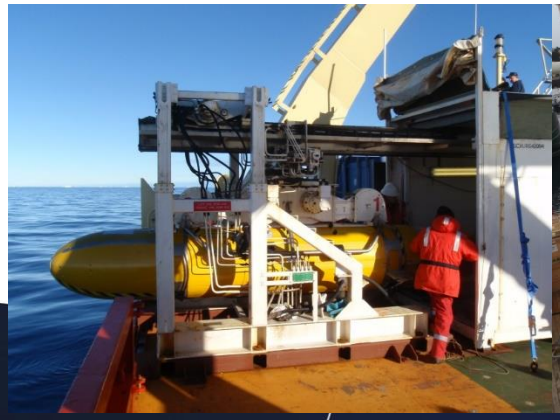
Project Lead – Matt Kingsland / Alex Phillips

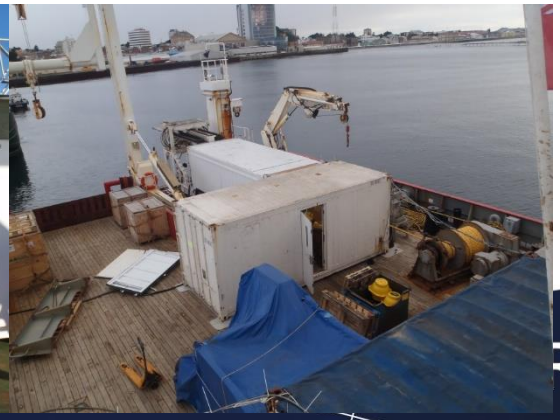


Autosub 3
(Retired 2017)



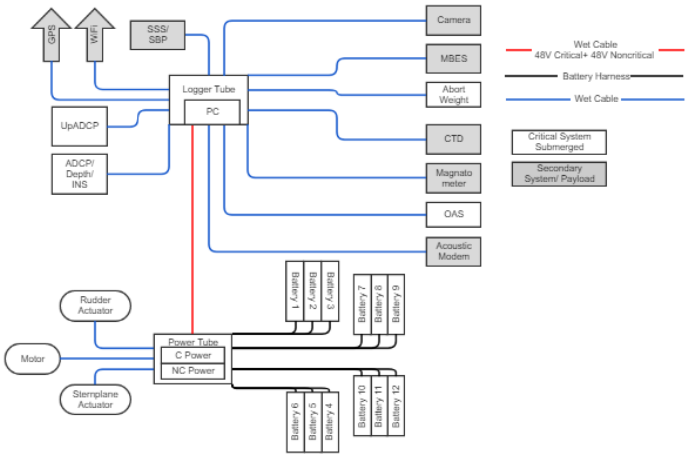
A2KUI
(Replacement ~2021)



