Remote science on the Mayflower Autonomous Ship

James Sutton
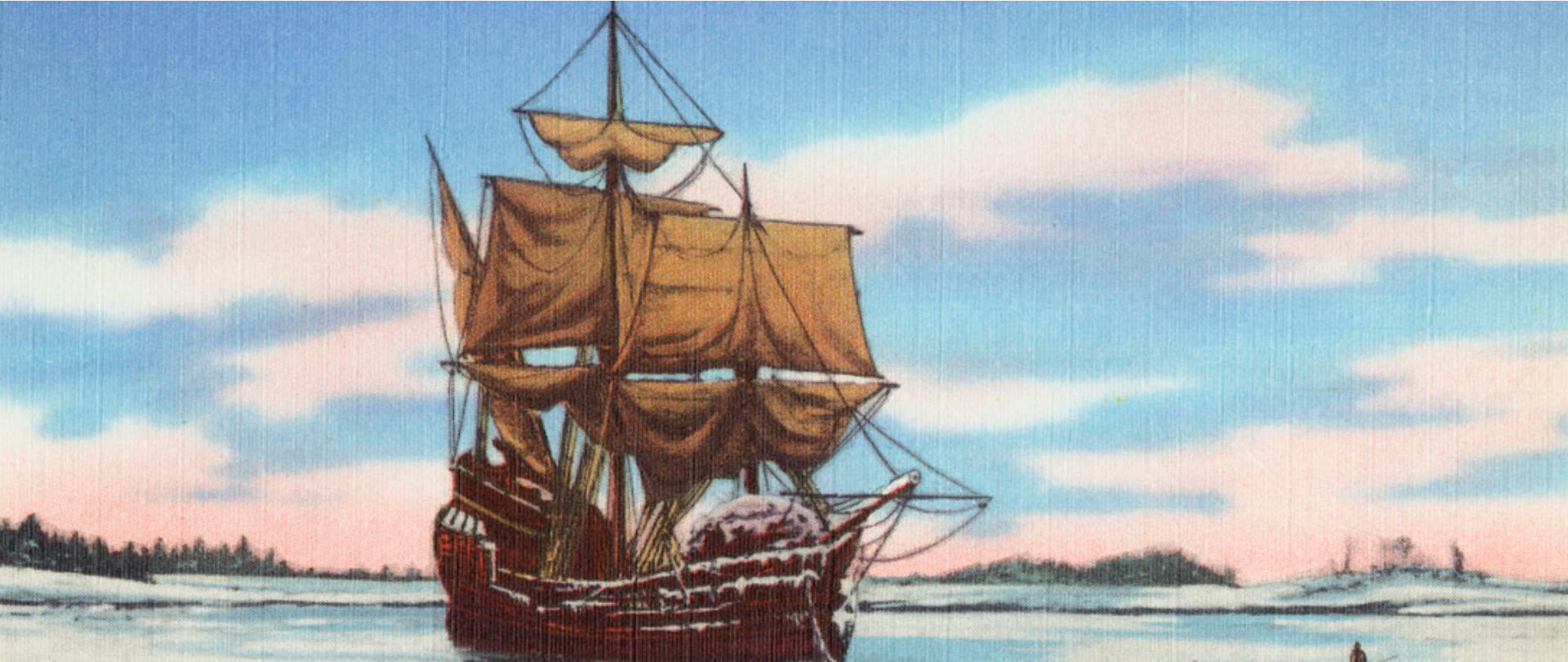
IBM UK – Emerging Technology

