Developments in Human Autonomy Teaming for Maritime Cybersecurity Resilience

Authors

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Cyber-SHIP Lab

SECURING MARITIME

CROWN

THE CYBER-RESILIENCE OF OFFSHORE WIND NETWORKS

REARDON SMITH NAUTICAL TRUST

UNIVERSITY OF PLYMOUTH

Cyber-SHIP Lab

Cyber-SHIP Lab
SECURING MARITIME

- Maritime cyber-physical research facility
- A Unique **£3.2 million hardware-based** platform
- Physical twin testbed
- Real-world solutions to real-world problems

CROWN Lab - Cyber Resilience of Offshore Wind Networks

The facility will create a generic representative turbine control network (turbine, array level, offshore substation, onshore substation, control system network) and use this to:

- identify emergent vulnerabilities
- recognise attack vectors
- replicate manual (hackers) and automated (malware) attacks
- identify defences and design architectural templates onshore to be deployed offshore
- test new defensive technology
- deliver training to shore-based and offshore workers
- provide advice to policymakers and regulators

CROWN
THE CYBER-RESILIENCE OF OFFSHORE WIND NETWORKS

The Plymouth "ecosystem"

Shipping operators (civil and defence), equipment manufacturers, regulators, insurers

Cyber-range labs

Exploits Tools

Cyber-SHIP Lab

Database

Visualisation and Simulation

Maritime Simulation Lab

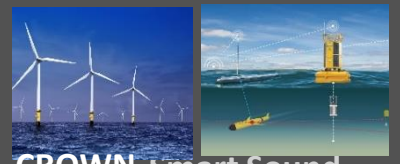
Data Scenarios

Ship simulators

Scenarios Training

Visualisation

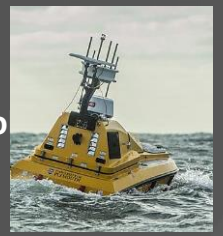
Training Inform



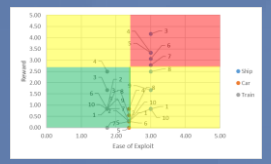
CROWN Smart Sound

MAS

Autonomous/ Remote contro

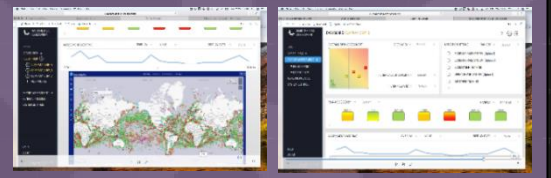


Drones



Profiles Reports

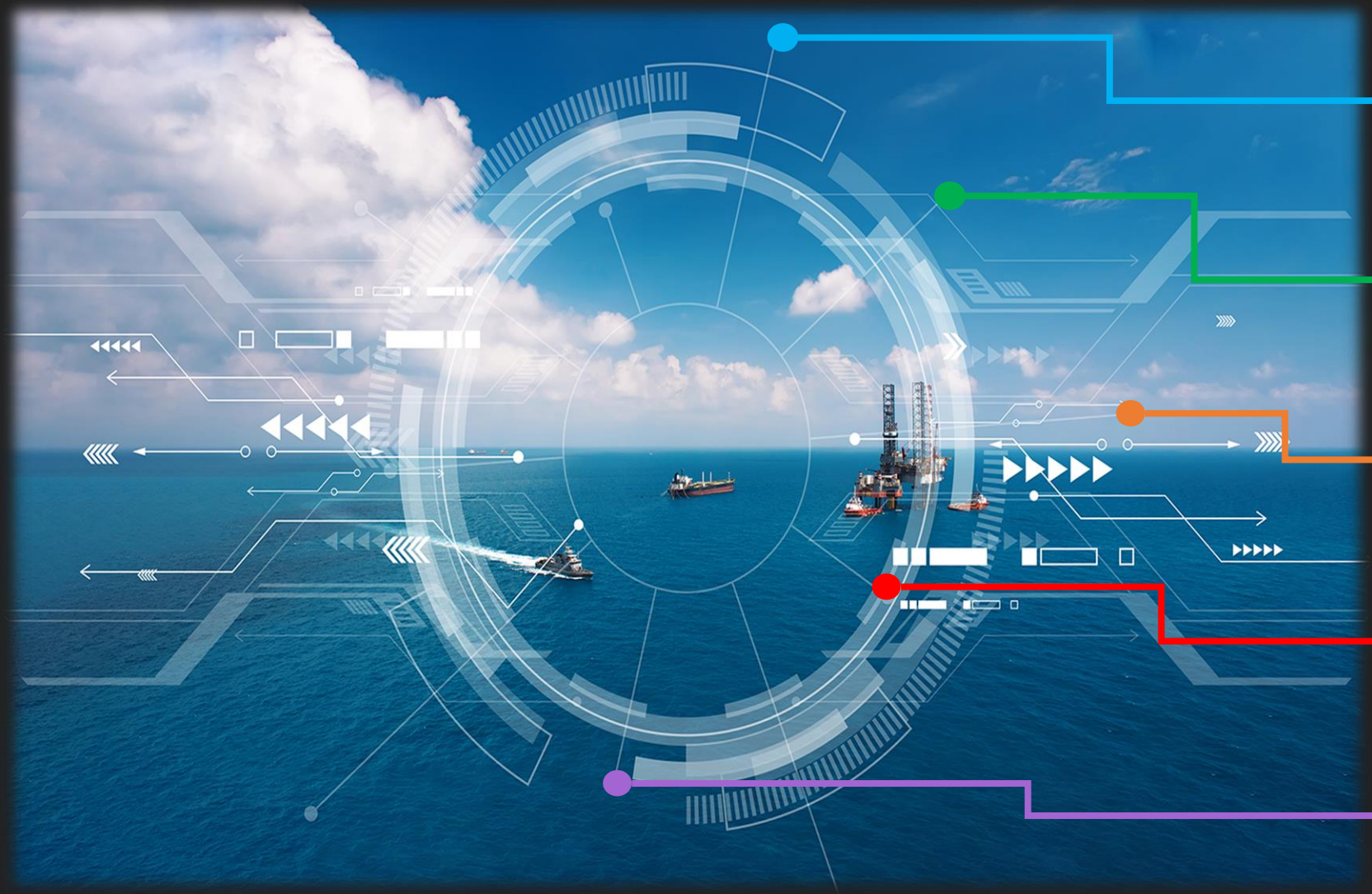
MaCRA



Riskocity: Risk Assessment

Shipping operators (civil and defence), equipment manufacturers, regulators, insurers

Outline of The Presentation



1. Remote and Autonomous Operations
2. Human Autonomy Teaming
3. Maritime Cybersecurity Resilience
4. Strategies for HAT
5. Training for HAT

Image Source: (ABS Group, 2024)

Maritime Remote and Autonomous Operations

Fleet Management Station

Remote Operator Station

Incident Management

Image Sources:
Top Left: (Rolls-Royce, 2017)
Top Right: (Massterly, 2024)
Bottom: (Kon, 2022)

International Maritime Organization's Vision

- **Non-mandatory Maritime Autonomous Surface Ship (MASS) Code by 2025**
- **Mandatory MASS Code in 2028**