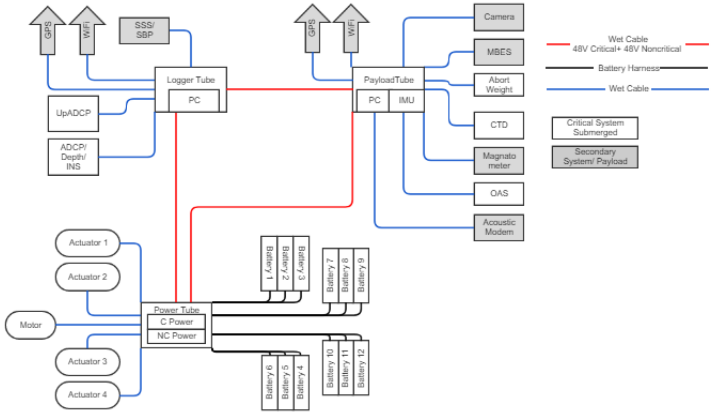


Key Technologies: Redundancy/Robustness

Driven by reliability



Update of Autosub6000
Limited Redundancy
P_{loss} Under Ice = 0.4326

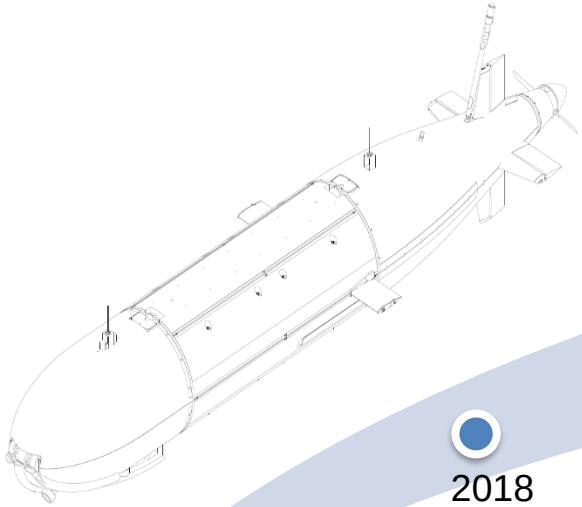


Partially Redundant (Limp Home)
Limited Redundancy
P_{loss} Under Ice = 0.1117

Autosub2000 Under Ice

Parameter	Autosub2KUI
Length	5.5 m
Diameter	0.9 m
Mass	1950 kg dry (2900 kg flooded)
Depth Rating	2000 m
Primary Propulsion	Direct drive fixed propeller(s)
Battery Technology	Lithium Polymer
Speed	1.1 to 1.6 m/s operational speed range
Range	200 km (science range)
Navigation Sensors	Sonardyne SprintNav 700 (INS/ADCP/Pressure) Sonardyne Syrinx DVL Norbit Norbit FLS forward facing sonar
Standard Communication	Iridium Short Burst Data, WiFi Sonardyne AvTrak Acoustic Modem
Standard Payload	Norbit Multibeam Echo Sounder Bathymetry (up or down) Edge Tech 2205 Sidescan Sonar Edge Tech 2205 Sub bottom profiler Seabird 9+ CTD

Autosub2KUI Timeline



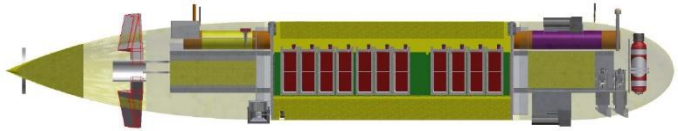
2017
- Requirements Capture

2018
- Concept Design
- Detailed Design

2019
- AUV Build
- Initial Engineering Trials

2020
- Payload Integration
- Payload Commissioning Trials

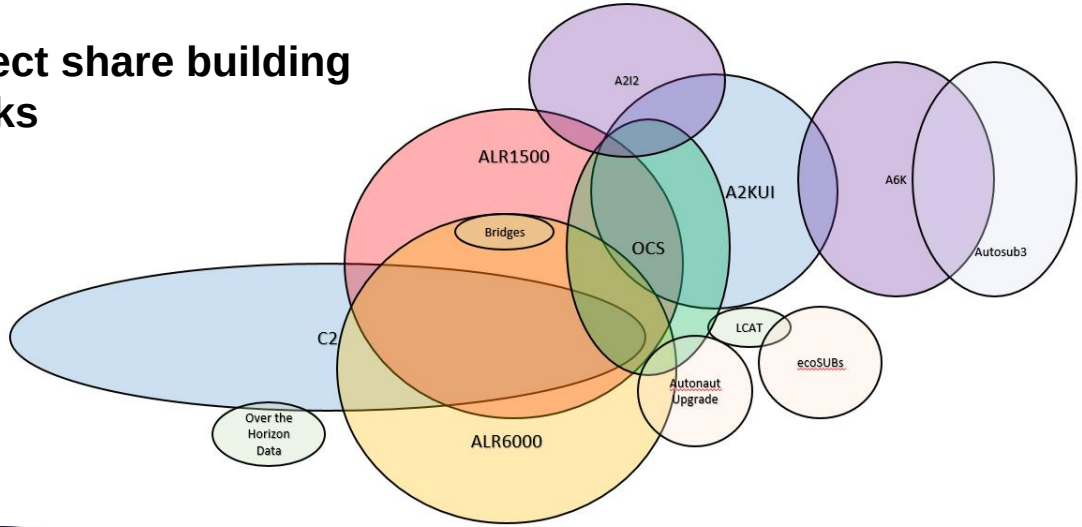
2021
- Under Ice Commissioning Trials
- Transfer to the NMEP



