Port Management and Navigation Seminar
A TRELLEBORG MARINE AND INFRASTRUCTURE INITIATIVE
QUEEN ELIZABETH (QE2), DUBAI, UAE
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Will intelligent ports, ships, and supply chains be the norm in the future?

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MRG
MARITIME RISK GROUP

The National Technical University of Athens

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1837

The NTUA campus

NTUA

Seakeeping Basin
School of Naval Architecture & Marine Engineering

Our group of researchers

- ***A research group*** within the School of Naval Architecture & Marine Engineering @*NTUA*
- ***Areas of expertise:***
  - Maritime safety & transport
  - Risk analysis and assessment, risk based design
  - Human element
  - Resilience & systems engineering
  - Autonomous shipping
  - Environmental engineering
- ***Coordination and participation in major national, EU and regional research and innovation projects***

MARITIME RISK GROUP

Introduction - Port operations

Conventional ports

The transition to new age ports involves:

Automation ☑

Autonomy ☑

Intelligent computing ☑

New age ports

- **1st gen:** loading/unloading (until 1960s)
- **2nd gen:** industrial ports (until 1980s)
- **3rd gen:** focus on logistics and supply chain (from the 1980s)

(Deloitte)

Moving towards 4th gen:

- Use of innovative technologies
- Increased efficiency
- Sustainability
- Increased safety

(allread.ai)

