

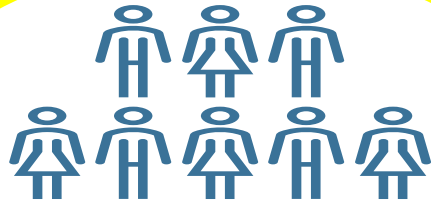


FMRI

**FUTURE
MARINE
RESEARCH
INFRASTRUCTURE**

HARNESSING CUTTING-EDGE CAPABILITIES

Emerging technologies: remotely operated & autonomous platforms, sensors and digital tools and



**UK
RI**

**Natural
Environment
Research Council**

**“All new ideas begin in a non-conforming mind that questions some tenet of the conventional wisdom”
Adm HG Rickover**



FMRI

FUTURE
MARINE
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INFRASTRUCTURE

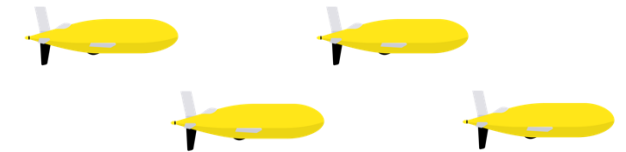
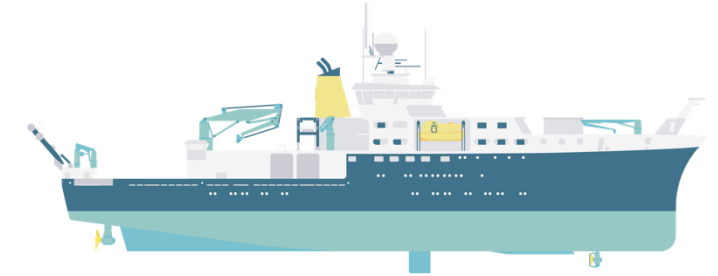
1. **Why – NZOC recommendation**
2. **The ‘Ironies of Automation’ (L Bainbridge)**
3. **Remotely operated and autonomous platforms**
4. **Marine sensors**
5. **Digital systems**
6. **Research infrastructure intangibles**



Natural
Environment
Research Council

Net Zero Oceanographic Capability report

- Green fuels are less energy dense therefore bigger ships or reduced endurance.
- Reduced endurance = reduced capacity SO how to maintain capacity?
- Autonomous systems as 'capacity multipliers'



**NZOC:
Net Zero
Oceanographic
Capacity**
Summary Report

https://fmri.ac.uk/sites/fmri/files/documents/nzoc_summary_report2.pdf



UK Future Marine Research Infrastructure

- Autonomous systems as ‘capacity multipliers’
- Autonomous systems as ‘capability multipliers’
- Autonomous systems as a shore or ship-launched independent capability



The Ironies of Automation – Lisanne Bainbridge

Abstract

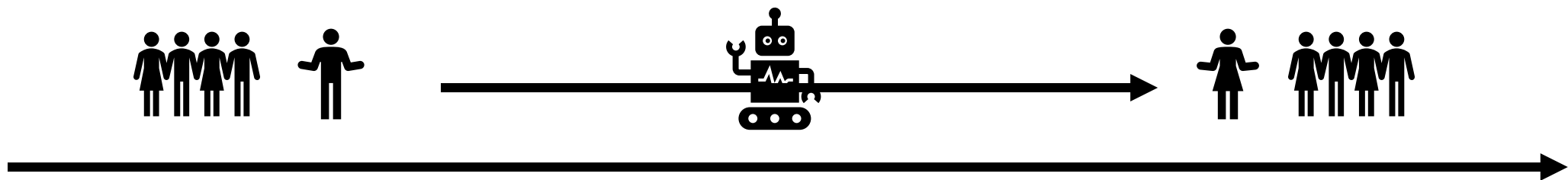
This paper discusses the ways in which automation of industrial processes may expand rather than eliminate problems with the human operator. Some comments will be made on methods of alleviating these problems within the 'classic' approach of leaving the operator with responsibility for abnormal conditions, and on the potential for continued use of the human operator for on-line decision-making within human-computer collaboration.