MARS Development – Leader Alex Phillips
Future Capabilities

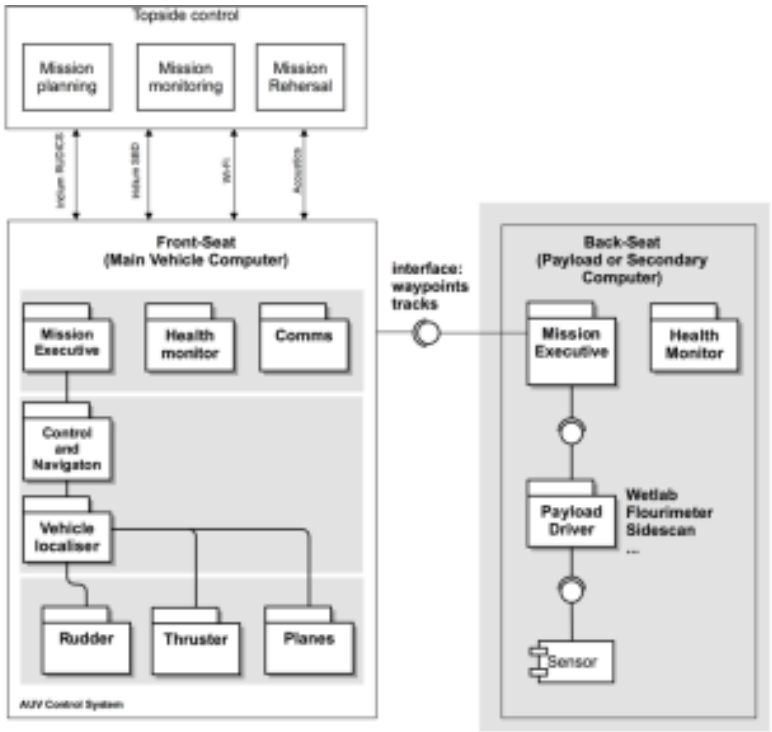
Modular Technology

Project share building blocks



Enabling Technologies – OCS
Project Lead – Miles Pebody

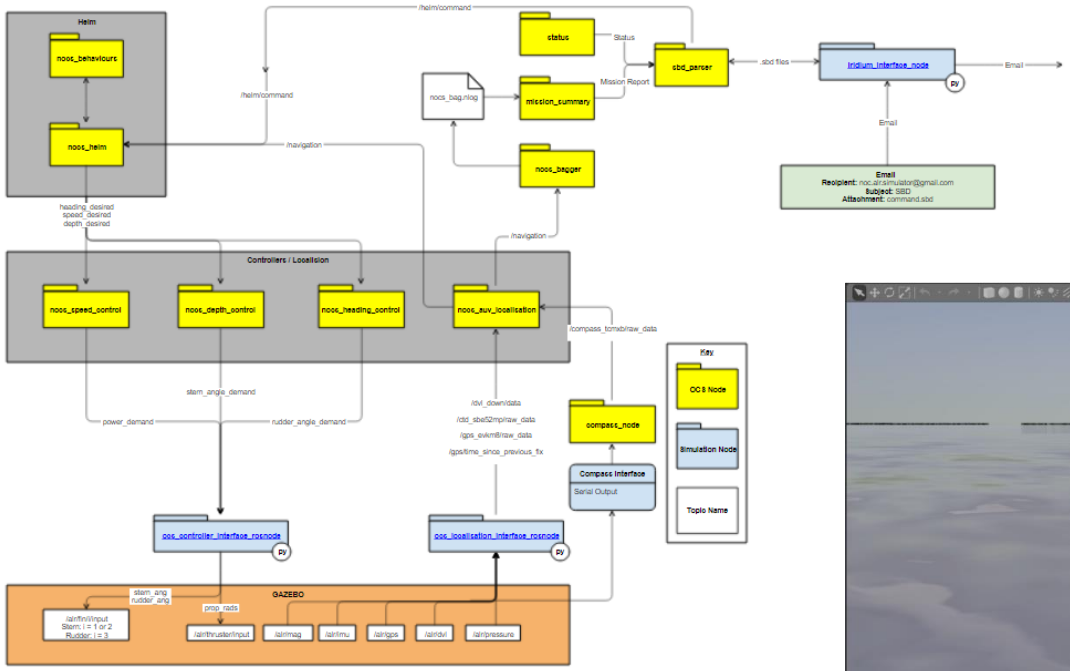
- New On-board Control System unified across Autosub vehicles
- Built using the Robot Operating System (ROS)
- Frontseat / Backseat Paradigm
- Common tested code base
- Independent of hardware/vehicle
- Software integration for sensors once