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Session 5AB

Mayflower - 1620
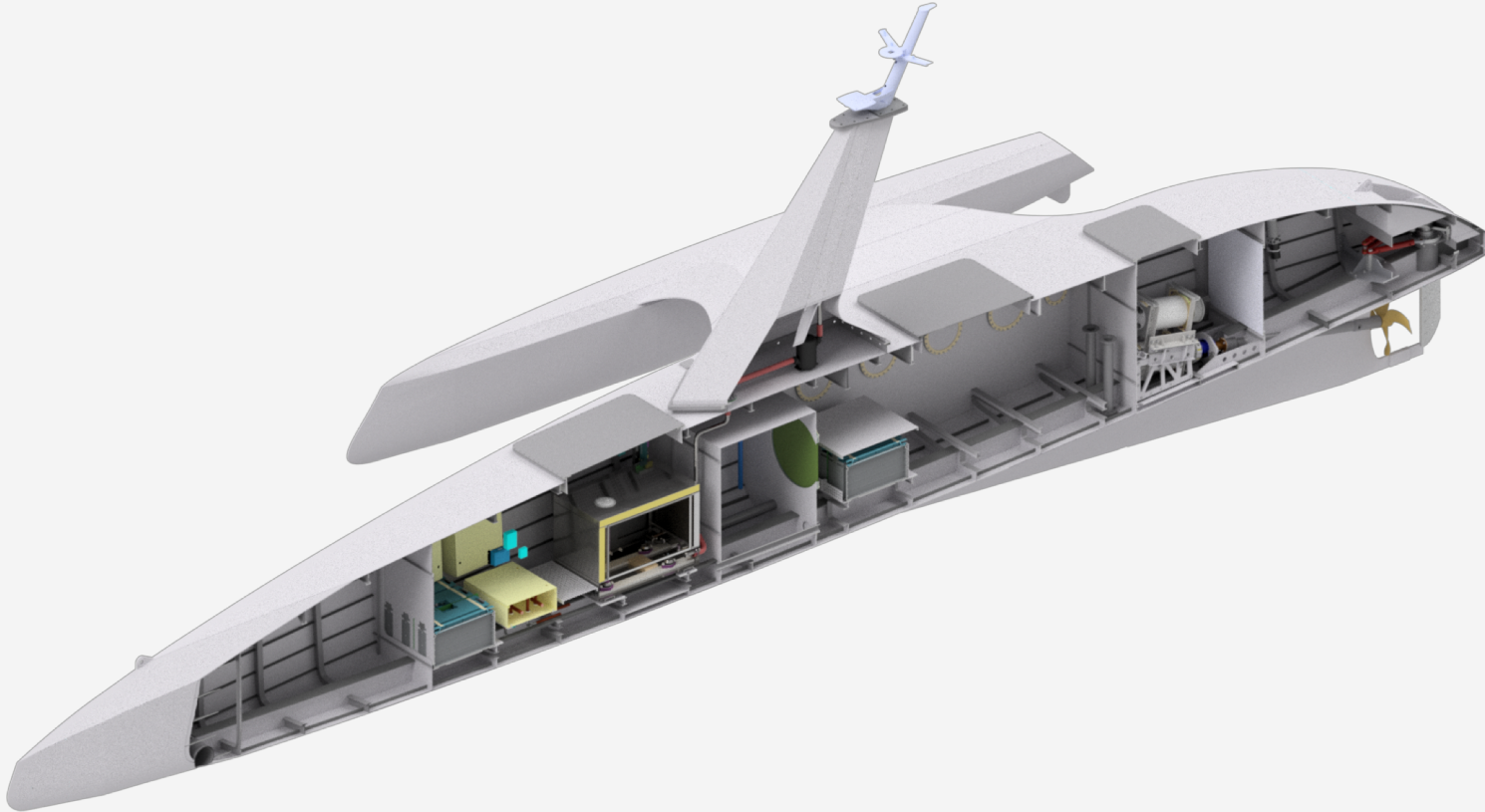
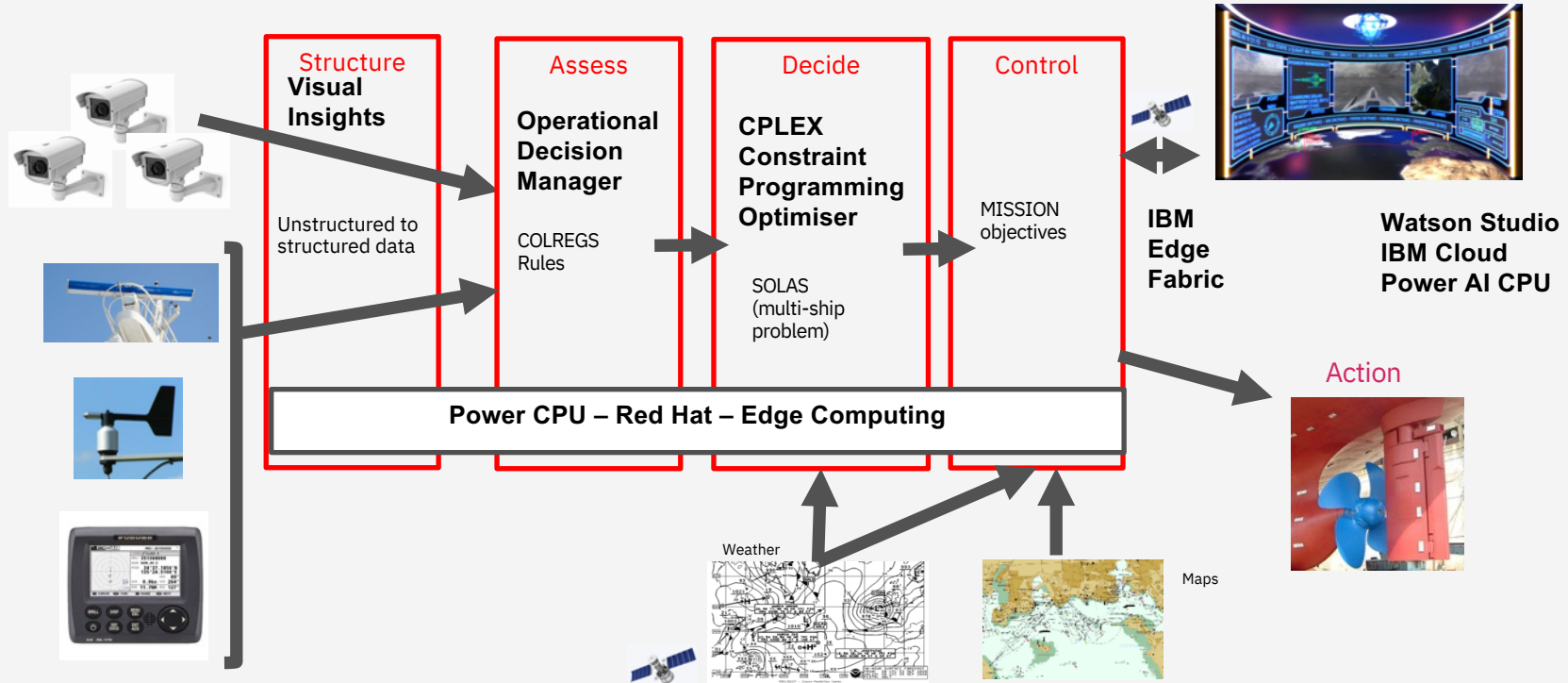# Mayflower Autonomous Ship - 2020