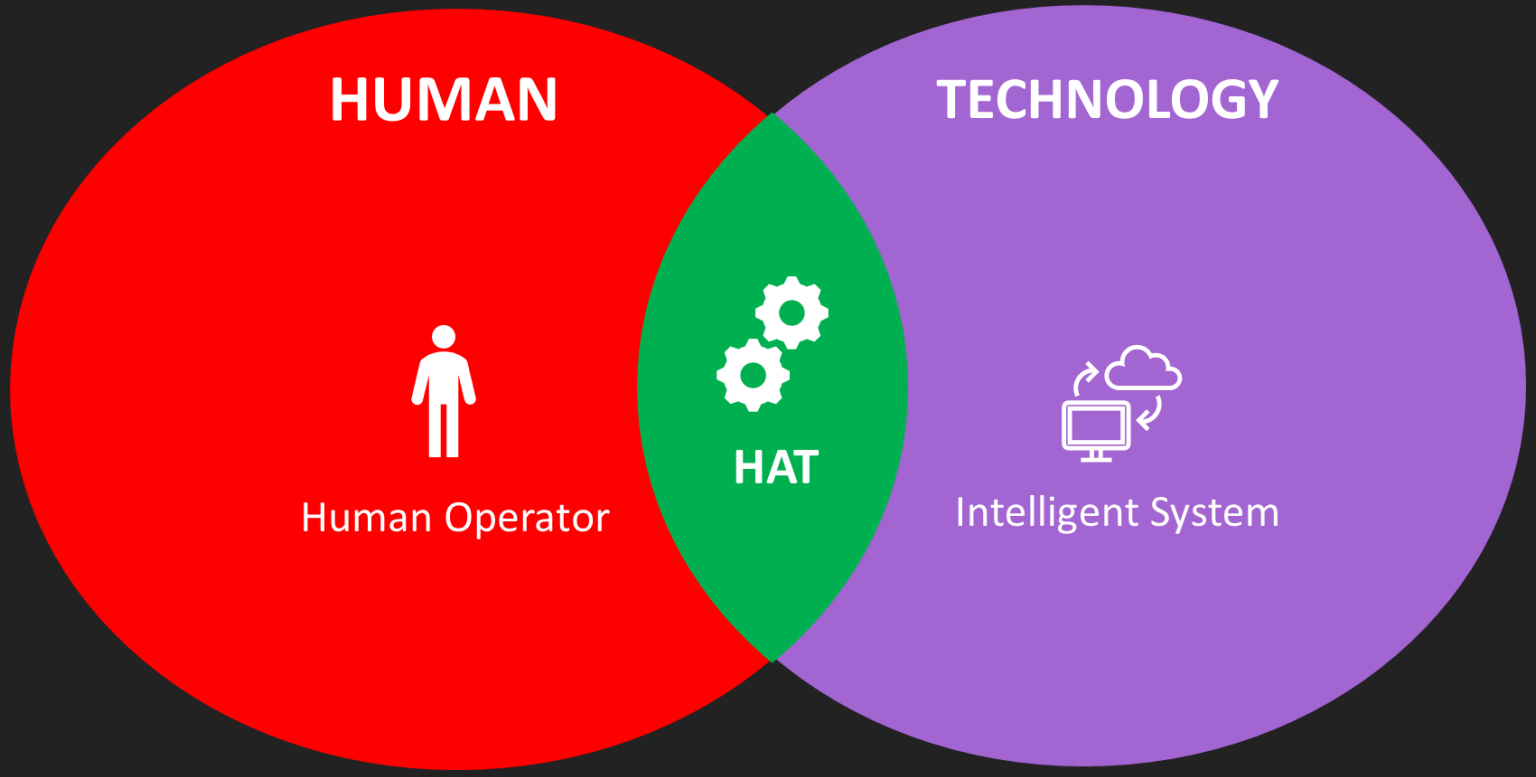
"There should be:

- **a human master is responsible** for a MASS regardless of **mode** of operation or degree or **level of autonomy**