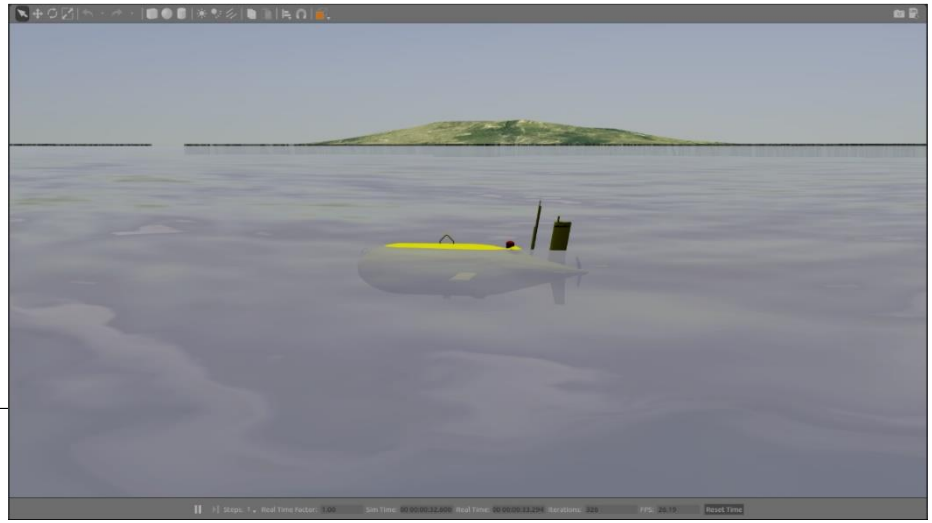


ROS infrastructure
- Virtual environments for simulation
- AI mission and vehicle planner
- Large open community support

Advanced robotic controls and autonomy
- Set of algorithms / behaviours / sensor drivers
- Control and navigation
- On-board sensor processing and situational awareness
- Network of vehicles

ROS OCS Simulation Using Gazebo





Command and Control (C2) and Data Management

Project Lead – Alvaro Lorenzo / Alex Phillips

Goals

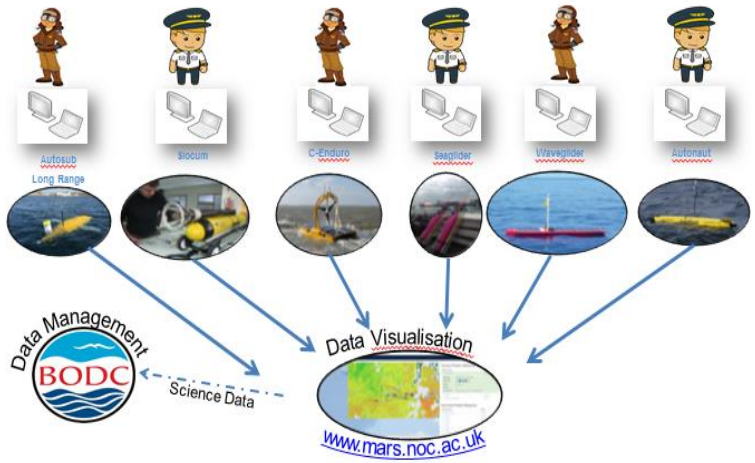
Phase 1 – Get the computers talking

1. Provide a unified and consistent infrastructure to control the MARS and broader fleets
2. Automate transfer and archiving of near real time science data to BODC
3. Improve access to the near real time data and associated metadata with appropriate user access controls.

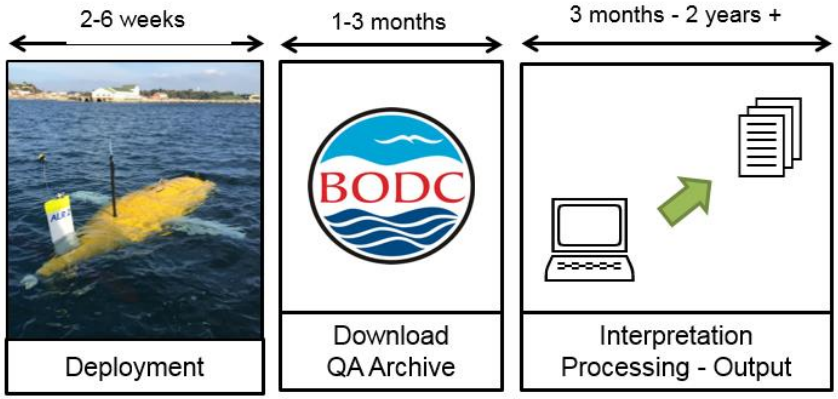
Phase 2 – Make the system smarter

1. Develop the infrastructure to automated piloting
2. Generate science and engineering data products eg reliability / mission risk information