Next April...

Journey Map

Plymouth, England

Mid-Atlantic Ridge

Isles of Scilly

Cape Cod

Plymouth, MA

Titanic Site

Source: IBM

No space for crew, lots of space for science.

The AI Captain

Structure
Visual Insights

Unstructured to structured data

Assess
Operational Decision Manager

COLREGS Rules

Decide
CPLEX Constraint Programming Optimiser

SOLAS (multi-ship problem)

Control

MISSION objectives

IBM Edge Fabric

Watson Studio IBM Cloud Power AI CPU

Power CPU – Red Hat – Edge Computing
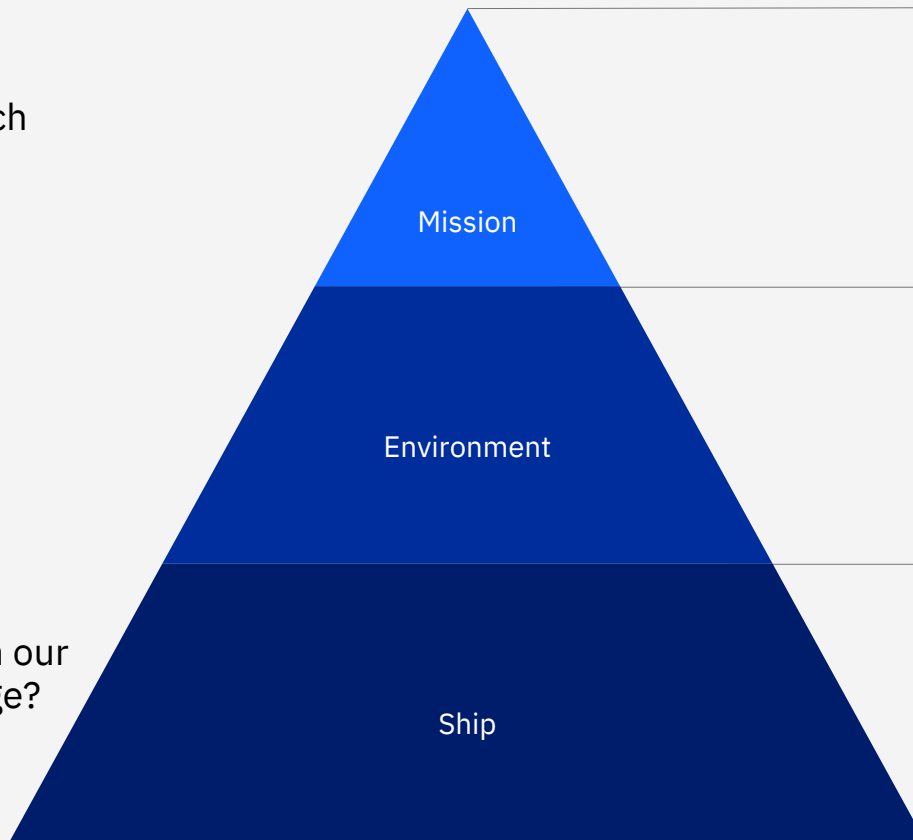
Action

Weather

Maps

The Weather Company

Decision making

What is the fastest route to reach this waypoint?