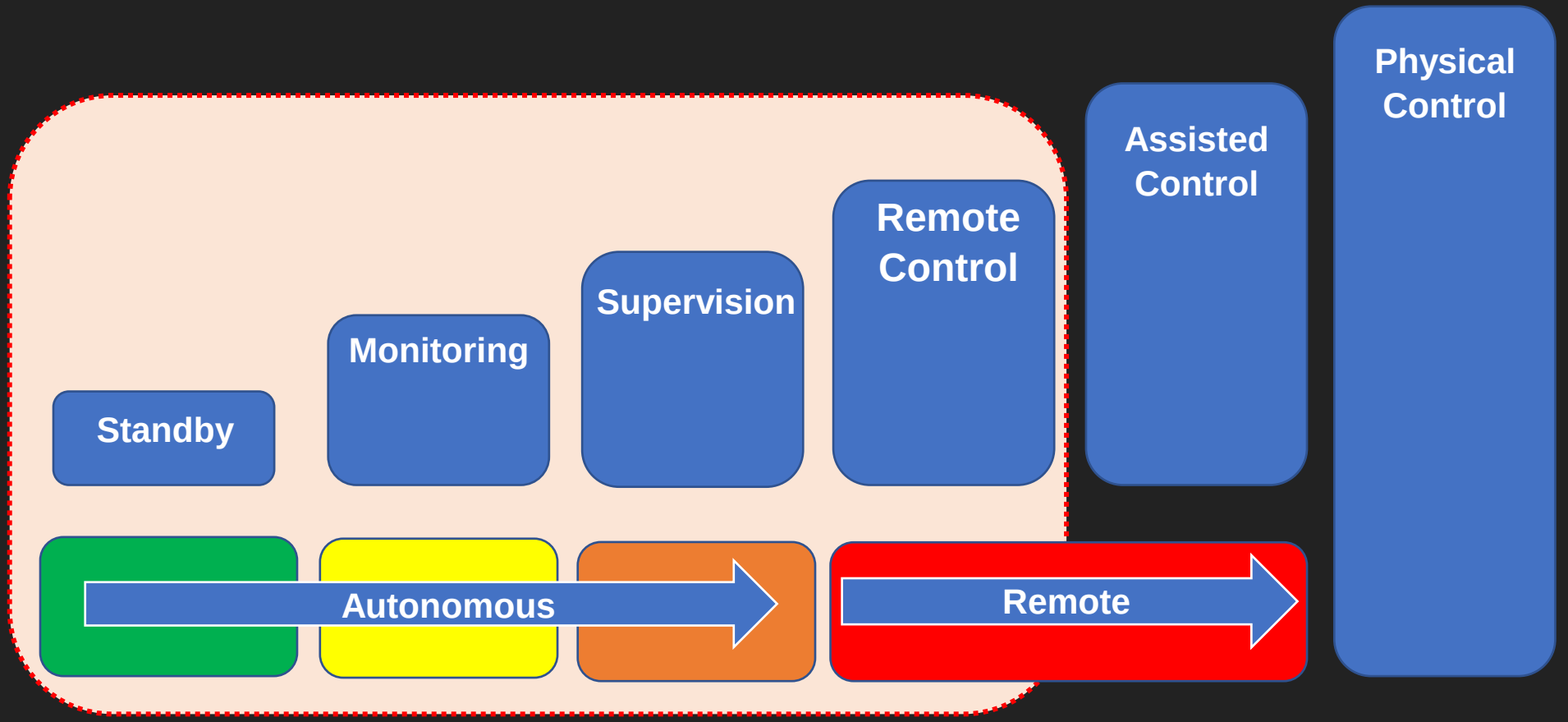
- regardless of mode of operation or degree or level of autonomy, the **master** of a MASS **should have the means to intervene when necessary**"

Reference: MSC 107/5-1 **(**IMO, 2023)

Human-Autonomy Teaming (HAT)



HAT in Autonomous and Remote Surface Vessel Operations (ARSVO)



HAT FOR MARITIME CYBERSECURITY RESILIENCE

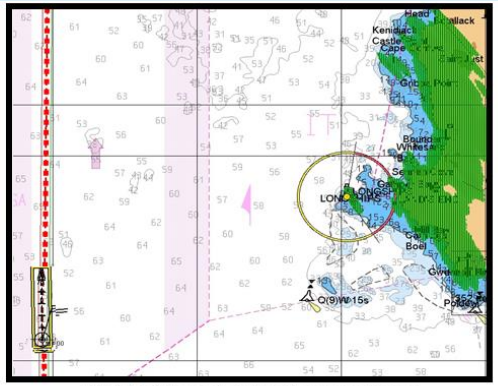
FINDINGS FROM LAST YEAR:

- Potential challenges faced in Autonomous and Remote Surface Vessel Operations
- Definition of the role of HAT in Maritime Cybersecurity Resilience.