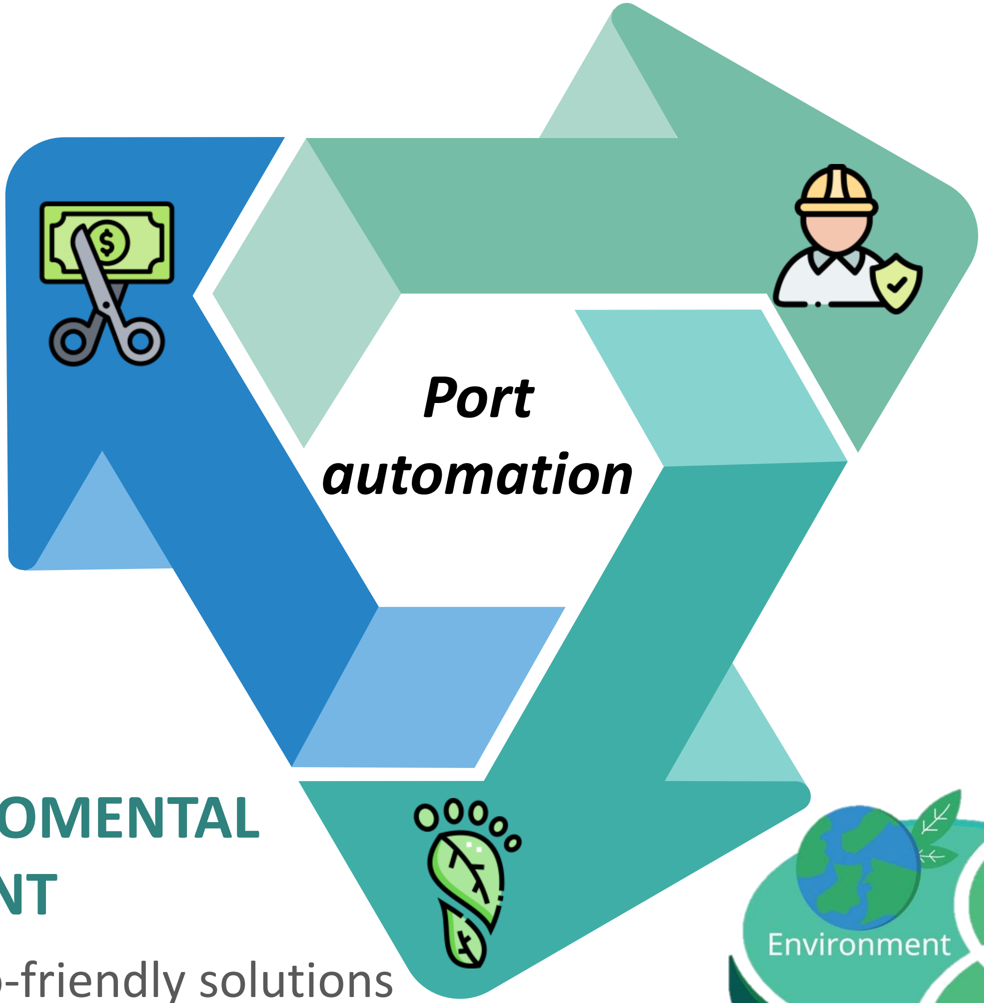
Objective of port automation transition

MAXIMISE COST EFFICIENCY

1. Decrease operational costs
2. Optimize energy usage,overall resource allocation, (long-term cost efficiency)

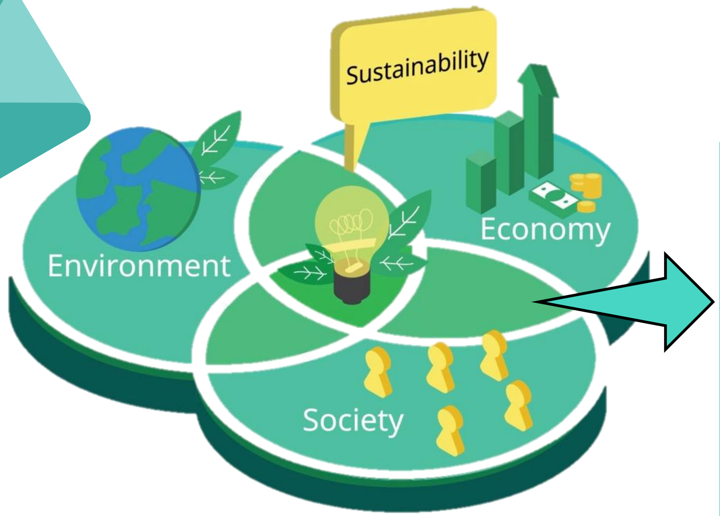
OPTIMAL SAFETY

1. Reduction of human-error related accidents
2. Continuous monitoring of various safety aspects



MINIMISE ENVIROMENTAL FOOTPRINT

1. Focus on eco-friendly solutions
2. Sustainability, emmissions reduction



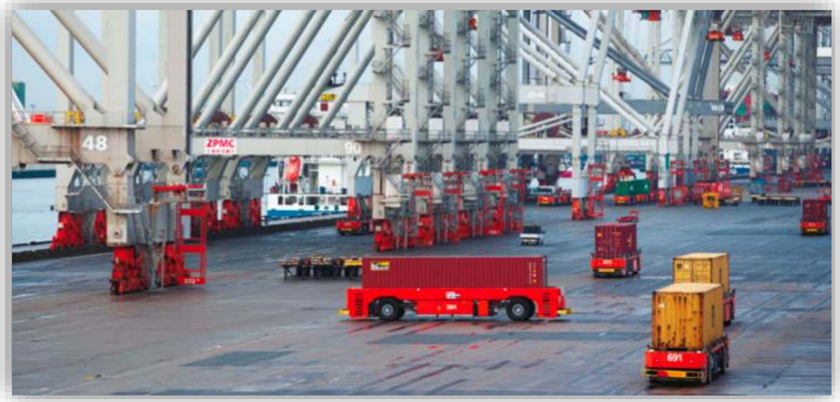
Quantifying the benefits of the innovations in terms of ***sustainability***