The Ironies of Automation – Lisanne Bainbridge

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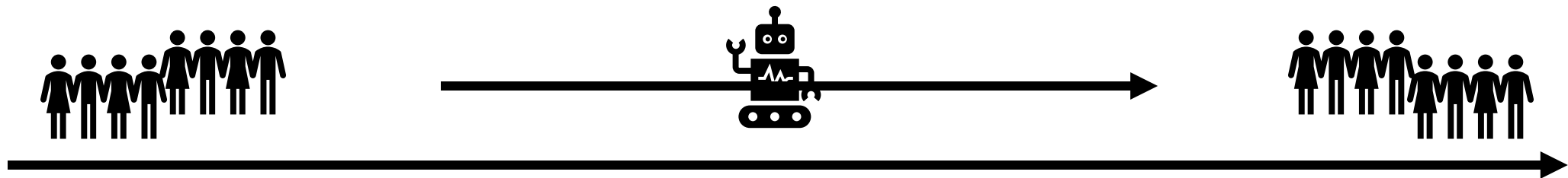
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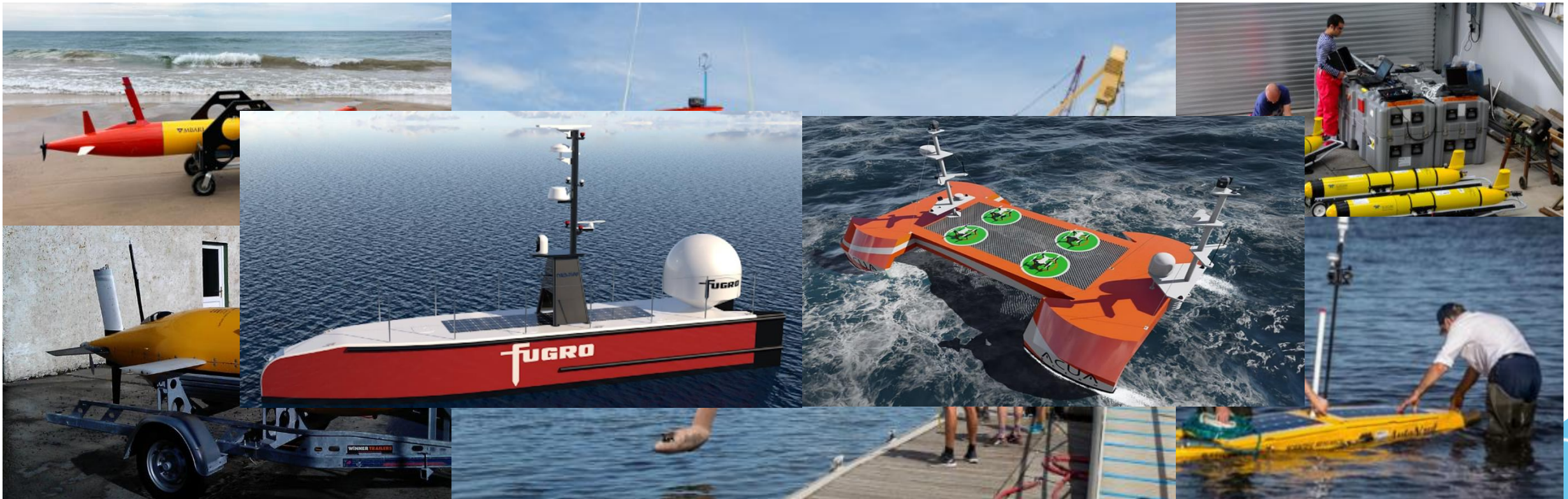
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AUVs & ROVs

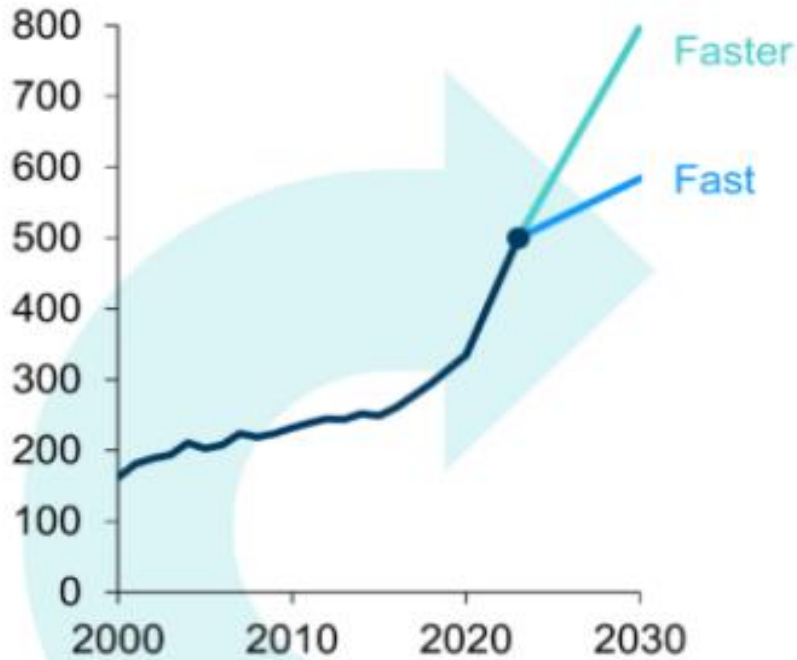
SUT's RCPOAMV wrt ODAS (SPURVs, AUVs, USVs, UUVs) engaged in MSR and the application of UNCLOS Art 94(4) and IMO regulations as proscribed by IACS members including ABS, CCS, NK, DNV and LR

Daiana Seabra Venancio (05 Aug 2025):Challenges in Defining the Legal Status of AUVs, Ocean Development & International Law, DOI: 10.1080/00908320.2025.2531164



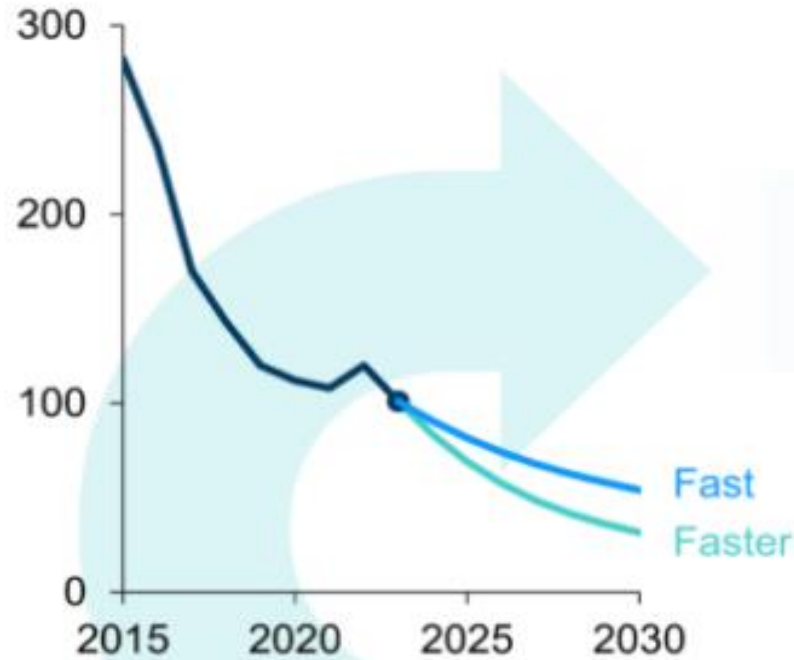
Battery energy density keeps rising...

