

# Reardon Smith Nautical Trust

Future of Maritime Autonomy

## Supervisors

Dr Kimberly Tam

Prof Kevin Jones

Mr Tom Crichton



**Cyber-SHIP Lab**  
SECURING MARITIME



**UNIVERSITY OF  
PLYMOUTH**

# Presentation Outline



# 1- Previous Experience



## Academic

- BSc (Hons) in Navigation
  - Dissertation title:  
*"Mariner's Current and Ideal Organisational Culture"*
- STCW 95 Safety Training
- Spanish maritime transport studies



## Maritime

- Shoreside experience:
  - Marine Surveys (Cargo, draft)
- Ocean going experience:
  - Containerships
  - Ro-Pax ferry & Dredger
- Working towards OOW oral exam



## Research

- Research Assistant in Navigation and Maritime Cyber
  - EU CYBER-MAR Research Project
  - Cyber-SHIP lab
  - Publications & Conferences

# 2- Maritime Cyber Research



- Maritime-Cyber training for ISCSS - **IMarEST** conference paper - **03/02/2021**



- Cyber-incident simulation scenario content for the **DIT** - **02/03/2021**



- **Cyber-MAR** pilot demonstration of Valencia Pilot Scenario - **05/05/2022**



- Presentation at **DEF CON** in Las Vegas as part of the Cyber-SHIP Lab online tour and demos - **14/08/2022**



- **Atlantic Future Forum (AFF)** - New York (New York Scenario) - **28/09/2022**



- **Cyber-SHIP lab Symposium** - IMO London (New York Scenario) - **26/09/2022**



- Presentation at **Delft University of Technology** for ISCSS – **IMaERST** Conference Paper - **08/11/2022**



- Maritime Cyber Defense **Hackathon** - **19/11/2022**



- Singapore Scenario for **Maritime & Port Authority of Singapore (MPA)** - **11/2022**

# Publications



## Academic Papers:

- **Future of Maritime Autonomy: Cybersecurity, Trust and Mariner's Situational Awareness", ISCSS 2022 - IMarEST;**  
*Authors: [Juan Palbar Misas](#), Rory Hopcraft, Kimberly Tam*
- **"Case Study of a Cyber-Physical Attack Affecting Port and Ship Operational Safety", Journal of Transportation Technologies, 2022, 12, 1-27;** *Authors: Kimberly Tam, Rory Hopcraft, Kemedi Moara-Nkwe, [Juan Palbar Misas](#), Wesley Andrews, Avanthika Vineetha Harish, Pablo Giménez, Tom Crichton, Kevin Jones*
- **"Developing a Maritime Cyber Safety Culture: Improving Safety of Operations", Maritime Technology and Research, 2022, 5, 1;** *Authors: Rory Hopcraft\*, Kimberly Tam, [Juan Dorje Palbar Misas](#), Kemedi Moara-Nkwe and Kevin Jones*

## Industry White Papers:

- **Maritime Autonomous Ship System: AI and Security (MAS AIMSec) 2022 v2;** *Authors: Kimberly Tam, Avanthika Vineetha Harish, Rory Hopcraft, [Juan Palbar Misas](#), David Barrett*

## In progress:

- **Maritime Cyber Incident Communication.** *Authors: Rory Hopcraft, Kimberly Tam, [Juan Dorje Palbar Misas](#)*
- **A Maritime Cyber Risk Decision Making Tool.** *Authors: Erlend Erstad, Rory Hopcraft, [Juan Dorje Palbar Misas](#), Kimberly Tam*

# "Future of Maritime Autonomy: Cybersecurity, Trust and Mariner's Situation Awareness"

- **Conference paper:** ISCSS – IMaREST (08/11/22)
- **Aim of this Research:**
  - Understand how mariners currently manage higher risk operations, and
  - how this will change with the introduction of remote operations.
- **Participants of the study:** 60 final year navigation students
- **Results:**
  - SA challenges in remote operations
  - Cyber security affecting SA
  - Trust in Digital Systems
  - Roles and Responsibilities for remote operations
  - Training needed for future remote operations



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# Cyber-MAR: Port of Valencia Scenario



Port Of Valencia

## Port Characteristics:

- Handling over 6 million tonnes of cargo a year
- Important regional hub for transshipment
- Handles a wide variety of cargo:
  - liquid bulk
  - dry bulk
  - containerised cargo and
  - vehicular traffic

