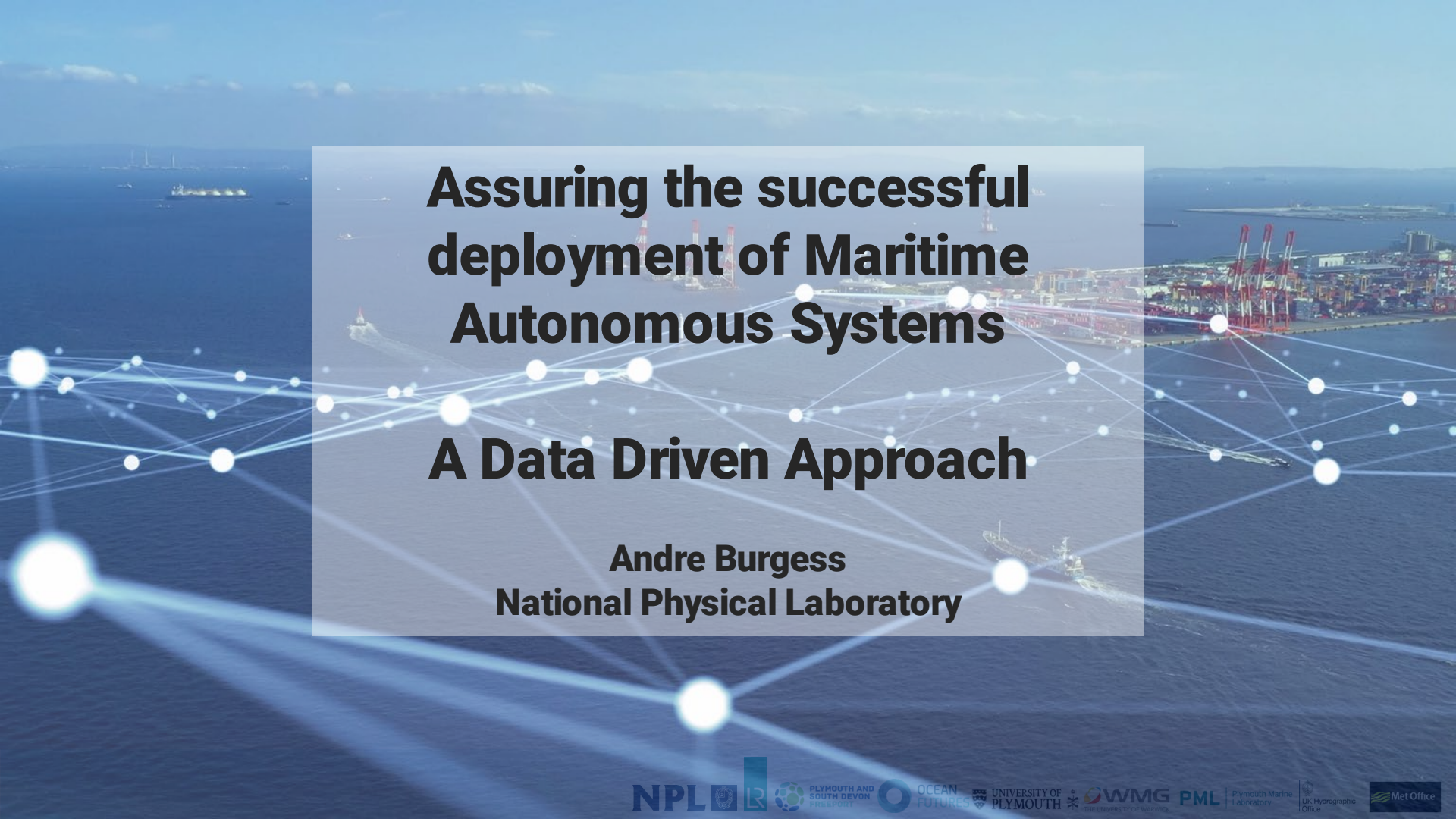


Assuring the successful deployment of Maritime Autonomous Systems

A Data Driven Approach

Andre Burgess
National Physical Laboratory

About NPL

UK's National Metrology Institute

- **Independent and impartial advice to industry and government**
- **Over 1000 scientific experts**
- **Over 400 Laboratories and state-of-the-art facilities**

NPL ensures that cutting-edge measurement science and technology have a positive impact in the real world.