Top-tier battery cell energy density outlook, Wh/kg



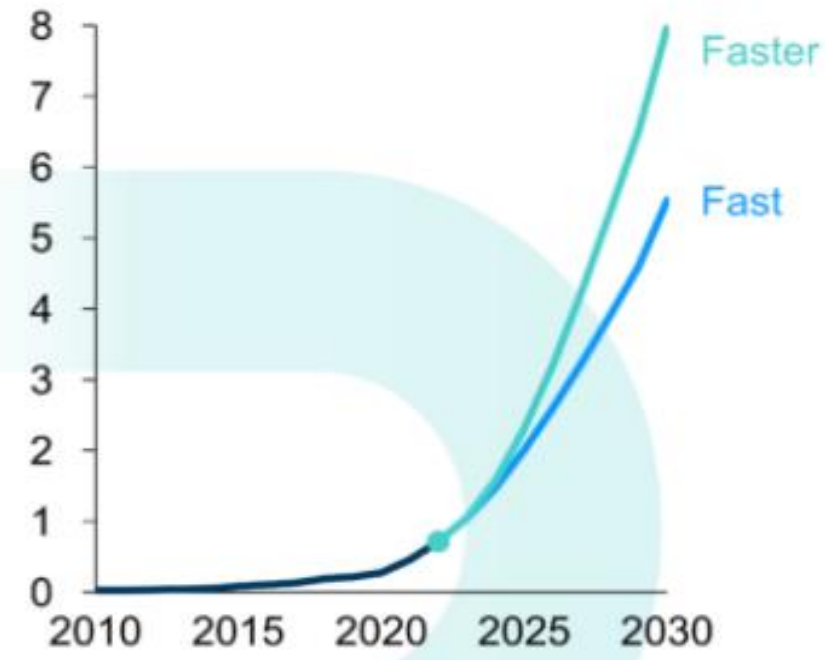
...while battery cost keeps falling...

Battery cell cost outlook, \$/kWh



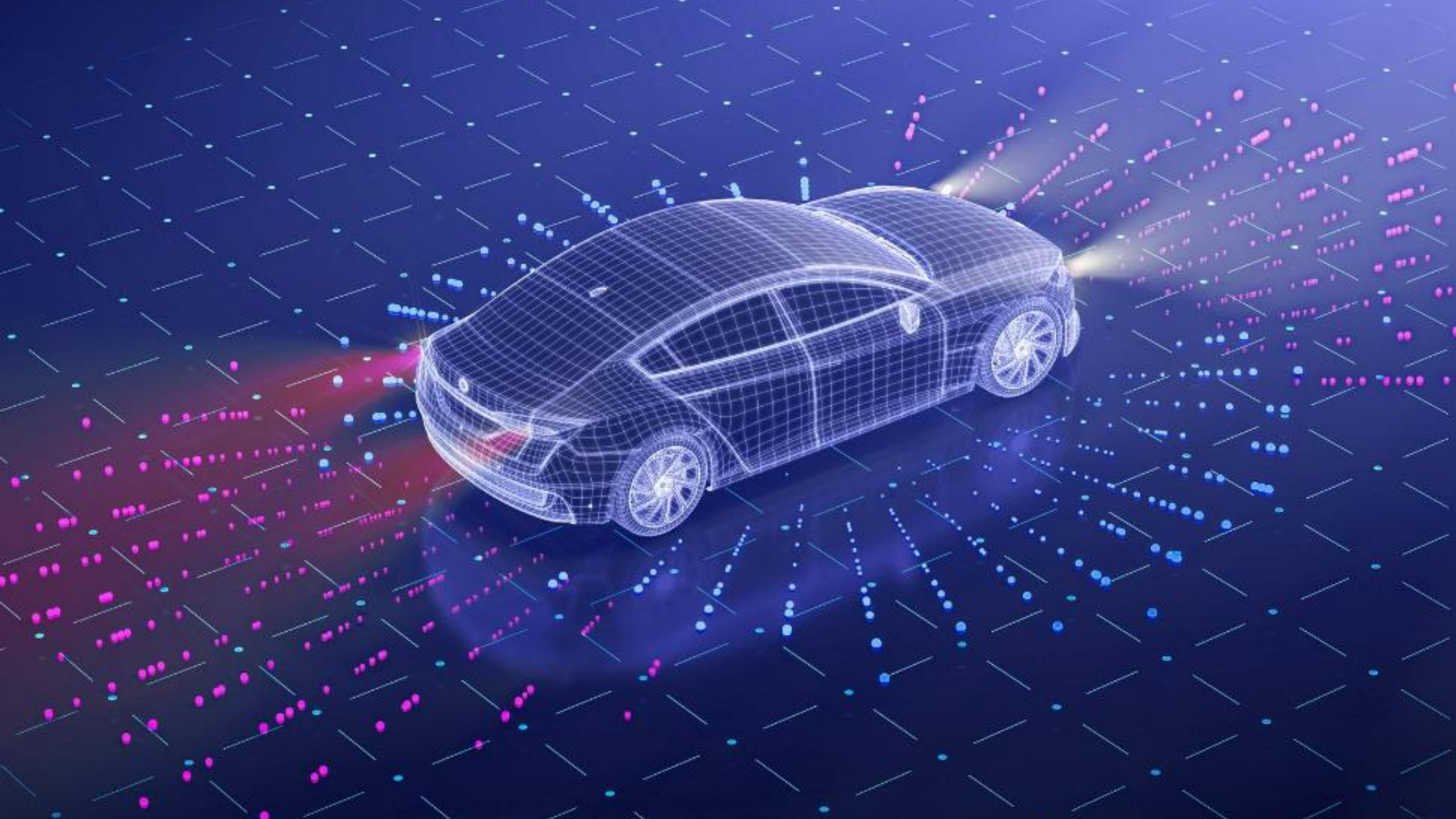
...driving exponential growth of battery demand...