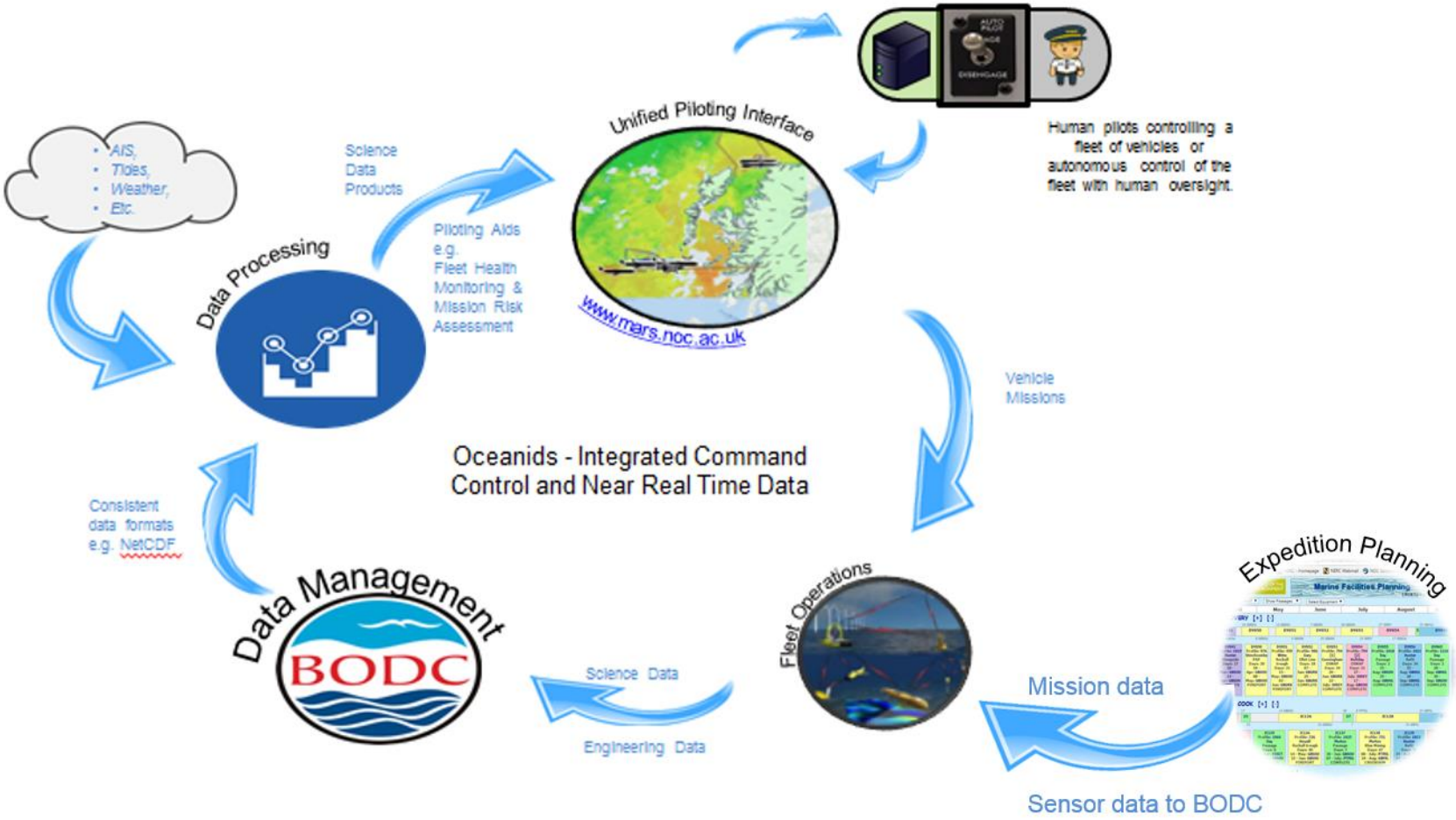
Problem 1 – Controlling the fleet



Problem 2 – Data Delivery

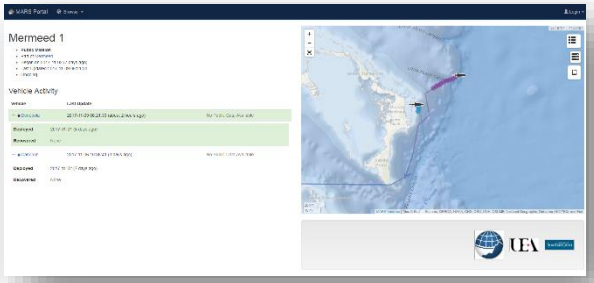


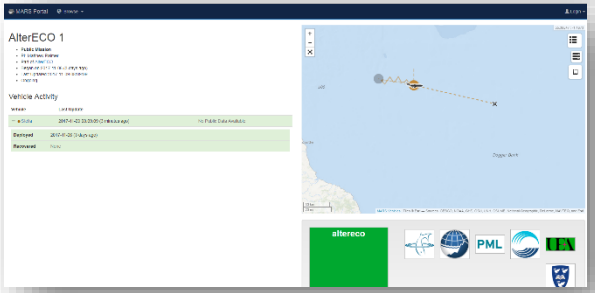
C2 Conceptual Workflow



Phase 1 – Developments (Agile)