Deliver world-leading measurement solutions critical to supporting business success across the globe.

Partner with 200+ organisations and 80+ Universities

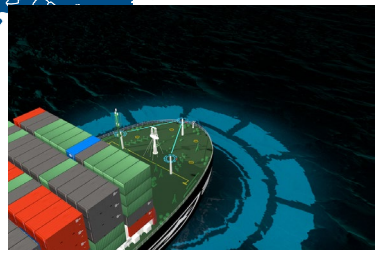
Opportunity and Challenge

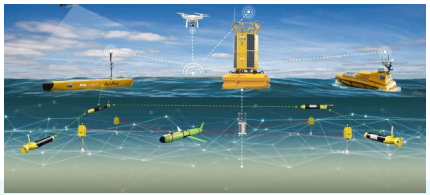
- **The Opportunity:** ***Projected demand for Maritime Autonomy is predicted to grow exponentially to become a £103bn / US$165Bn market by 2030.***
- **Maritime Autonomy will fundamentally change the operating and business models of many maritime sectors, making their operations safer, more sustainable, and efficient.**
  - **Fleet Decarbonisation: energy management of hybrid & full electric propulsion**
  - **Offshore energy / renewables, fisheries & aquaculture, environmental survey: compliance, reliability, maintenance & logistics**
  - **Port Operations**
  - **Maritime security and naval logistics**
- **The Challenge:** ***A paradigm shift in how these unmanned / uncrewed technologies are tested and certified is required.***
  - **Without the capacity to assure Maritime Autonomous Systems (MAS), exploitation and benefits shall be significantly inhibited, slowing/limiting innovation & ecosystem growth potential.**