Battery demand outlook, TWh/y

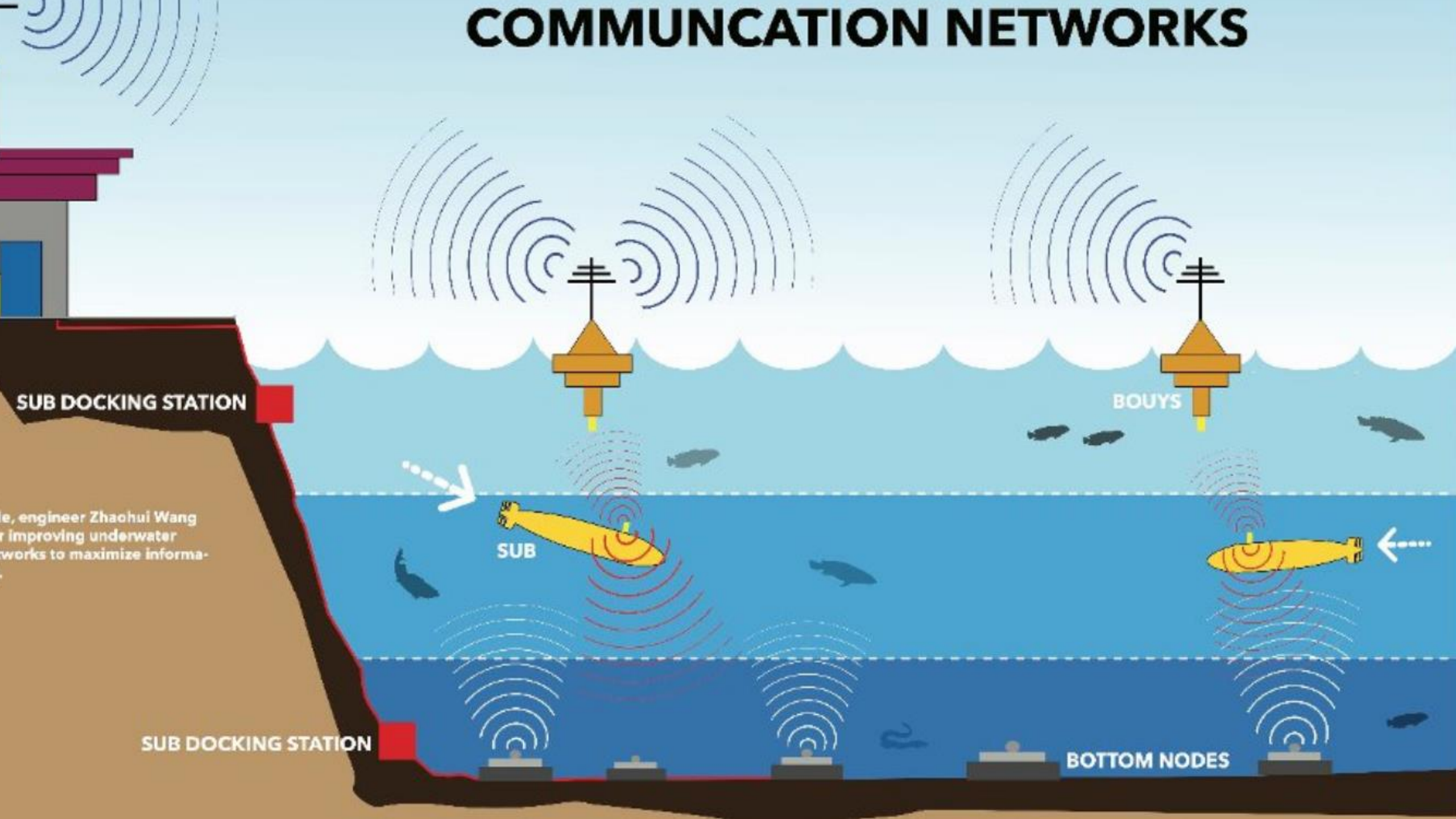


...which, in turn, further increases energy density and lowers cost through economies of scale and learning effects.

Source: Ziegler and Trancik (2021) before 2018 (end of data), BNEF *Long-Term Electric Vehicle Outlook* (2023) since 2018, BNEF Lithium-Ion Battery Price Survey (2023) for 2015-2023, RMI analysis.