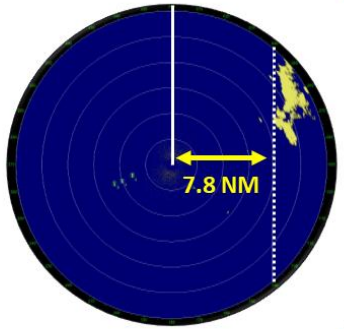
Participants: 75 Navigators (Cadet → Senior Officers)

- **Maritime Cyber Awareness Questionnaire**
- **Future of Remote Operation Tabletop Exercises**
- **Full Bridge Cyber-attack Simulation Exercises**

0 minutes



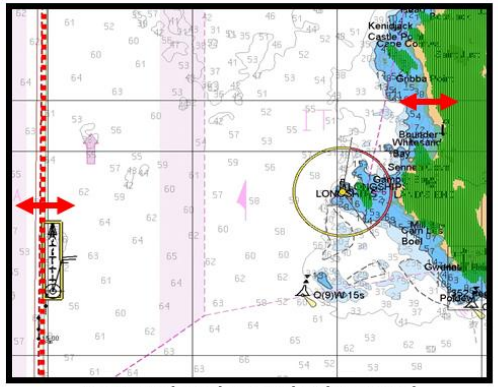
ECDIS with Radar Overlay (on green)



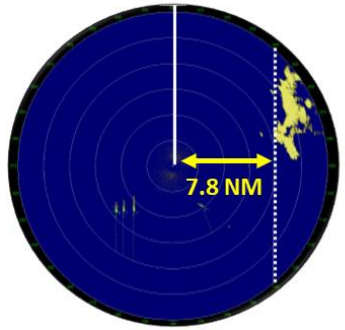
Radar with PI line (dotted line)

4 minutes

600m GNSS Drift to the East of their position (*see red arrows*)



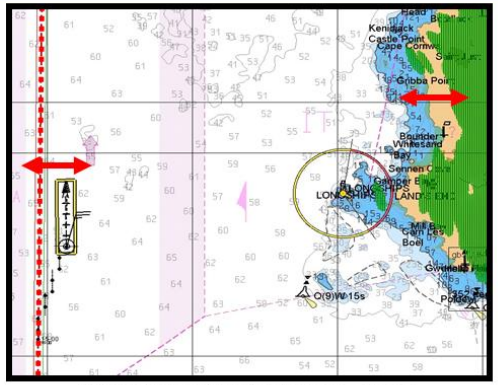
ECDIS with Radar Overlay (on green)



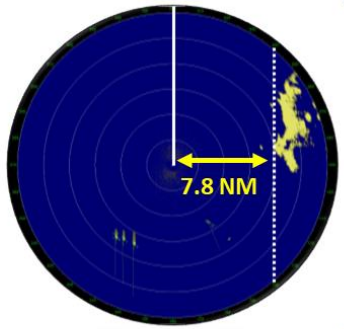
Radar with PI line (dotted line)

8 minutes

1200m GNSS Drift to the East of their position (*see red arrows*)