Challenge and Assurance

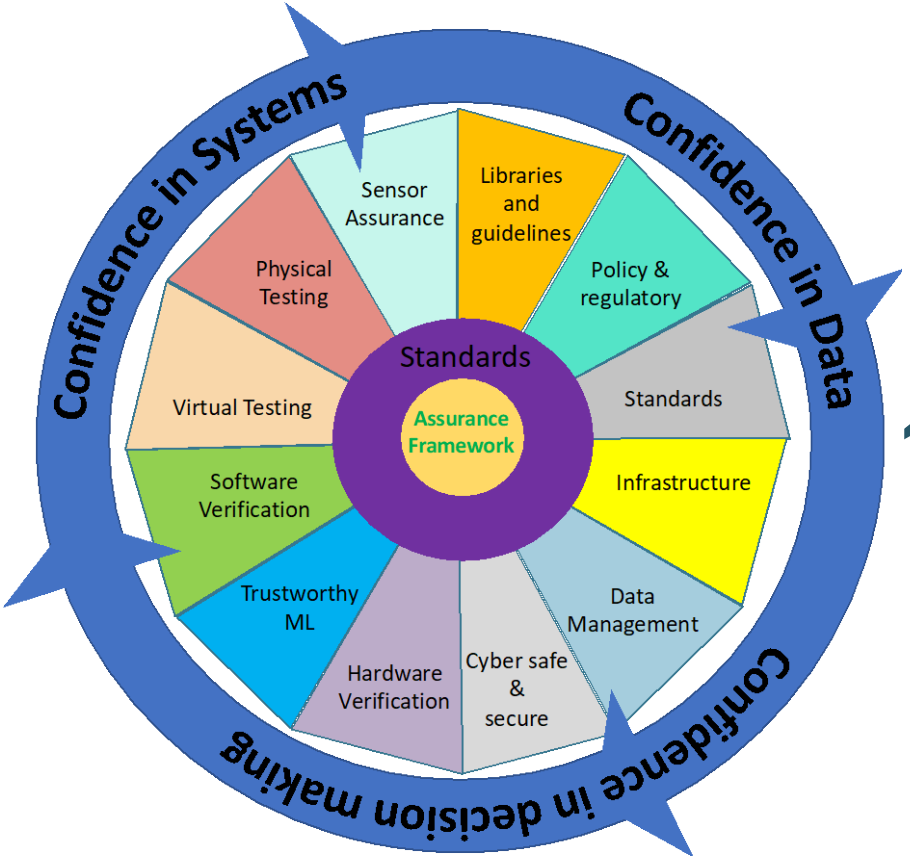




- Proportional
- Standards
- Defining Safe
- Responsibility

Delivery requires a Multi themed / multi layered approach

Integrated approach delivers the trusted systems and frameworks that test, assure and validate maritime autonomy developments globally. **Input from a wide and diverse range of disciplines and functions.**



Exploitation of Autonomy

Assurance approaches: Maritime Autonomy Assurance Testbed (MAAT)

- **Objective: To enable the fastest adoption of technology, making autonomy affordable & business viable. Results in accelerated and increased realisation of benefits of earlier adoption of the technologies.**
- **Approach: Develop an internationally relevant assurance capability, eventually addressing all types of smart/autonomous maritime platforms including System of Systems.**
- **Enabled through the development of a world-first cyber-physical testbed for Maritime Autonomy and operational certification framework. Networked structure integrated across the UK regions and internationally.**
- **Initiated out of the Plymouth & South Devon Freezone, MAAT will combine the 1000 km^2 fully digitalised Plymouth 'Smart Sound' of authorised, deconflicted water space with the world's first validated virtual test environment.**
- **Developed in partnership between National Physical Laboratory, Lloyd's Register and leading entities in the Ocean Futures Group (including the PSD Freeport, University of Plymouth and Plymouth Marine Lab) as well as national agencies and centres of excellence such as UKHO, Met Office and WMG.**

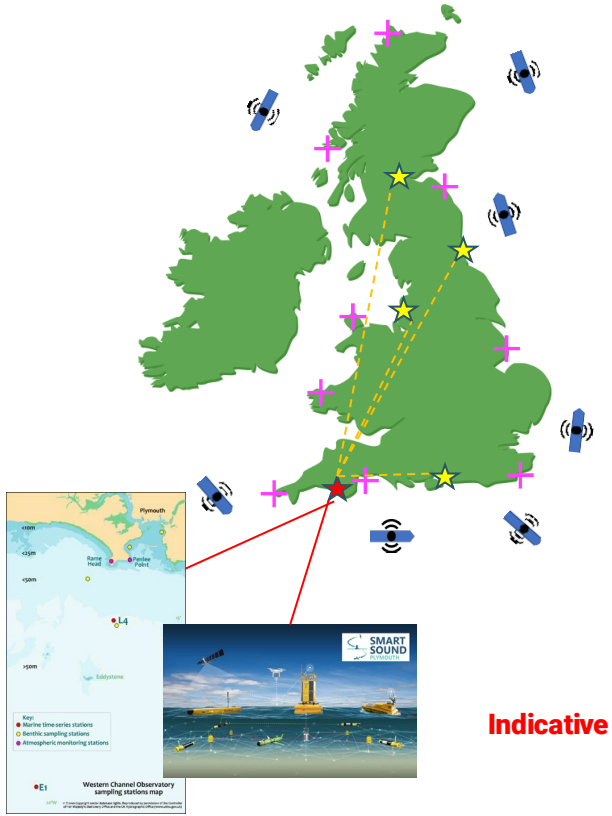
Smart Sound Digital: 1000km^2 of deconflicted Test Infrastructure

- Mission critical to develop assurance tools
- Reference Data for Sensor Assurance Framework and provides reliable environmental and sensor models for Virtual Testing
- Training Data Library in accordance good practice guides for ML compliance assurance
- Data for Libraries for Operating Conditions and Behaviours and the development of Digital COLREGS
- Test Scenario development
- RT Situational awareness of test areas & sound for remote operations – provides blue-print for nationwide deployment
- Human Factors Analysis