COMMUNICATION NETWORKS



SUB DOCKING STATION

BOUYS

SUB

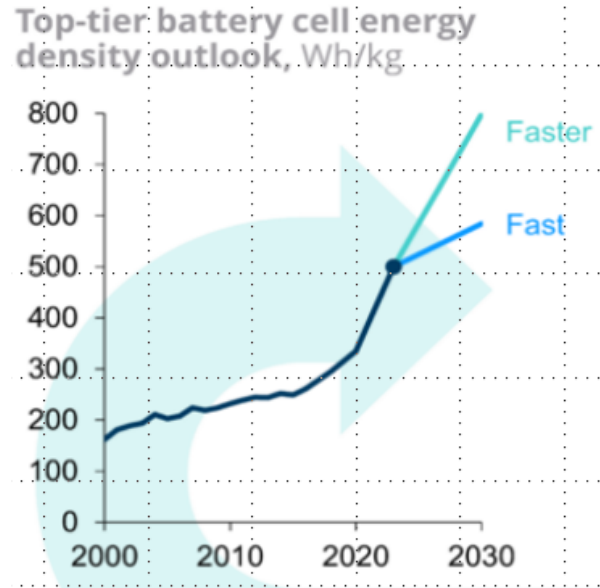
SUB

SUB DOCKING STATION

BOTTOM NODES

le, engineer Zhaohui Wang
r improving underwater
works to maximize informa-

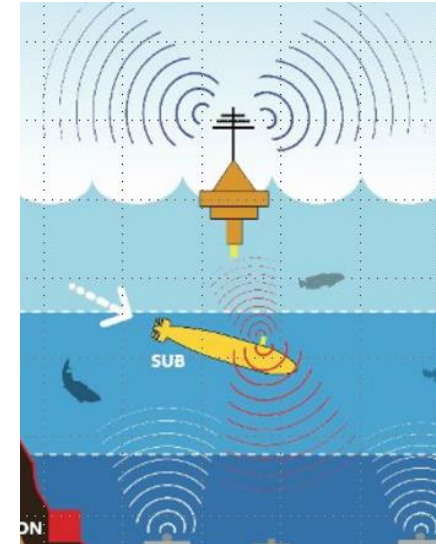
Leap Forward



X



X



Scientific Sensors

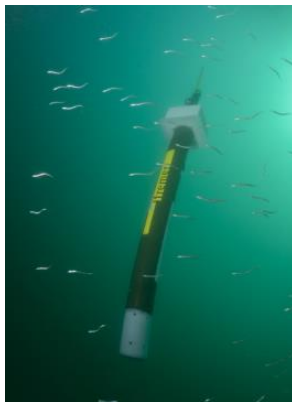
Standardised Sensor Package

Lower cost

Higher reliability

Improved interoperability

Less useful???



Bespoke Sensor Package

Higher cost

Lower reliability

Reduced interoperability

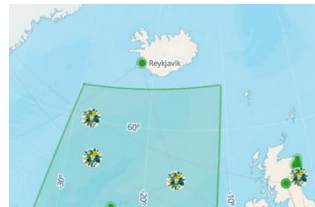
More useful???