Is this radar image showing an iceberg or fishing boat?

What speed can we sail at given our current remaining battery charge?

Mission
- Navigate to destination.
- Collect data.
- Execute science experiments..

Environment
- Manage global situation.
- Understand environment fully.
- Respect rules at sea...

Ship
- Manage local situation.
- Maintain systems operation.
- Avoid collisions
- Face into waves...

Mission
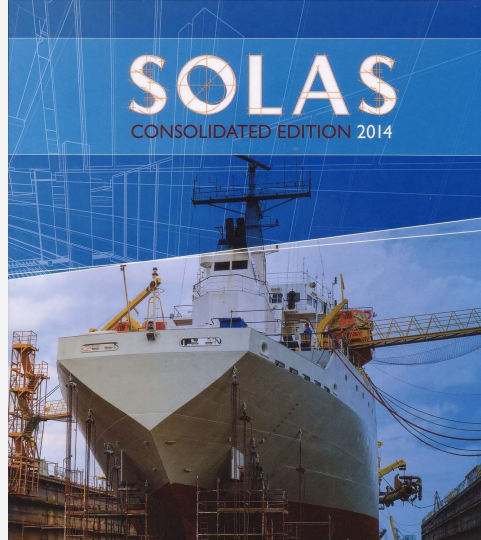
Environment

Ship

Rules – COLREGs / SOLAS

NavControl Model

- NavHazard output

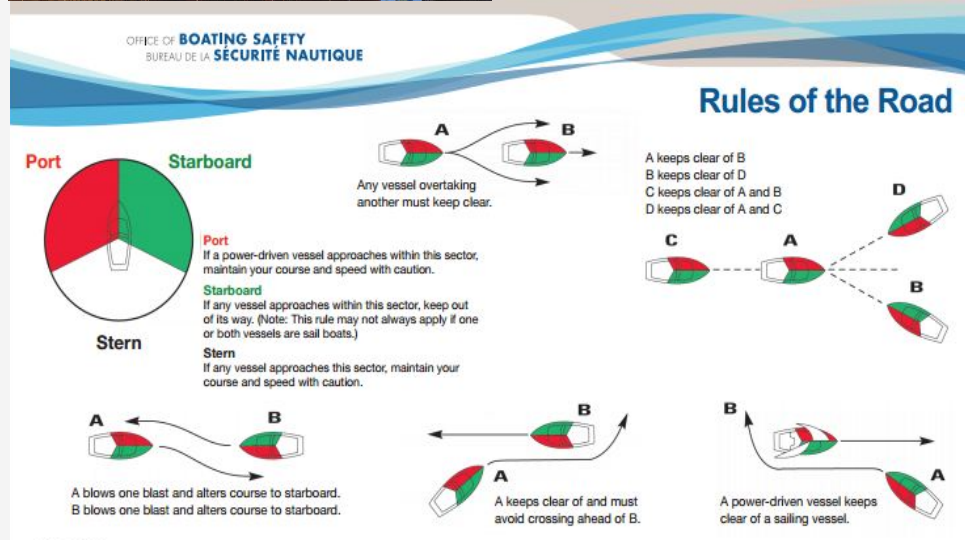- Integrated with GPS, AIS, Radar & Chart data

- COLREGs

Reinforcement Learning

- Buoys, markers & shipping lanes

- Single vessel

- Multiple Vessels

- COLREGs violators

Outcome: Target Speed and heading

Overall policy:

Don't hit anything!
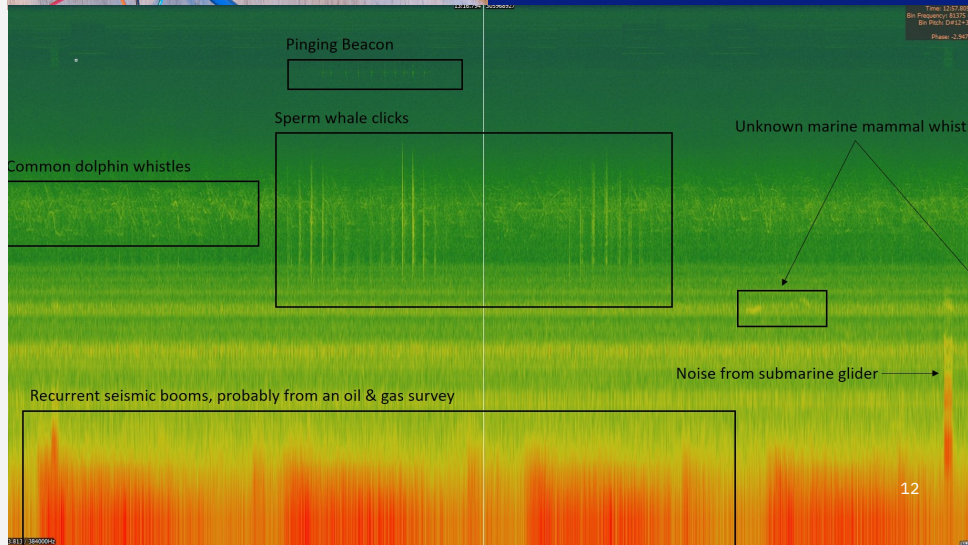
The science

- Whale populations

- Ocean Chemistry

- Tides, sea level & wave field

- Music synthesis

- Microplastics

- Phytoplankton productivity

- Wave energy

- Temperature, salinity & depth

Whale Populations

Streaming 384KHz audio from a hydrophone attached to the hull of the MAS through a classification model to identify Whale species from their song.

- Goal to identify rough location of whales and their species.

- Can be used to eventually monitor the populations of whales and their migratory habits.

- Also using the same audio stream to identify anomalies in the audio signature of the MAS itself over time.

Roughly 1TB expected audio data will be recorded for the 14-day voyage.

Pinging Beacon

Sperm whale clicks

Unknown marine mammal whist

Common dolphin whistles

Noise from submarine glider

Recurrent seismic booms, probably from an oil & gas survey

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Ocean Chemistry

Measuring pH and nutrients in sea water to understand the rate of ocean acidification in different parts of the ocean

– An array of Hypertaste sensors; "digital tongues" will sample the seawater at numerous points during the voyage.

– Readings from Hypertaste sensor processed by Machine learning model running on Raspberry Pi in the science Pod.
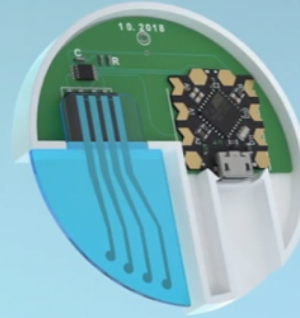
Hypertaste was originally created to "fingerprint" liquids in order to identify concentrations of ingredients, or even the authenticity of a wine or scotch.

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Open Ocean Wave Energy

HD video camera footage paired with accurate IMU (Inertial Measurement Unit) data will help the MAS calculate the energy of the wave field in real time.

– 6 HD network cameras on board the MAS.

– 1 IMU located in the middle of the ship.

– Data collected by two Raspberry Pi 4b modules saved onto SSD.

More accurate wave energy models will help predict the damage that waves do to coastal infrastructure as well as the energy that wave energy systems could harness

Open ocean tides and sea level.

Using multiple GNSS receivers, the MAS will record highly accurate sea level measurements.

– Will show the pattern of change in the open ocean as well as tides and wave height.