Proprietary Information: NPL and Lloyd's Register

Networked UK Test & Assurance Capability for MAS(S)

- Establishing and measuring true capabilities and limitations of the autonomous system
- Ensuring autonomous vessels / systems are operating within their performance limitations and providing confidence in the management of a more integrated seaspace (+ airspace) including both manned and unmanned vessels of various nature and characteristics.
- Informing and enabling new Regulation and Standards
- Underpins a high growth UK marine and maritime autonomy industry forecast to exceed £700m GVA p.a. and 5,500 high-value jobs by 2030.
- Generating a pipeline of skilled technical operators for the most sophisticated maritime autonomy testing, development and manufacturing equipment in the world.
- UK as partner of choice for international R&D collaboration in Maritime Autonomy



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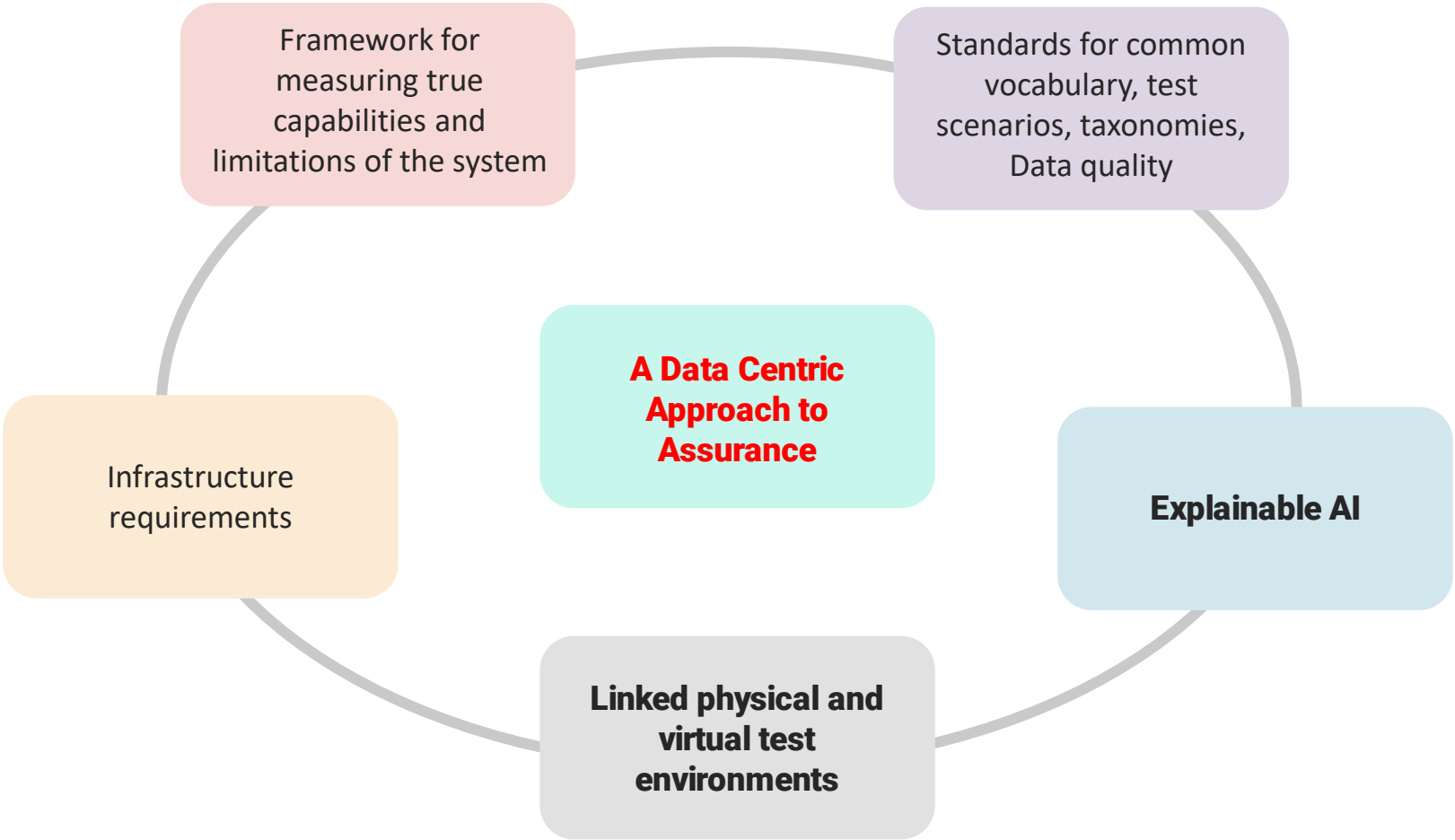
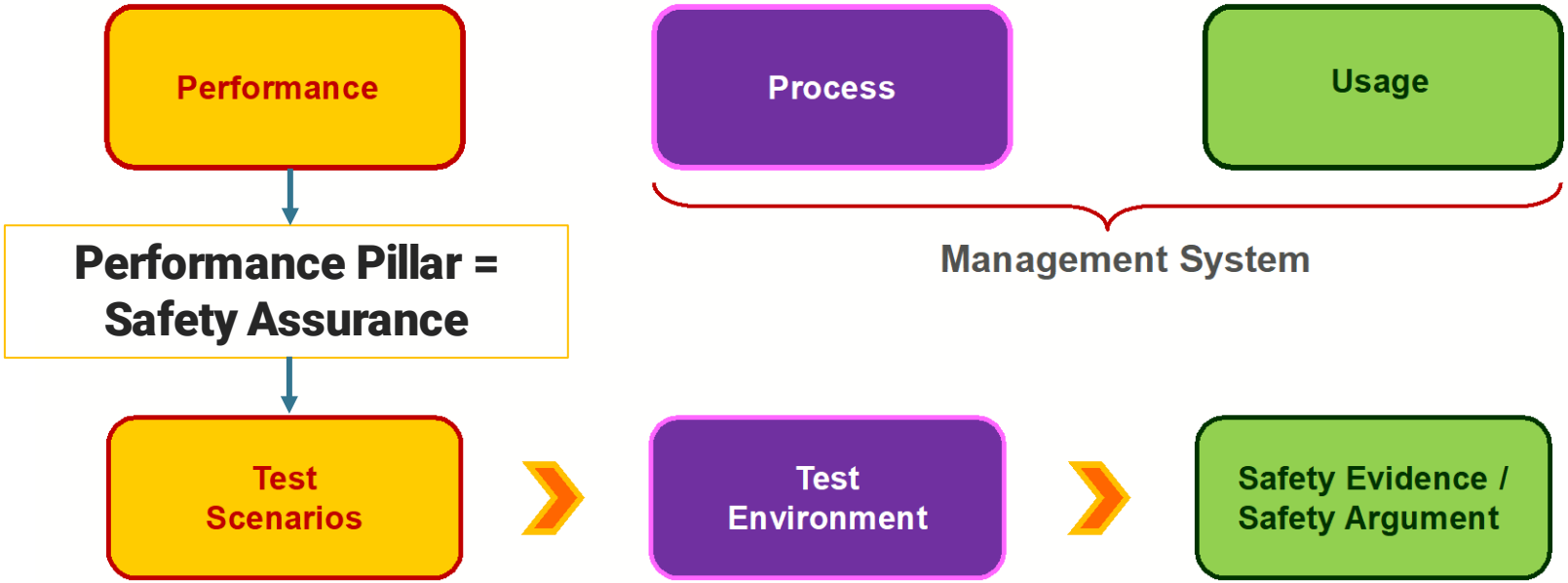

Framework for measuring true capabilities and limitations of the system
Standards for common vocabulary, test scenarios, taxonomies, Data quality
A Data Centric Approach to Assurance
Infrastructure requirements
Explainable AI
Linked physical and virtual test environments