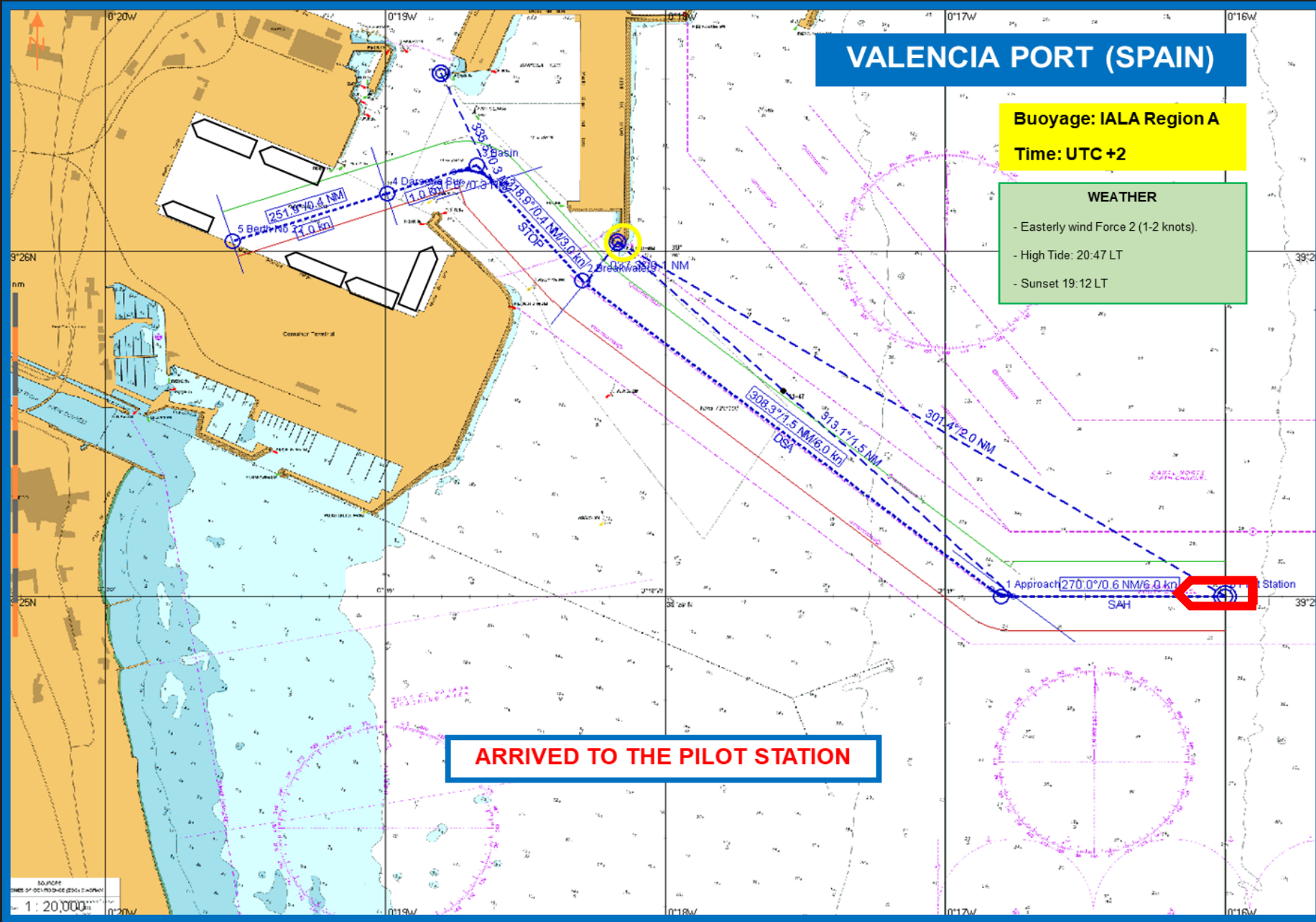


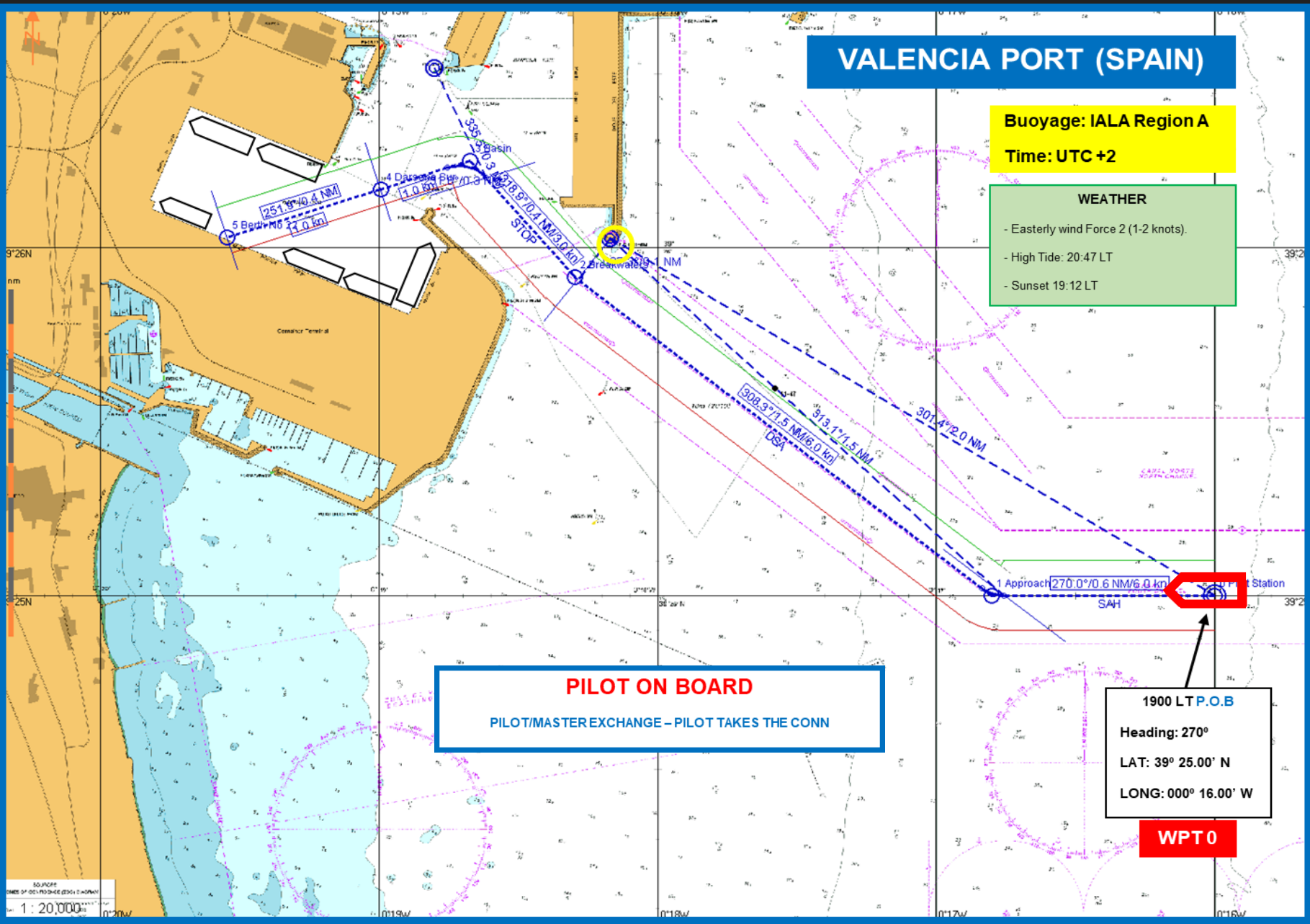
# Target Ship

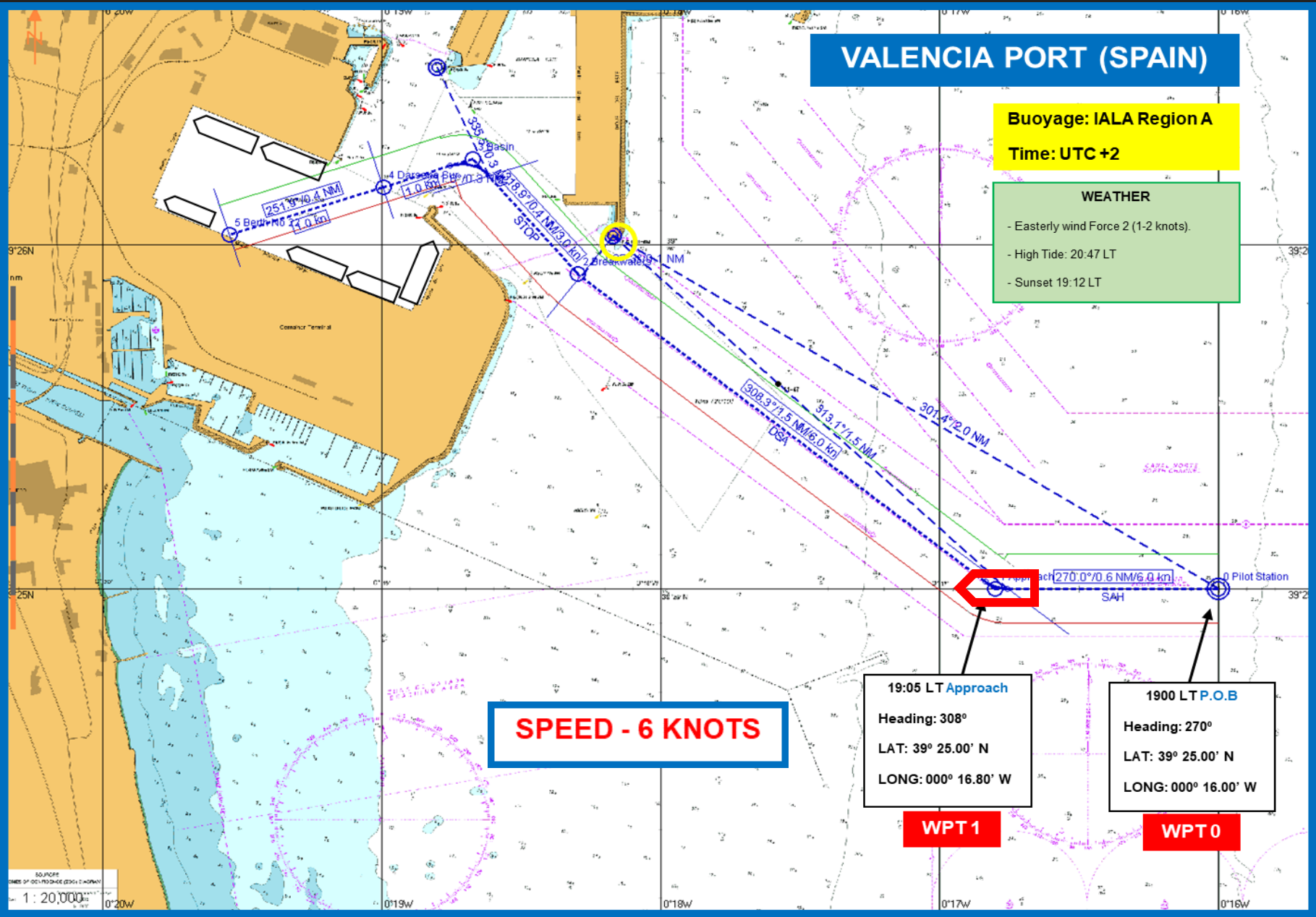