– Multiple GNSS receivers connected to Raspberry Pi 4b which will store the high frequency positional data.
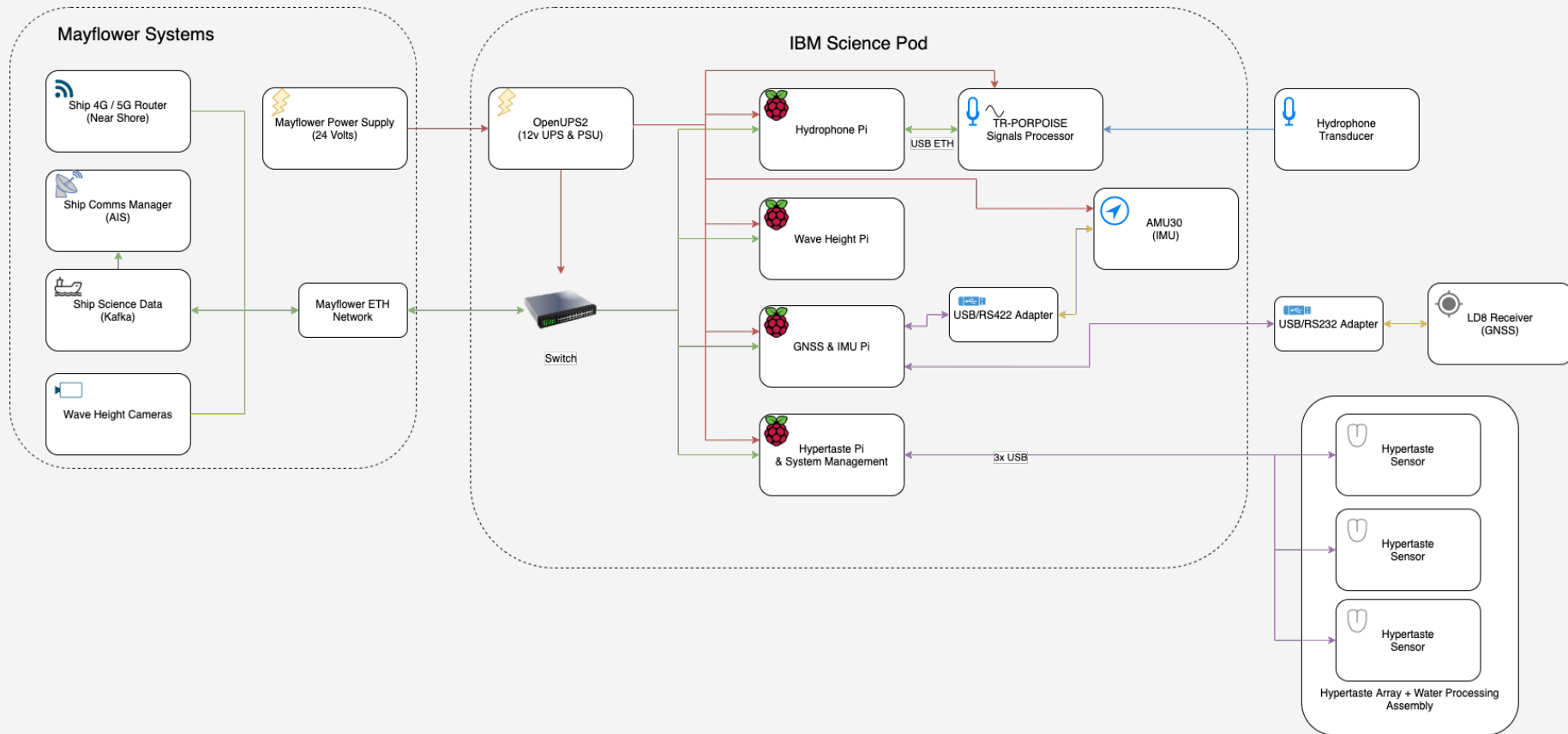