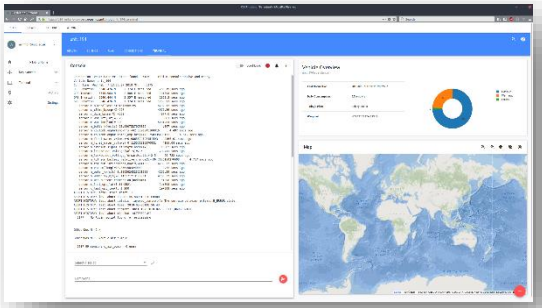
Near real time plots

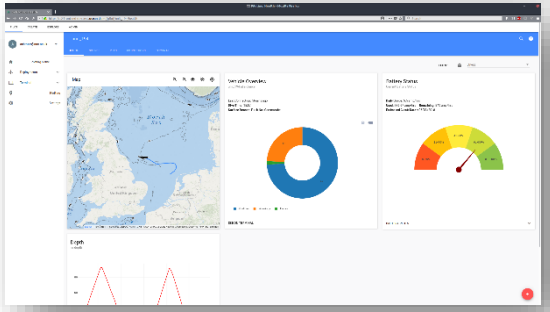


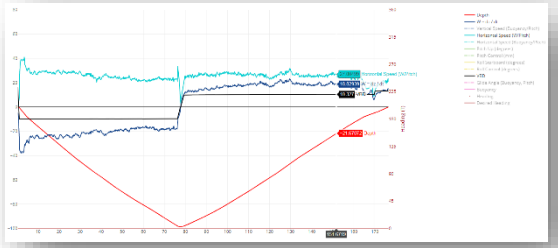


Vehicle Portal
mars.noc.ac.uk

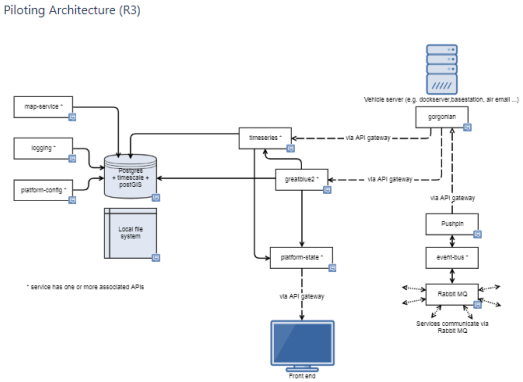
Unified Piloting Tools