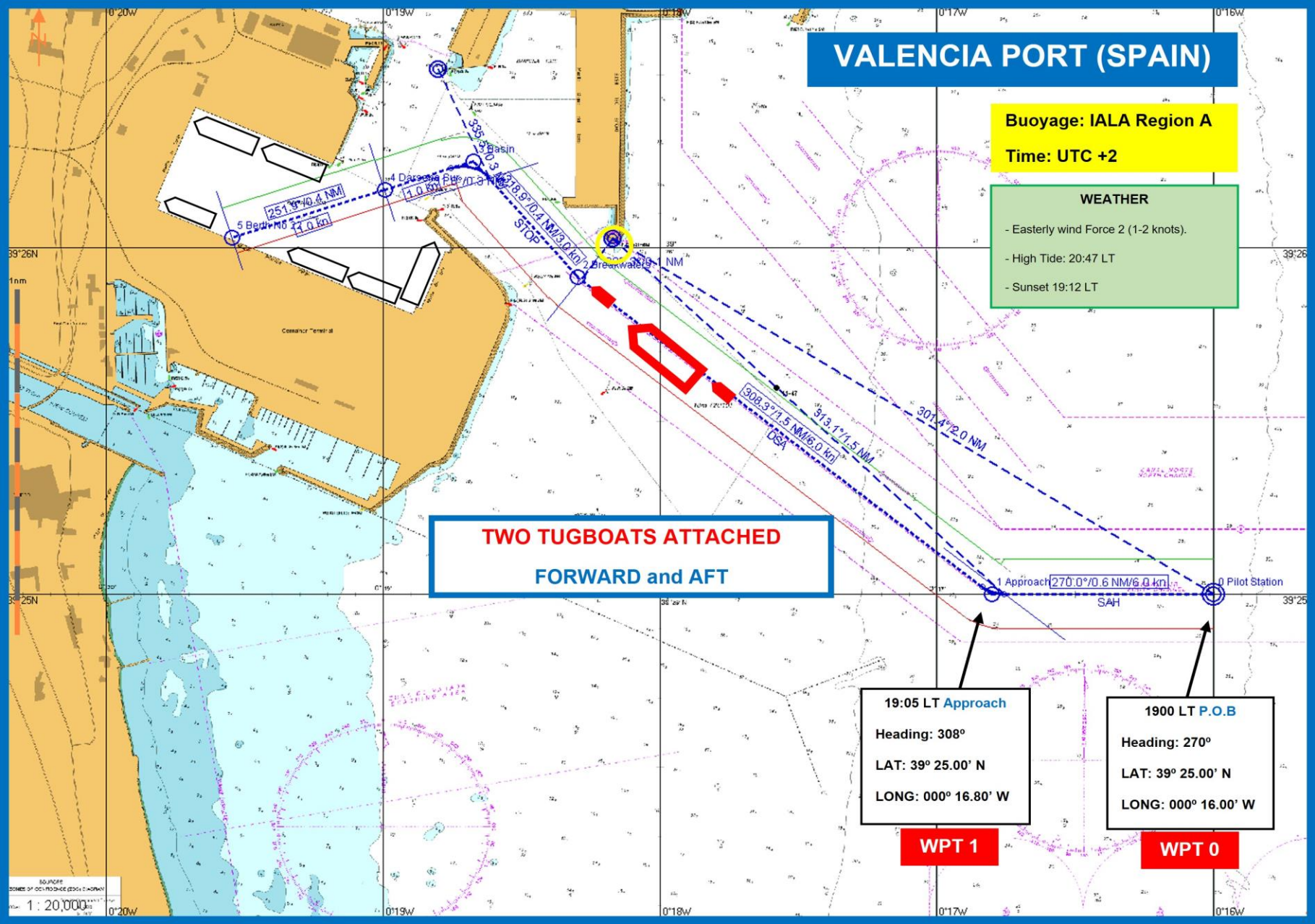
<b>Length</b>	<b>397 m (1,302 ft 6 in)</b>
<b>Beam</b>	<b>56 m (183 ft 9 in)</b>
<b>Draught</b>	<b>16.02 m (52 ft 7 in)</b>
<b>Max. Speed</b>	<b>25.5 knots (47.2 km/h; 29.3 mph)</b>
<b>Capacity</b>	<b>14,770+ <u>TEU</u></b>