Results will help scientists study large-scale currents and surface flows of the ocean providing an understanding of the spatial variations in sea level.
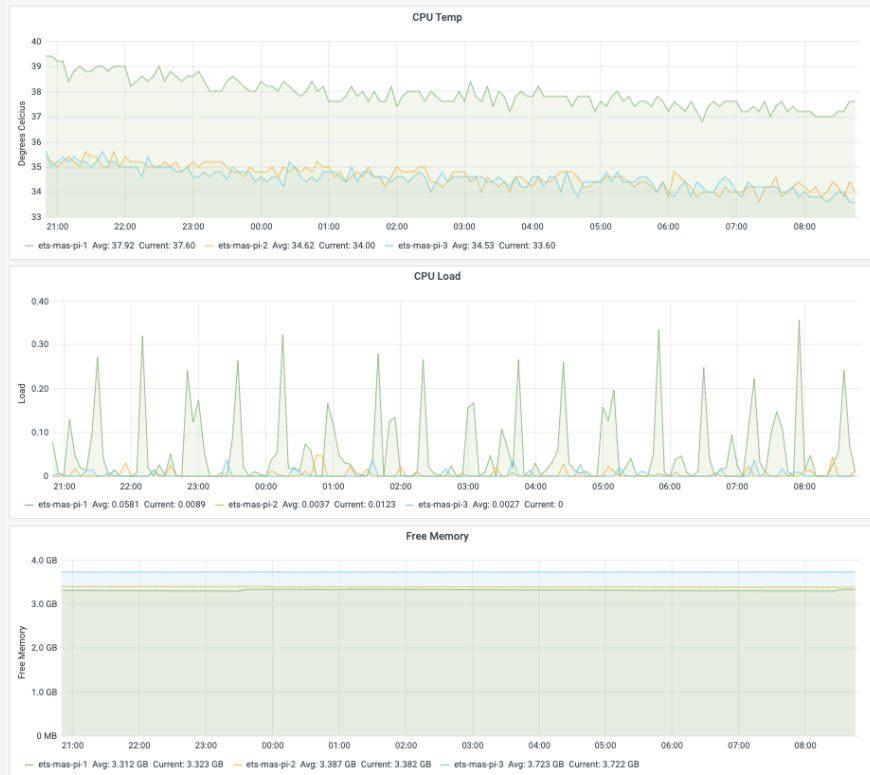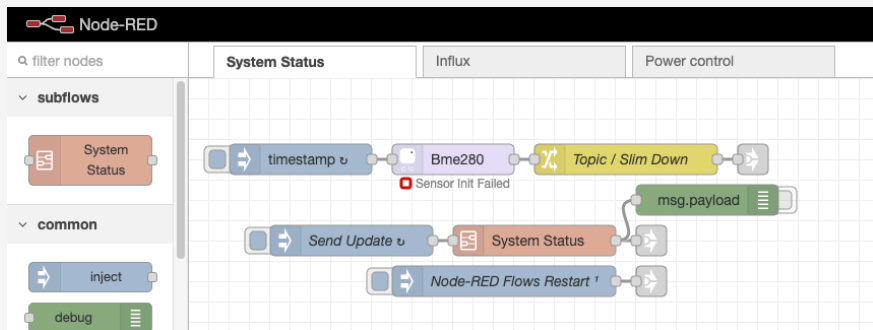
The science Pod
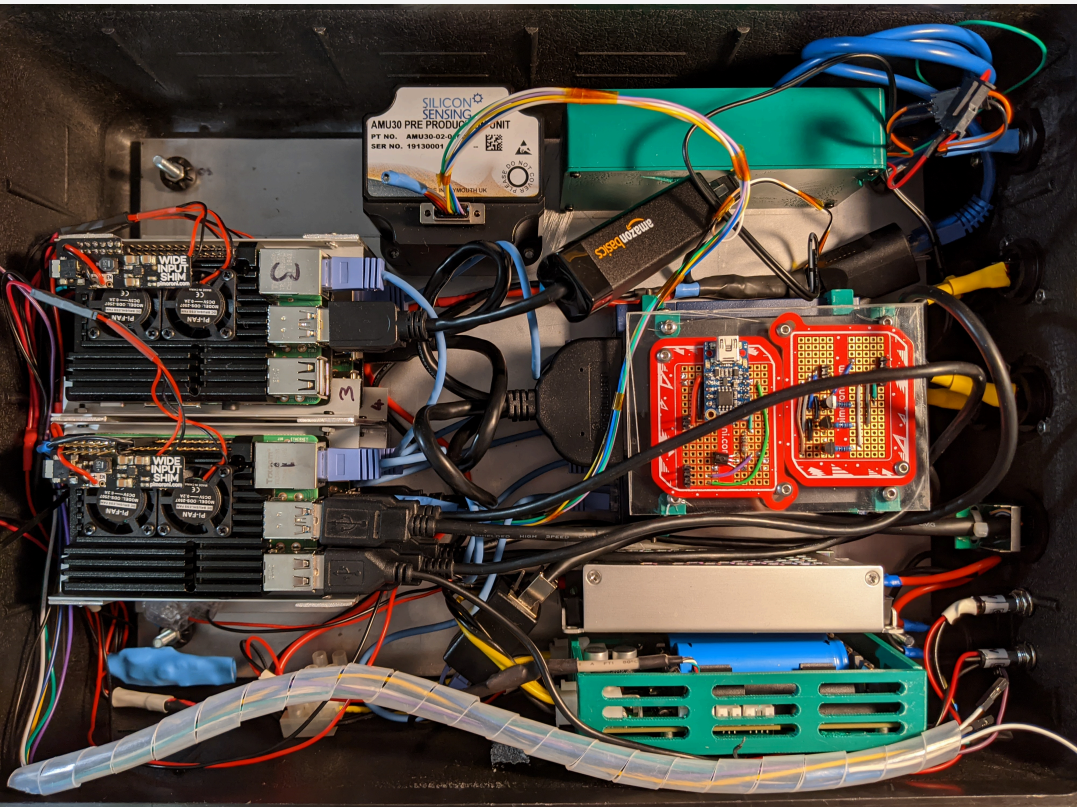
# Under the hood

Supporting Software

Educational Outreach

Goal to introduce the Mayflower Autonomous Ship and its mission to students of all ages.