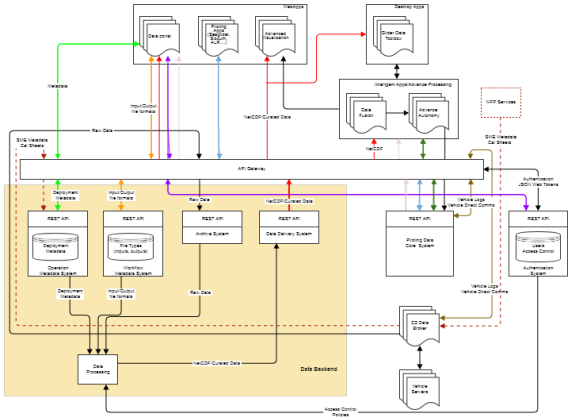






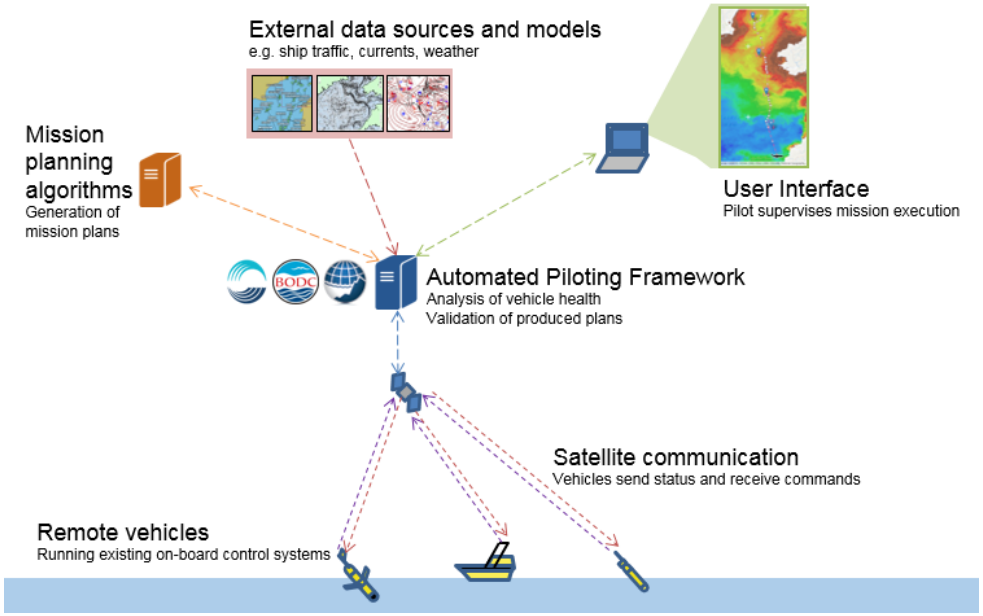
Computer plumbing



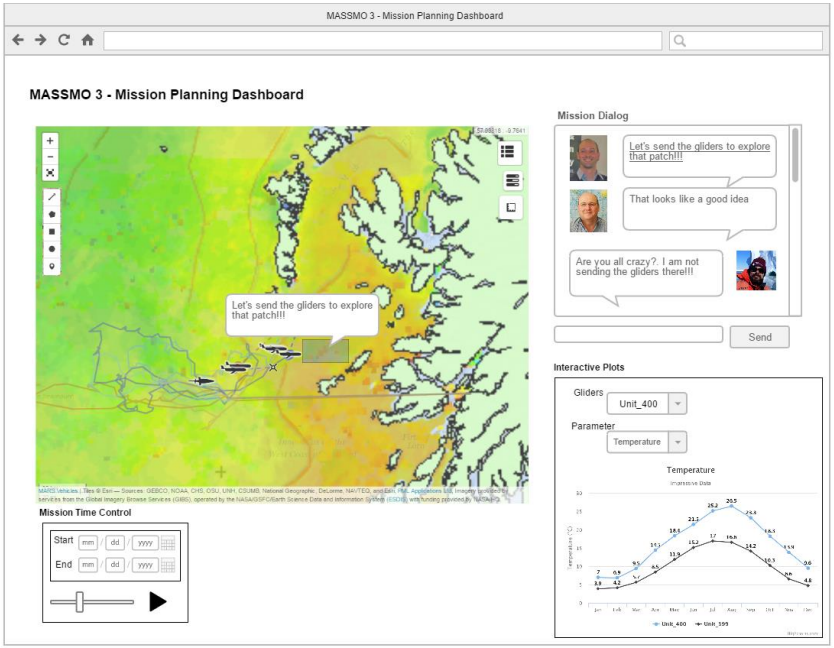


Phase 2 – Developments (Agile)

Automated Piloting Tools



High Level PI Mission Planning



Demonstrated Alter Eco trial – Q1, 19