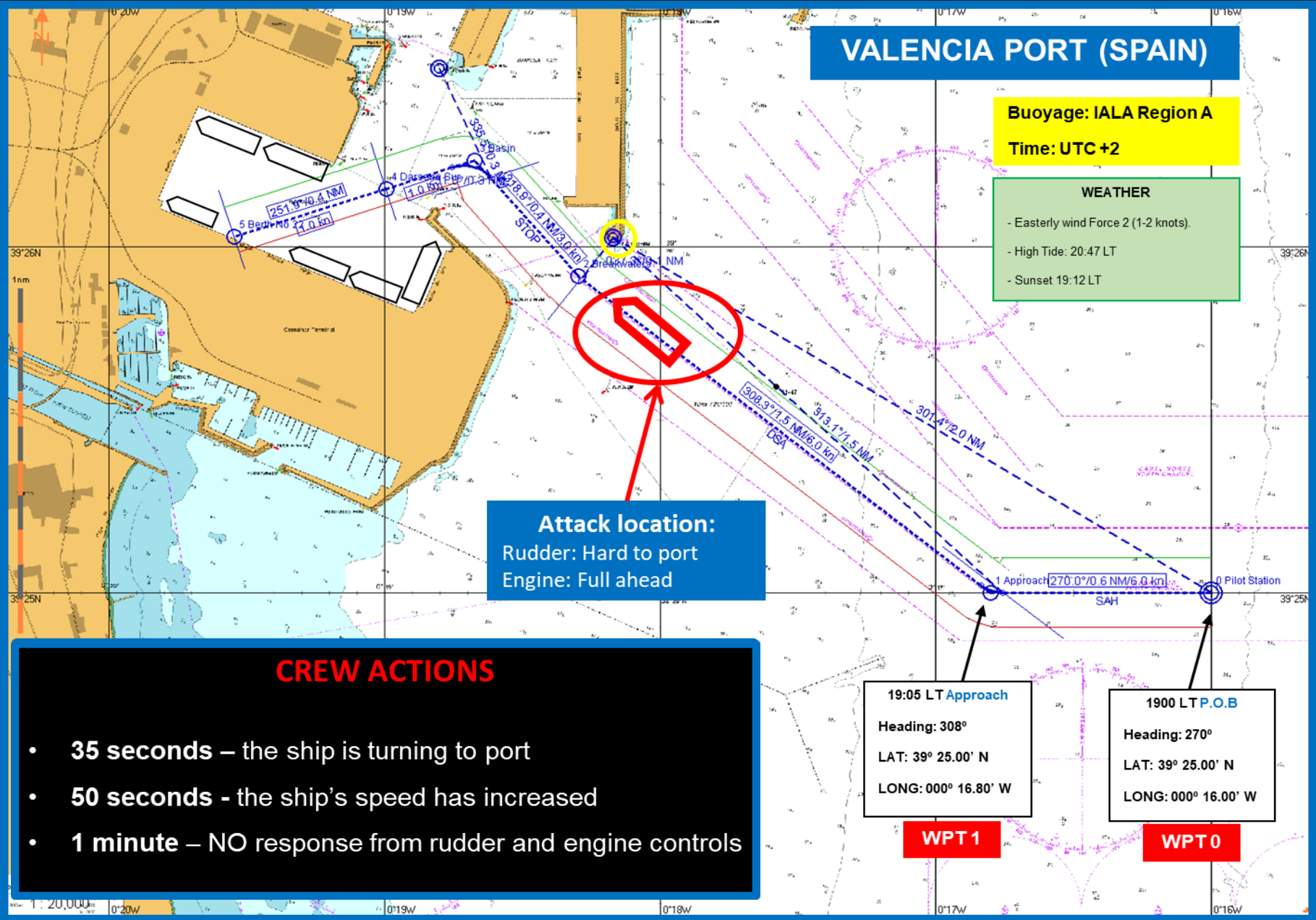


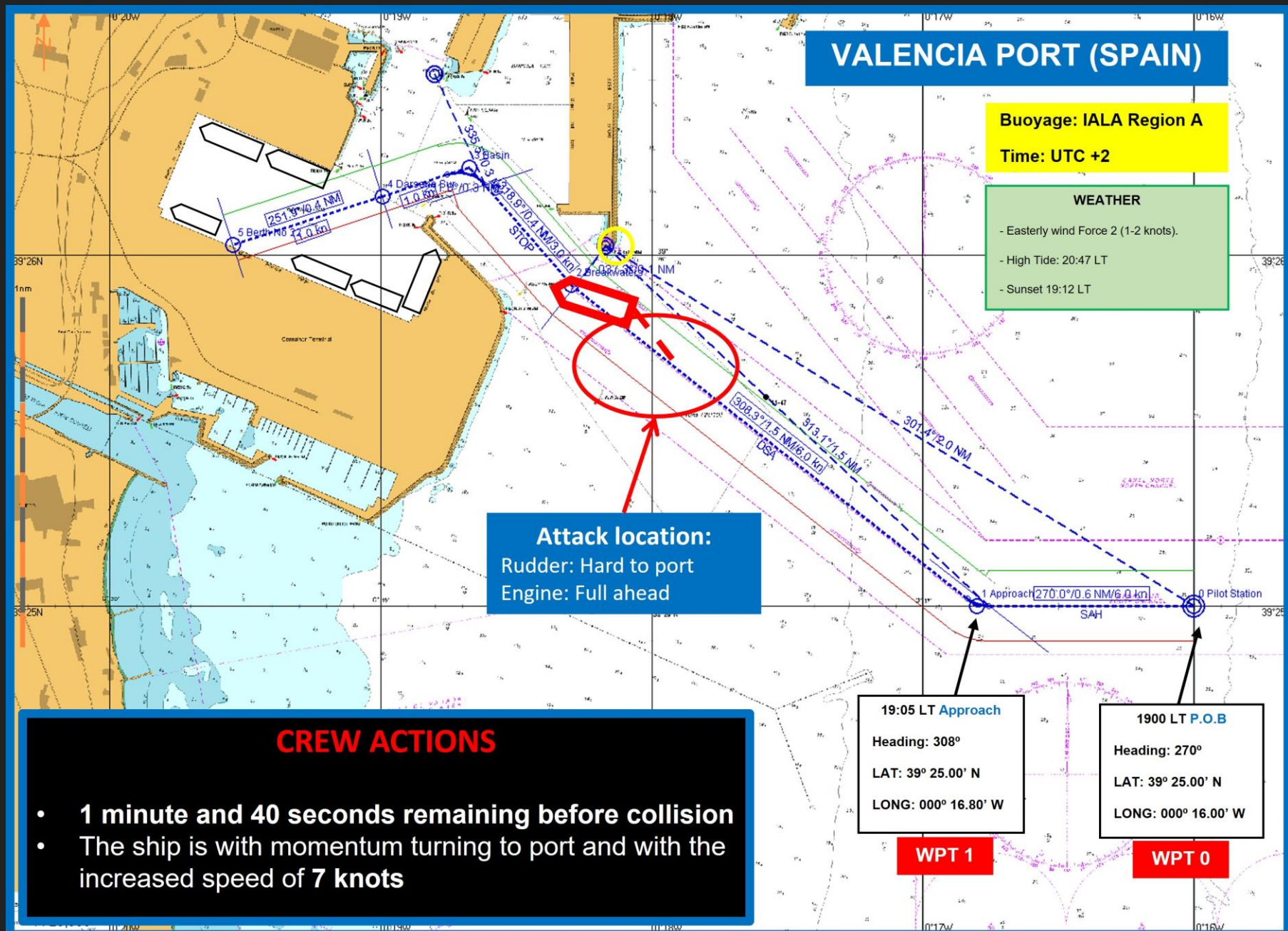


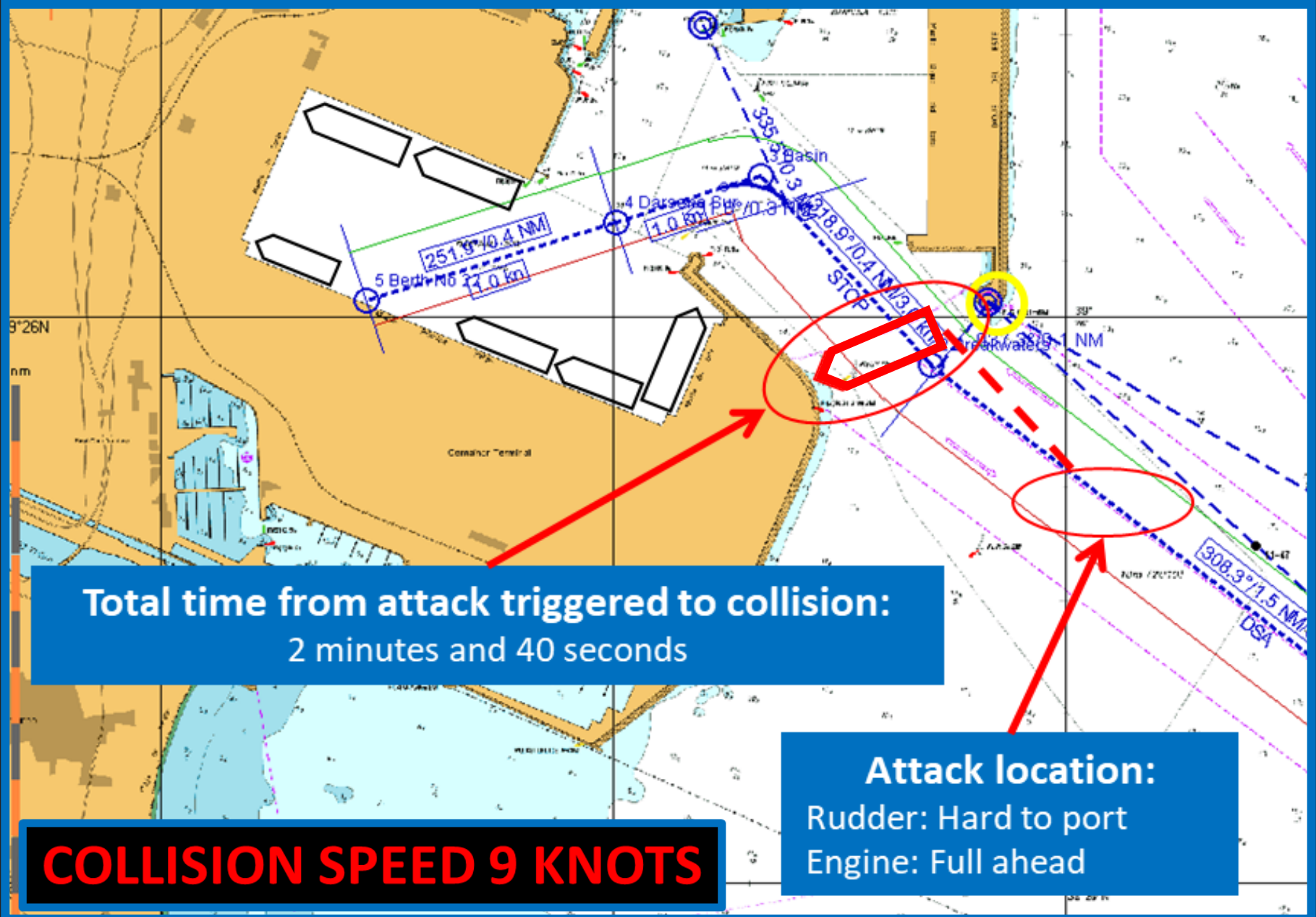












**Total time from attack triggered to collision:**  
2 minutes and 40 seconds

**COLLISION SPEED 9 KNOTS**

**Attack location:**  
Rudder: Hard to port  
Engine: Full ahead

# Consequences

1. Unavoidable collision with rock pier
2. Blockage of Port entrance 3-7 days
3. Depending on Salvage operations:
  - Possible damage to the ship and environment
  - Substrate removal operations
  - Available tugboats



Losses (EUR M)	Initial Port Disruption		
	3 days	5 days	7 days
France	950	1,600	2,200
Germany	1,000	1,700	2,400
Italy	600	1,000	1,400
Netherlands	550	900	1,300
Spain	2,500	4,200	5,900
UK	800	1,300	1,900