– Introduction to programming exercises.

– Access to sensor data recorded on the MAS

– Opportunity to design and program their own science experiments that will run on the MAS.

Raising awareness of the link between ocean health and climate change whilst also showing students how easy it is to write code for science.
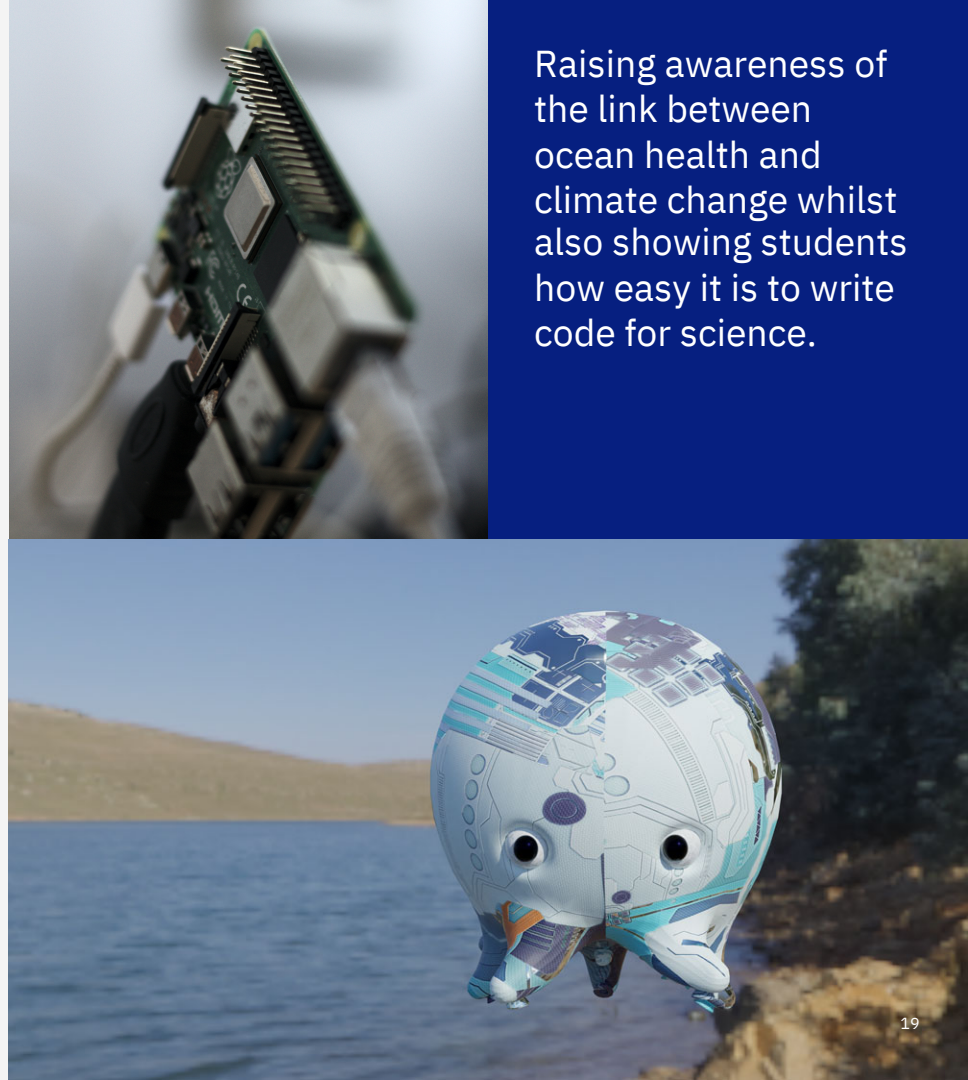
Thank you

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1. What is your conference registration number?

💡 **This is the three digit number on the bottom of your delegate badge**

2. Was the length of this presention correct?

💡 **1 to 4 = "Too Short" 5 = "OK" 6-9 = "Too Long"**

1	2	3	4	5	6	7	8	9
○	○	○	○	○	○	○	○	○

3. Did this presention meet your requirements?

💡 **1 to 4 = "No" 5 = "OK" 6-9 = "Yes"**

1	2	3	4	5	6	7	8	9
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4. Was the session content what you expected?

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1	2	3	4	5	6	7	8	9
○	○	○	○	○	○	○	○	○

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