Digital Tools



PLAN



DO



PUSH



STORE

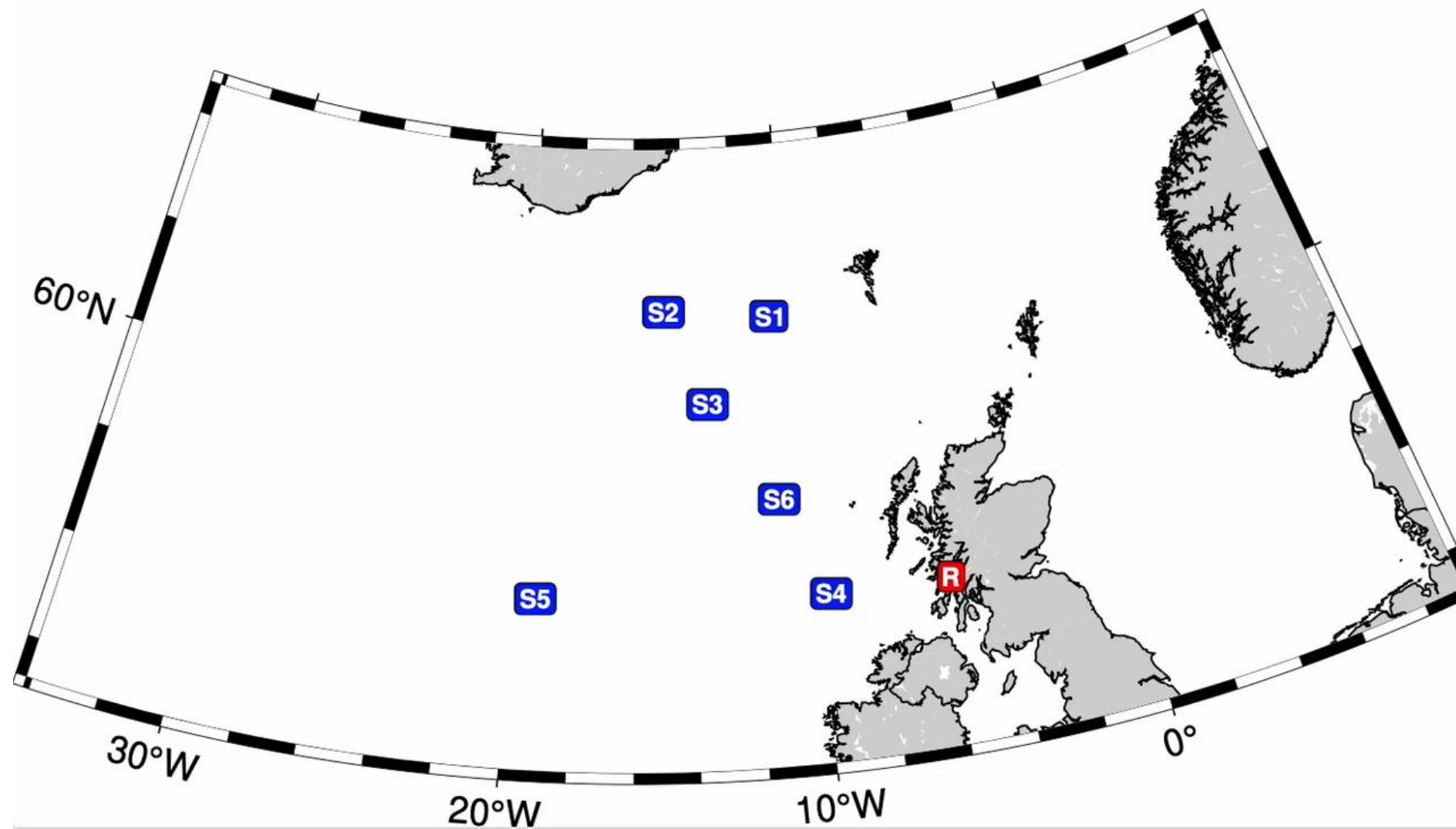


FMRI - AI Enabled Planning: Scenarios

Name		Available Assets	Science Tasks	Total number of deployments	Deployment	
					Shoreside	Ship
Scenario a – Scotland / Iceland / Greenland	1. Oban - Iceland	15 Slocum, 5 ALR1500	11	40	✓	
	2. Kangerlussuaq Fjord, East Greenland	15 Slocum, 5 ALR1500	11	47		
	3. Oban - W. Scotland	15 Slocum, 5 ALR1500	11	40		
Scenario b – Ship Deployment, Southern Atlantic		10 Slocum, 2 ALR1500	12	24		✓
Scenario c – scenario a/1 with speed and battery improvements	1. +10% on AUVs' speed	Same as in scenario a/1 (Oban - Iceland)				
	2. +10% on AUVs' batteries					
	3. +10% on AUVs' speed and batteries					