Reference of tugboats salvage operation as per following case:  
 "Mumbai Maersk, which ran aground outside Bremerhaven, Germany on 2 February, 2022"



# New York Scenario



Note: Low tide inbound pilotage plan due to vertical clearance under Bayonne Bridge <2ft



# Experiencing the Attack

Video Courtesy: Luke Christison



# Experiencing the Attack

Video Courtesy: Luke Christison



- Kill Van Kull blocked - width of channel is <350m
- 85-90% of traffic passes through the Kill Van Kull in NY

Length of Disruption (in hours)	Profit loss based on port hourly profit
6	\$137,774.66
18	\$413,323.97
30	\$688,873.29
42	\$964,422.60
54	\$1,239,971.92

Note: figures just for goods that require the Kill Van Kull 18

## 3- PhD Idea

# ***“Holistic scenario-based training for maritime cybersecurity in autonomous and remote surface operations”***

***Key words: Scenario, Maritime, Training, Cybersecurity and Autonomous.***

### **Research questions:**

1. What is the current state of understanding the **risk** regarding **Remote Surface Vessel Control Centre (RSVCC) operations**?
2. What elements need to be introduced, or changed, to maritime training in order to ensure **competence, resilience, and skills** for Remote Surface Vessel Control Centre (RSVCC) operators, allowing them to perform **cyber-safe and cyber-secure operations**?
3. Creating a holistic approach that can support the development of a **new training framework for operators** future-proofing **safe and secure navigation** for autonomous and remote surface operations?