Establishing and measuring true capabilities and limitations of the system



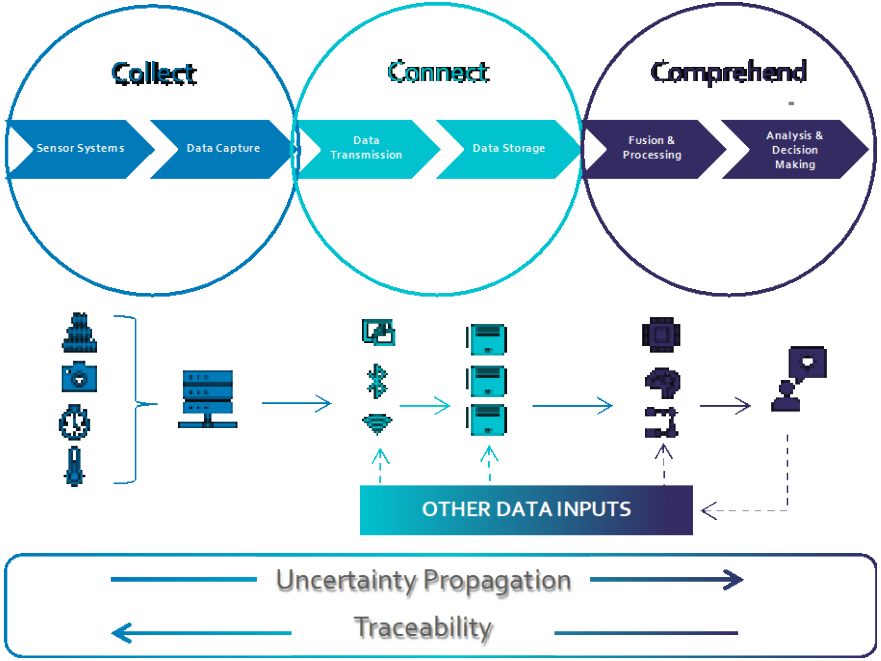
Credit: WMG

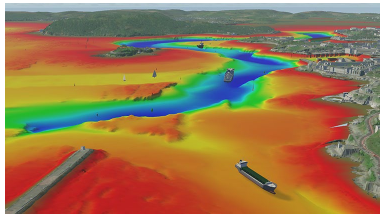
Common Definitions and Understanding

- **Test scenarios and outputs**
- **Operating Domain taxonomies**
- **Autonomy levels**
- **Maritime definitions for MASS - ‘vessel’; ‘responsible person’**

Infrastructure requirements

- International relevance
- Communications
- Resilient PNT
- Situational Awareness
- Data quality and management.