Scenarios (a.1) and (a.3) as one

01/01/2025



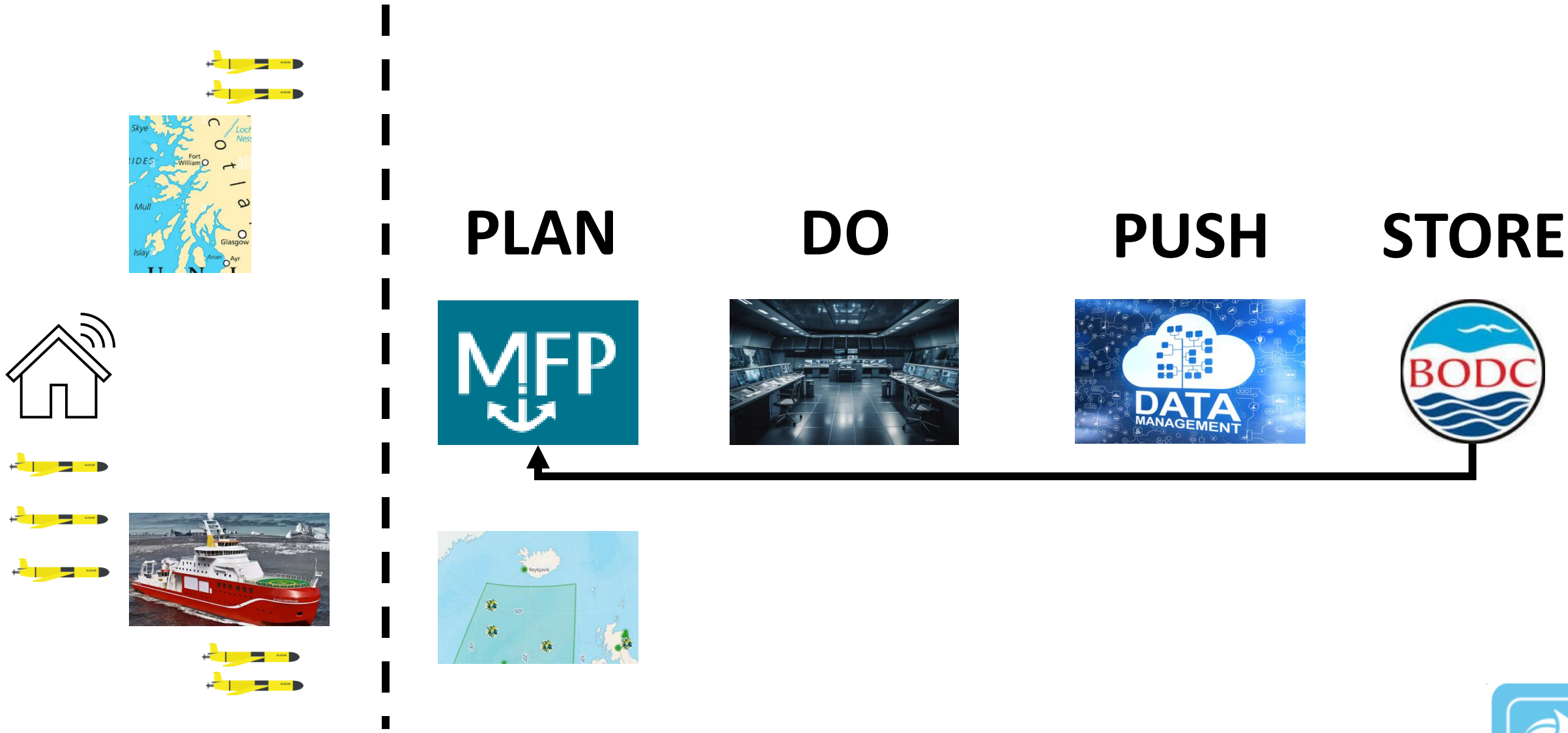
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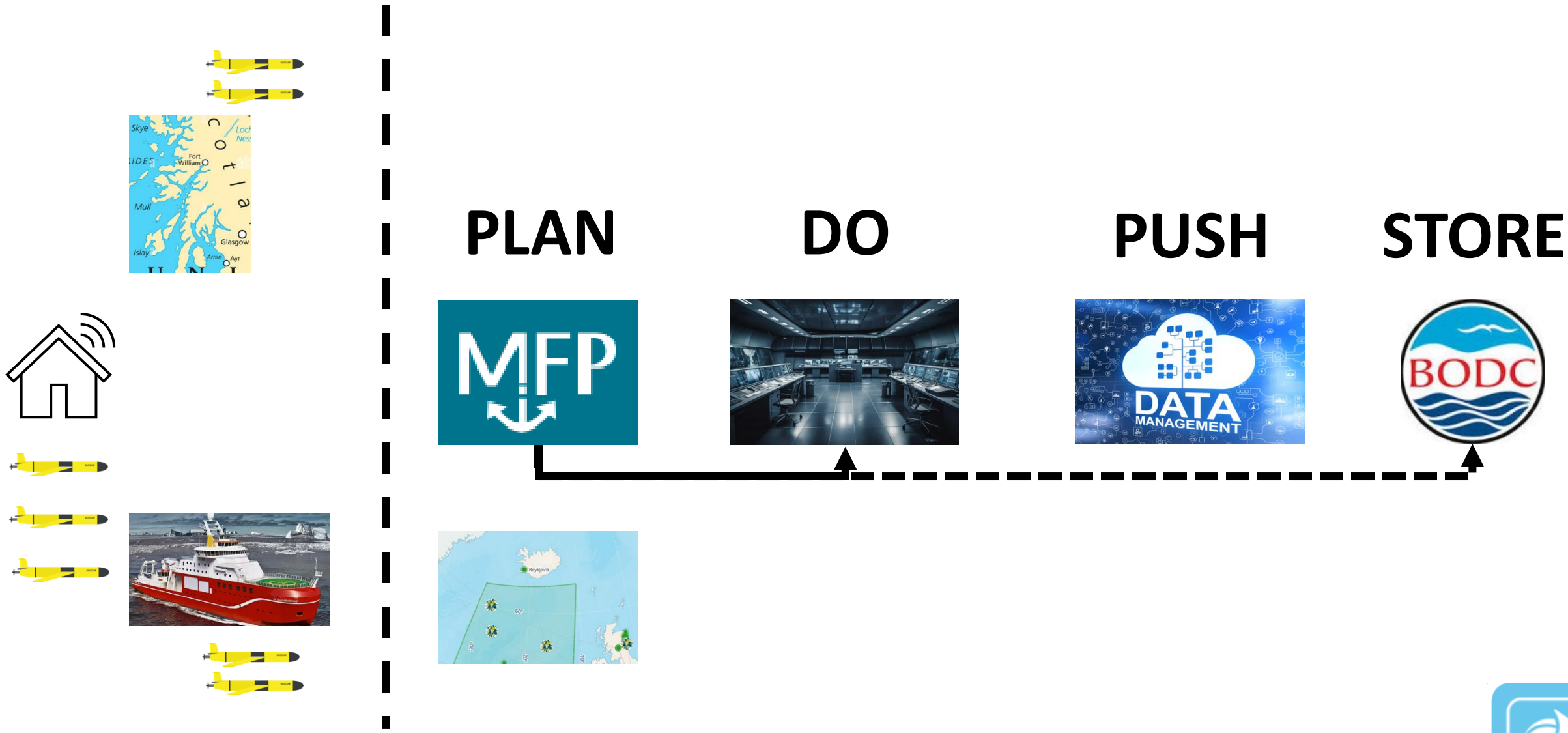
Scenario (c): Simulation with improved AUVs