# 4- Literature



- *“Operational management of autonomous ships: A need for **new competence and resilience skills**” MARESEC 2022; Authors: Aud Marit Wahl, Trond Kongsvik and Gunnar M. Lamvik – Norwegian University of Science and Technology (NTNU)*
- *“The **operator's stake in shore control centre design: a stakeholder analysis for autonomous ships**” The Royal Institute of Naval Architects 2020; Authors: E Veitch, A Hynnekleiv and M Lützhöft HVL - Norwegian University of Science and Technology (NTNU)*
- *“A systems perspective on maritime autonomy: The **Vessel Traffic Service's contribution to safe coexistence between autonomous and conventional vessels**” Doctoral theses Norwegian University of Science and Technology (NTNU), 2020; Author: Tore Relling*
- *“Uncrewed Vessel **Port Entry**” Master thesis 2022 at Novia UAS; Author: Declan Black*

# 5- Methodology (under development)

## DATA COLLECTION MAY INCLUDE



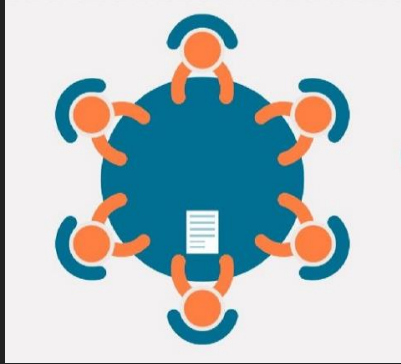
### Simulation Scenarios

- Type of data:
- Qualitative & quantitative
  - Multi-ship management, cyber incidents, ship types under different route, traffic and weather environments, hand-over
- Participants:
- Students & Industry



### Questionnaires

- Type of data:
- Qualitative
  - Quantitative
- Participants:
- Students & Industry



### Focus Group Interviews

- Type of data:
- Qualitative – Perspective on results gathered
- Participants:
- Organisations working in remote operation centres

# 6- Challenges and Ethical Considerations



- Lack of academic research in the field for the role of human element in remote operations (Sharma and Kim, 2021).



- High quality and statistically valid results based on real world data using appropriate sampling



- Creating high quality simulation scenarios with appropriate validity

# Research Outcomes

- This research will **develop a novel approach to mitigation of human element risk** to enhance safety for IMO degrees of autonomy 3 (specifically) and 4 (occasionally) - IMO MSC.1/Circ.1638
- Building on the novel approaches this research will **develop a framework** to enhance training, practice, standards and policies benefiting maritime industry.



# 7- 2023 PhD Project Goals

Addressing and sharing my research challenges from point 6 and sharing my research at:



- **Training:** Maritime Cyber Security course – NTNU, Norway (15/02/2023)



- **Simulation:** Combined Naval Event (CNE) - Farnborough, UK (23/05/2023)



- **Security:** Cyber-SHIP lab Symposium – IMO, London (10/2023)



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**Thank You!** Any Questions?

Contact email: [juan.palbarmisas@plymouth.ac.uk](mailto:juan.palbarmisas@plymouth.ac.uk)



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# 2023 PhD Project Goals

	2023											
	January	Feb	March	April	May	June	July	August	September	October	November	Decemeber
RDC			01/03/23									
AM							31/07/23					
Supervisory meeting	01/01/23			04/01/23			01/07/23			01/10/23		
Monthly												
Reading	Background reading											
Prepare	RDC1 prep	RDC1 prep	RDC2 prep	RDC2 prep	RDC2 prep	RDC2 prep	RDC2 prep	RDC2 prep	RDC2 prep	RDC2 prep	RDC2 prep	RDC2 prep
Training	PGR Training	Maritime Cyber Security Course 15/02/23	PGR Training	PGR Training	PGR Training	PGR Training	PGR Training		PGR Training	PGR Training	PGR Training	PGR Training
Writing	RDC1	RDC1	RDC2	RDC2	RDC2	RDC2	RDC2	RDC2	RDC2	RCD2	RDC2	RDC2
Conferences/ Events		Cyber Security Course at NTNU 14-18/02/2023				Defence Leaders 23-25/05/2023					Cyber-SHIP Lab Symposium	