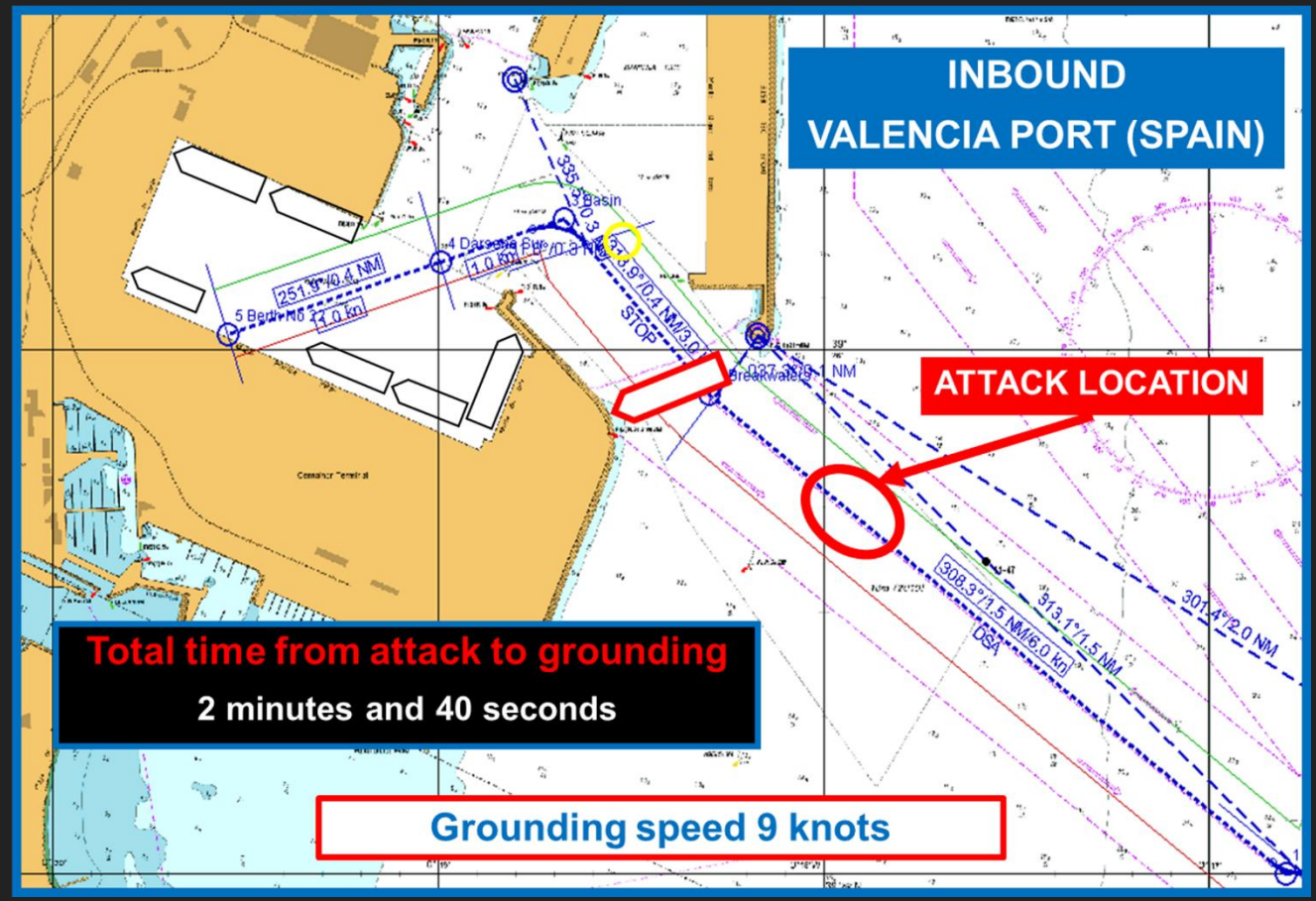


ECDIS with Radar Overlay (on green)



Radar with PI line (dotted line)

GNSS SPOOFING



RUDDER JAMMING FULL TO PORT
ENGINE JAMMING FULL AHEAD

KEY FINDINGS – Future of Maritime Autonomy

New training providing skills to interact with current & future digital systems including cyber incident management.

Incident management in a multi-stakeholder environment is needed for dealing with cyber incidents in ARSVO.

Previous workshops demonstrated that these types of training events **increase cyber awareness across workforce.**

Development of new exercises for future implementation within Maritime Education and Training (MET) institutions.