Demonstrating Trustworthiness of AI/ML

User

Generate target behaviours and environment for system

Developer

Process audit, generate evidence for system safety case

Assurer

Assessment and formal verification

ODD

Specification / system safety case

VTE

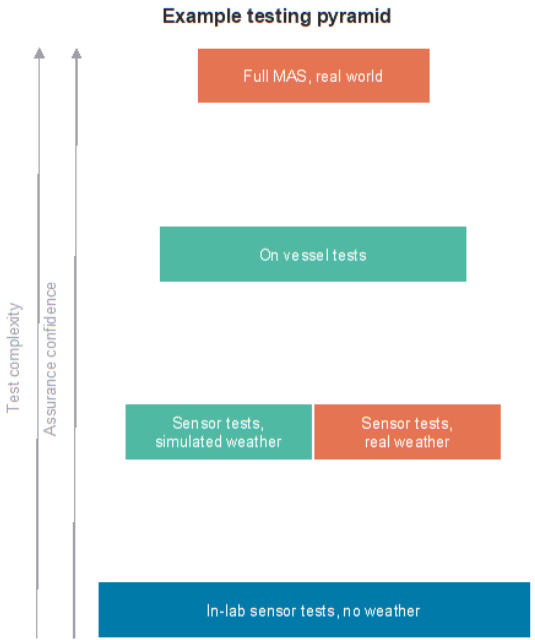
Development and Audit
Link to RW tests

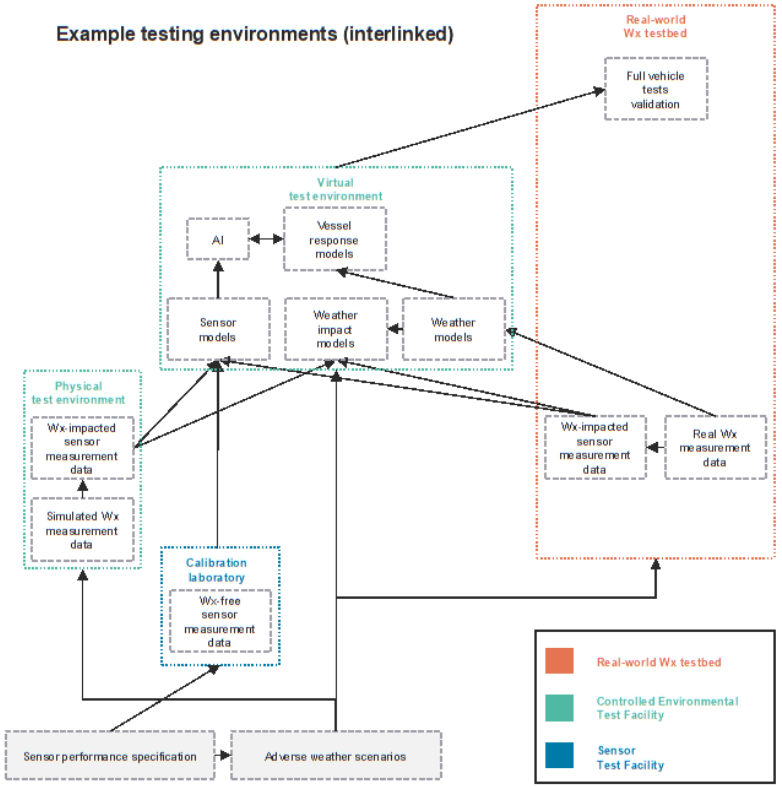
Explainable AI

AI development, compliance, standards

- Spot testing
- Deployment
- Real world testing and usage audit

Confidence in the system - Linking Test Environments

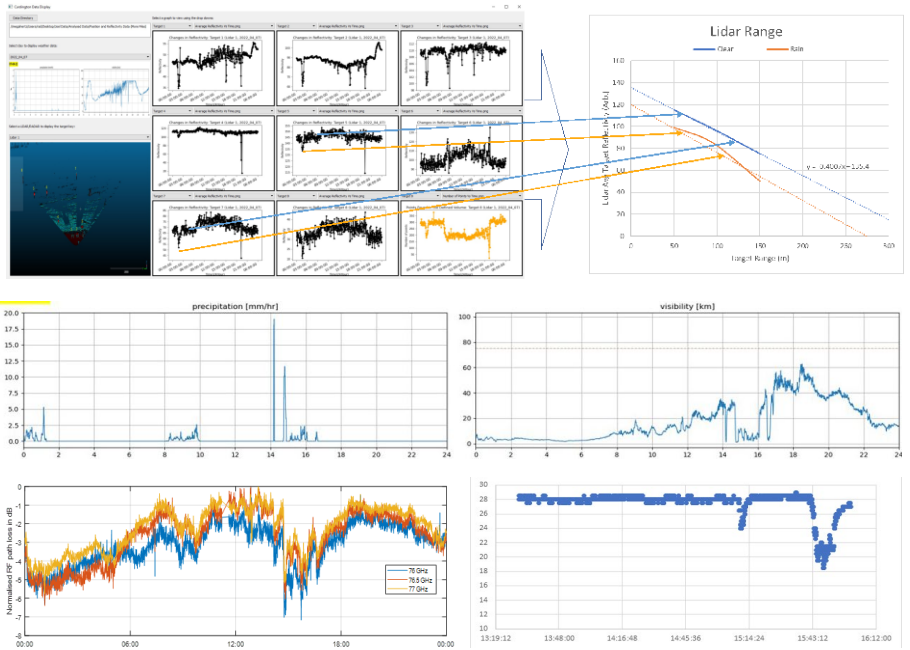