Port automation – current conditions

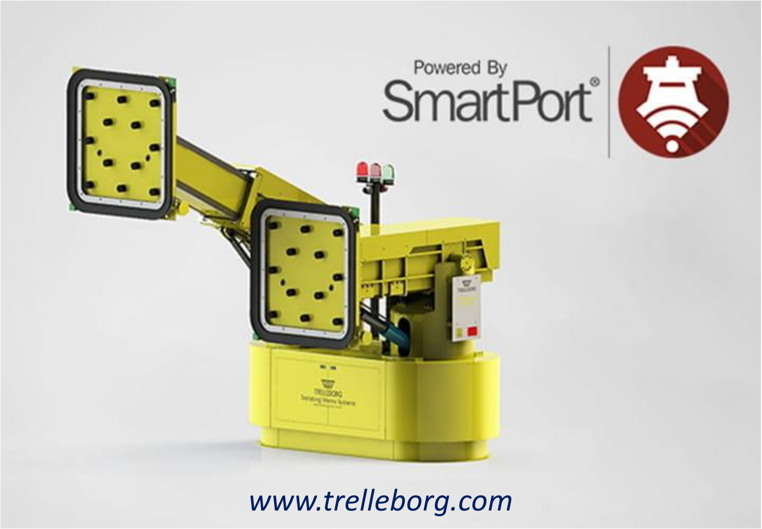
Progress has been made with port automation and different kind of automation ***technologies*** are ***currently used*** *(Negenborn et al., 2023)*:

- Cargo handling
  - Automated reach stackers
  - Automated guided vehicles for moving containers
- Mooring

Automated guided vehicles move shipping containers in the port of Rotterdam



TRELLEBORGS' AutoMoor - Automated Mooring Solution



"If autonomous vessels are to fulfil their promise, much remains to be done — and soon"

(Negenborn et al., 2023)

Room for improvement

The ***goal*** is to incorporate the ports into an ***automated supply chain*** that will include intermodal transportation (waterborne, rail, road) and will ***efficiently address the needs of involved stakeholders***

Ten-T network*: the plan for integrated, intermodal transportation in Europe*

By 2024 Yara Birkeland is expected to carry fertilizer autonomously from plant to port with zero emissions (Negenborn et al., 2023)

Supply chain integration

massterly

2012	2013	2017	2018	2019	2020	2022	2024

MUNIN

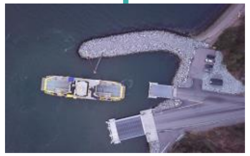
Critical design factors

DNVGL - ReVolt

Concept Study

Svitzer Hermod

Remote Control



Yara Birkeland Falco Demo

Aim at large-scale operation

AUTOSHIP

> TRL7 remote and autonomous vessels

MOSES

Aegis

Autonomous Short Sea Shipping

SEAMLESS

Automated feeder loop service

AUTOFLEX

Small autonomous zero emission vessels

Ship automation

Port automation

Combination of ***innovations*** in order to create a more ***efficient supply chain***

Additions to existing port automations

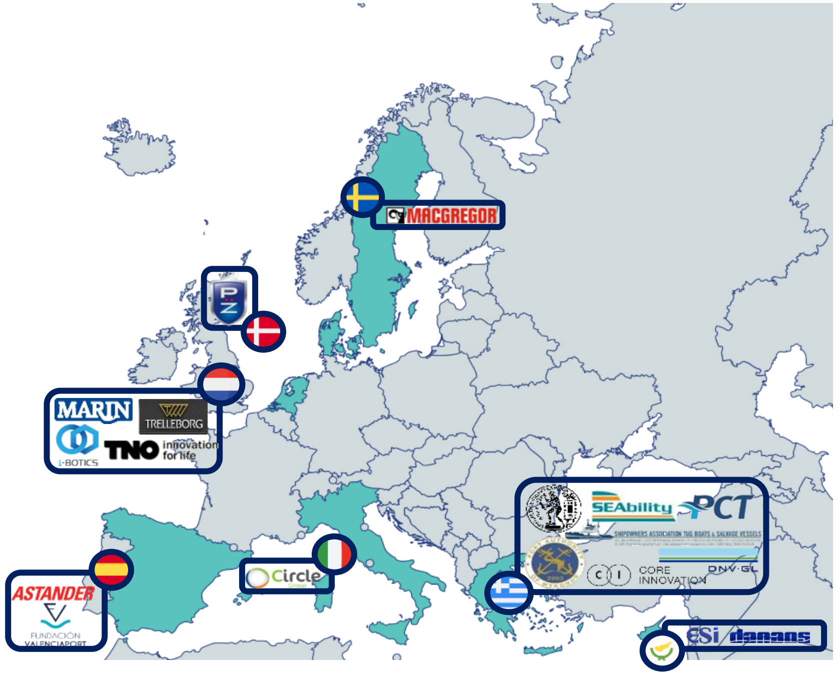
- ***Automating tugboat operations:*** Currently heavily dependent on the human element
- ***Collaboration between automated systems:*** Autonomous tugboats with automated mooring