Reference: (Palbar Misas et al. 2024)

STRATEGIES FOR HAT IN MARITIME CYBERSECURITY RESILIENCE

Image Source: (Konsberg, 2021)

STRATEGIC:

Organisational Level - Safety / Security / Efficiency

Responsibility & Control Measures

TACTICAL:

ROC Management – Mission Planning / Review

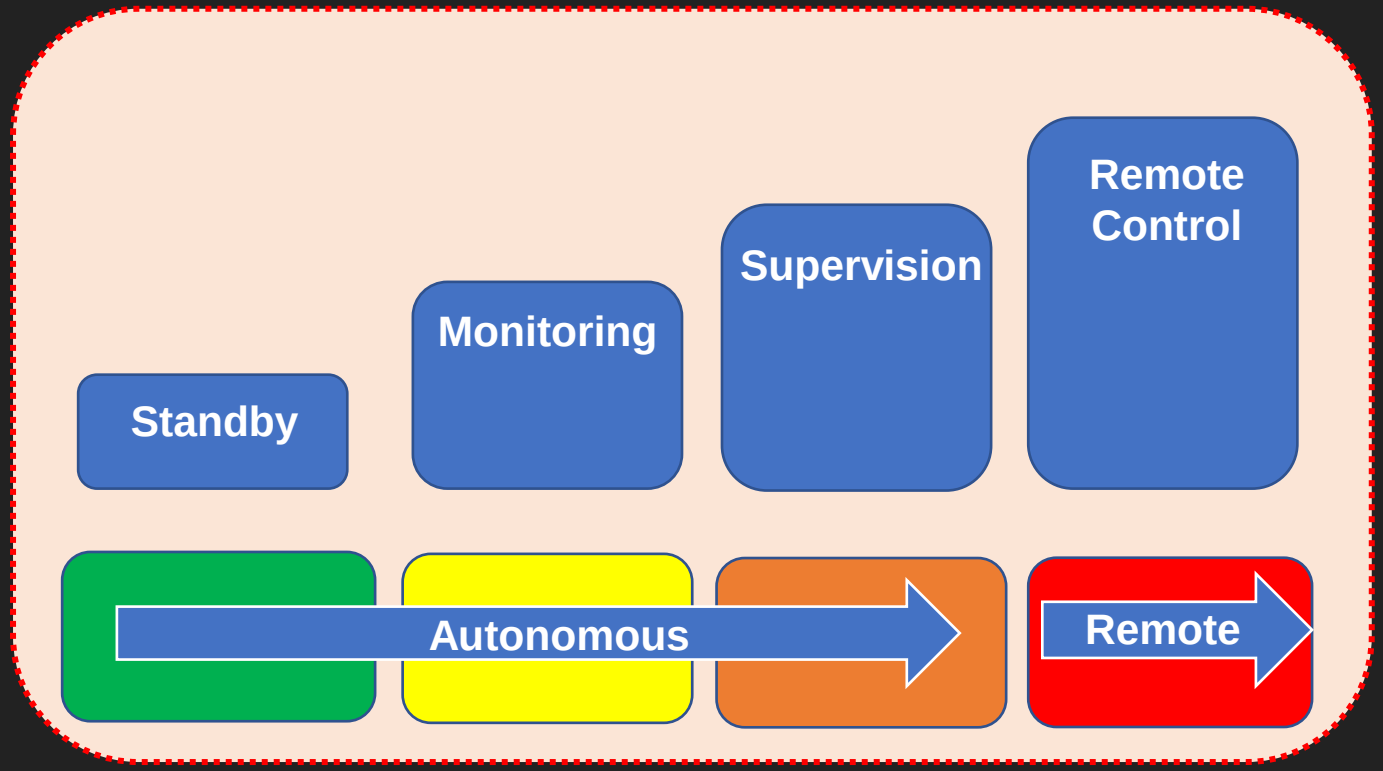
OPERATIONAL:

Operators – Intervention / Accident Management

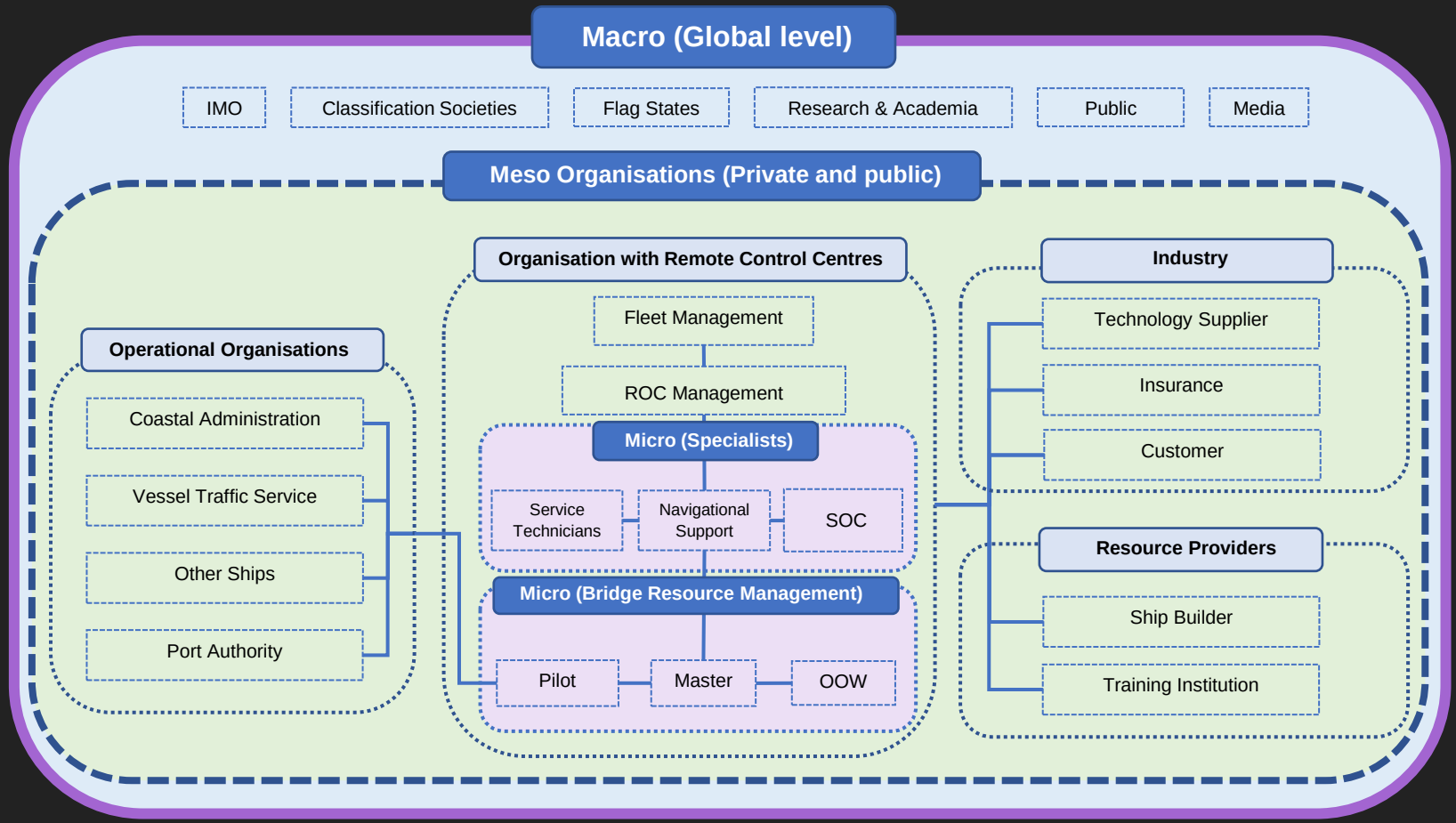
Execution & Monitoring

Adapted from References: (Relling, 2020; Rødseth et al., 2022; Veitch and Andreas Alsos, 2022; Chan et al., 2023; Mehta et al., 2021; Mallam et al., 2020)

OPERATIONAL LEVEL



TRAINING FOR HAT IN MARITIME CYBERSECURITY RESILIENCE



FUTURE RESEARCH FOCUS

Facilitate seafarers (the end-user) to be involved throughout the design, production and evaluation

Explore new operational vulnerabilities to enhance proactive mitigations and responses

Develop an iterative training process that operates concurrently with developments of new risks and vulnerabilities

Contribute to institutions design and deployment of ARSVOs by embedding operational best practices led by research

"Sustain a competent workforce for safe and secure operations in Autonomous and Remote Surface Vessel Operations"

Thank You

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