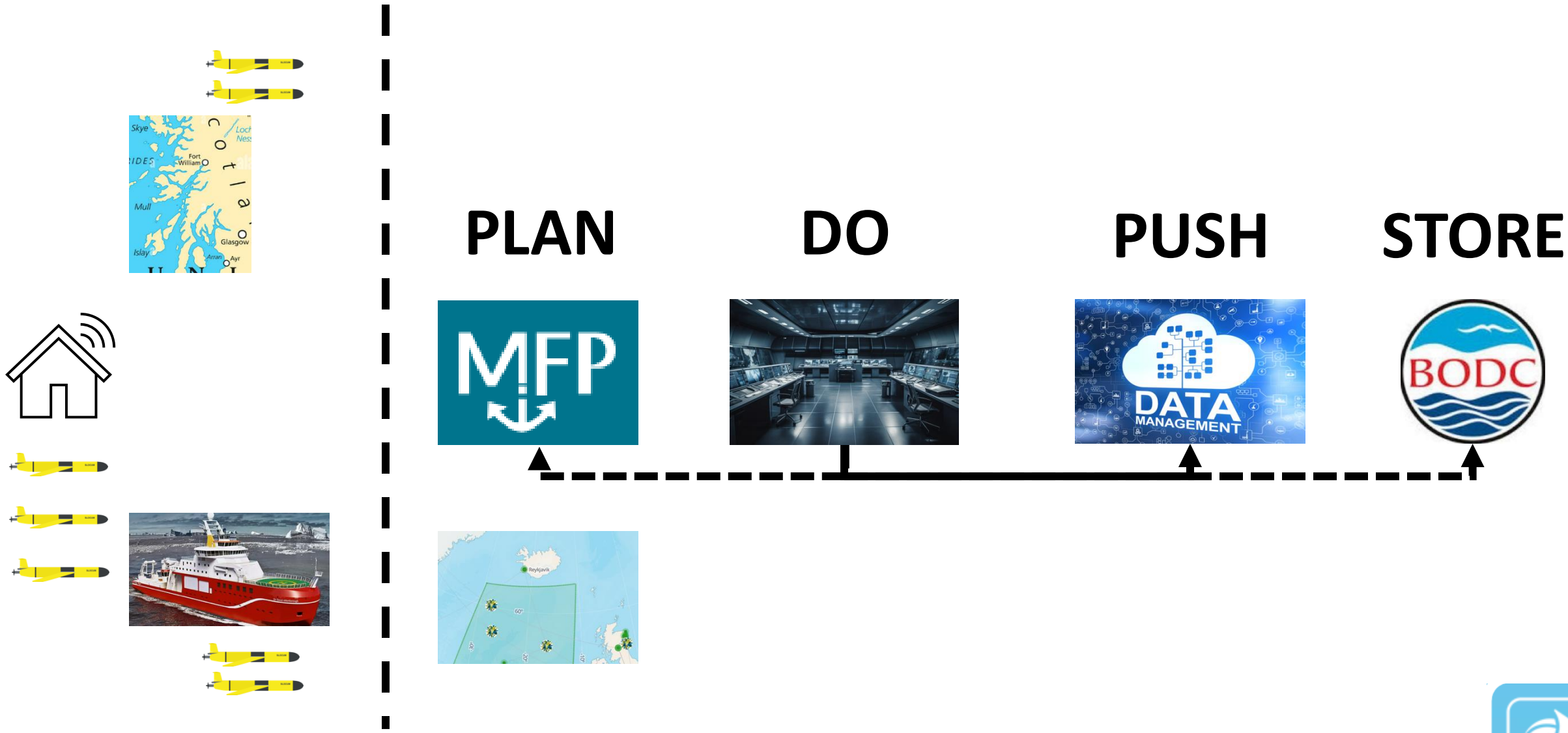
Digital Tools



Digital Tools



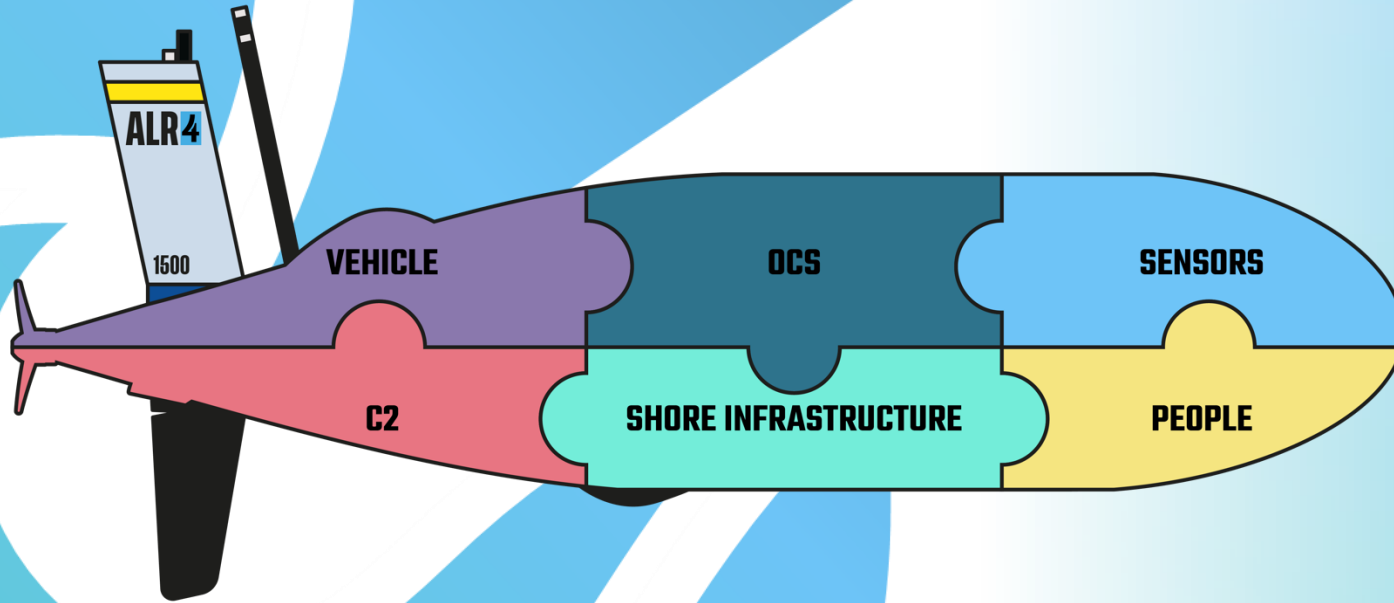
Digital Tools



Research Infrastructure - Intangibles

- Collaboration - <https://www.linkedin.com/in/leigh-storey-59079627/>
- Training - <https://www.linkedin.com/in/leigh-storey-59079627/>
- Soft Power
- Data Policy





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