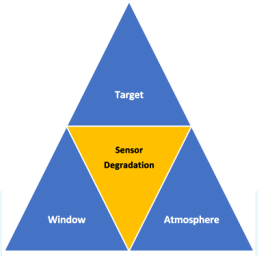


Met Office | NPL

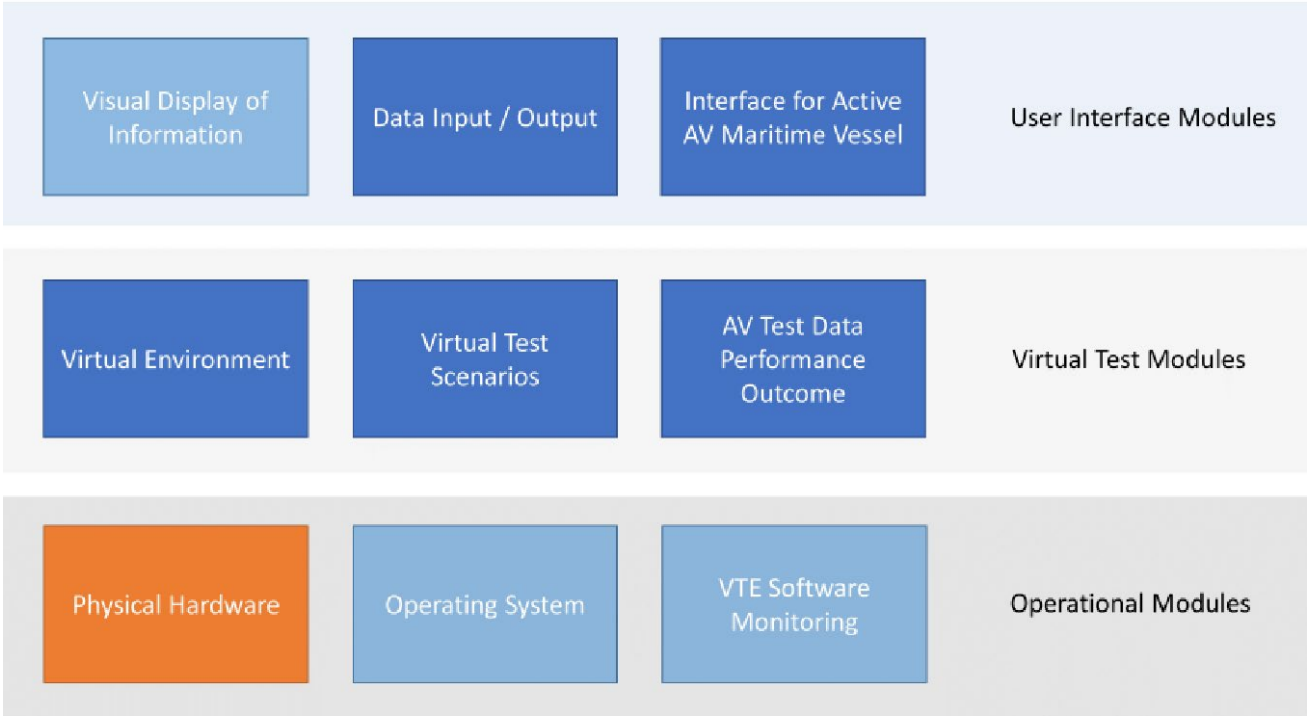
MAS Sensor Performance Characterisation and Assurance

- **MAS perception sensor testing framework spanning modelling, simulation, and physical testing for the UK.**
- **Taxonomy for degradation pathways of MAS sensors**
- **Generating clear links between simulation-based validation and safety argument.**
- **Simplifying the volume of training data needed for Maritime AI/ML systems**





Virtual Test Environments



Thank you

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