The MOSES project

Create sustainable feeder services from large container terminals to **small ports with no infrastructure to replace trucks on Ro-Ro ships**

AutoMated Vessels and Supply Chain Optimisation for Sustainable Short SEa Shipping

- **Duration:** 01.07.2020 - 31.12.2023
- **Budget:** 8 million €
- **Consortium:** 17 Partners
- **Coordinator:** NTUA



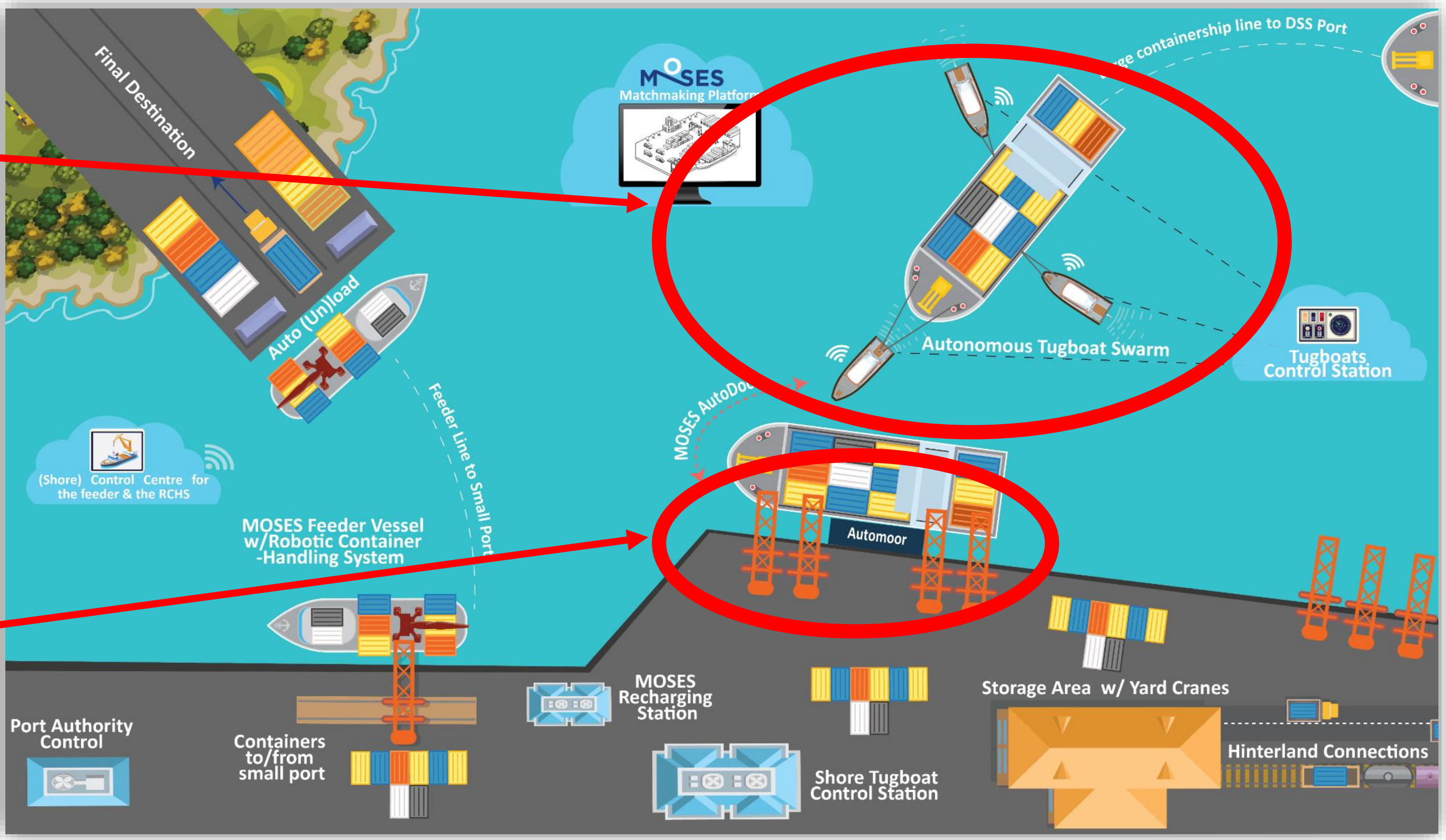
MOSES

MOSES project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 861678.

The MOSES project

MOSES AutoDock:

- *Autonomous tugboat swarm*
- *AutoMoor unit*



MOSES Innovations:

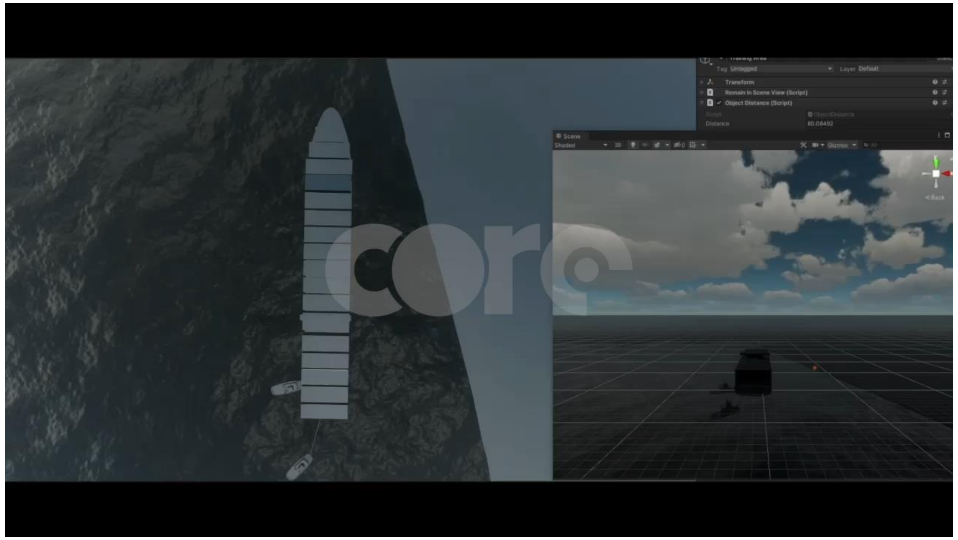
1. **MOSES AutoDock (MOSES Autonomous tugboats + AutoMoor)**
2. **MOSES Recharging Station**
3. **Innovative Feeder Vessel**
4. **Robotic container-handling system**
5. **MOSES matchmaking platform**

MOSES pilot demonstration

Demonstrated autonomous operations:

- Autonomous tugboat operations autonomous tugboat swarm with machine learning-based intelligence
- AutoMooring of a barge
- Technically feasible combination of the two systems

- Port of Faaborg, Denmark
- October 16-20, 2023
- Involved partners: NTUA, TUCO, CORE, TRELLEBORG, ESI



Performing the first steps towards automating tugboat operations within the context of port operations

Challenges beyond MOSES

How can the MOSES autonomous tugboats and automated mooring system be **integrated with port operations and the rest of the supply chain**?

The Next Step – SEAMLESS Project

MOSES

SEAMLESS

Automation of individual port processes

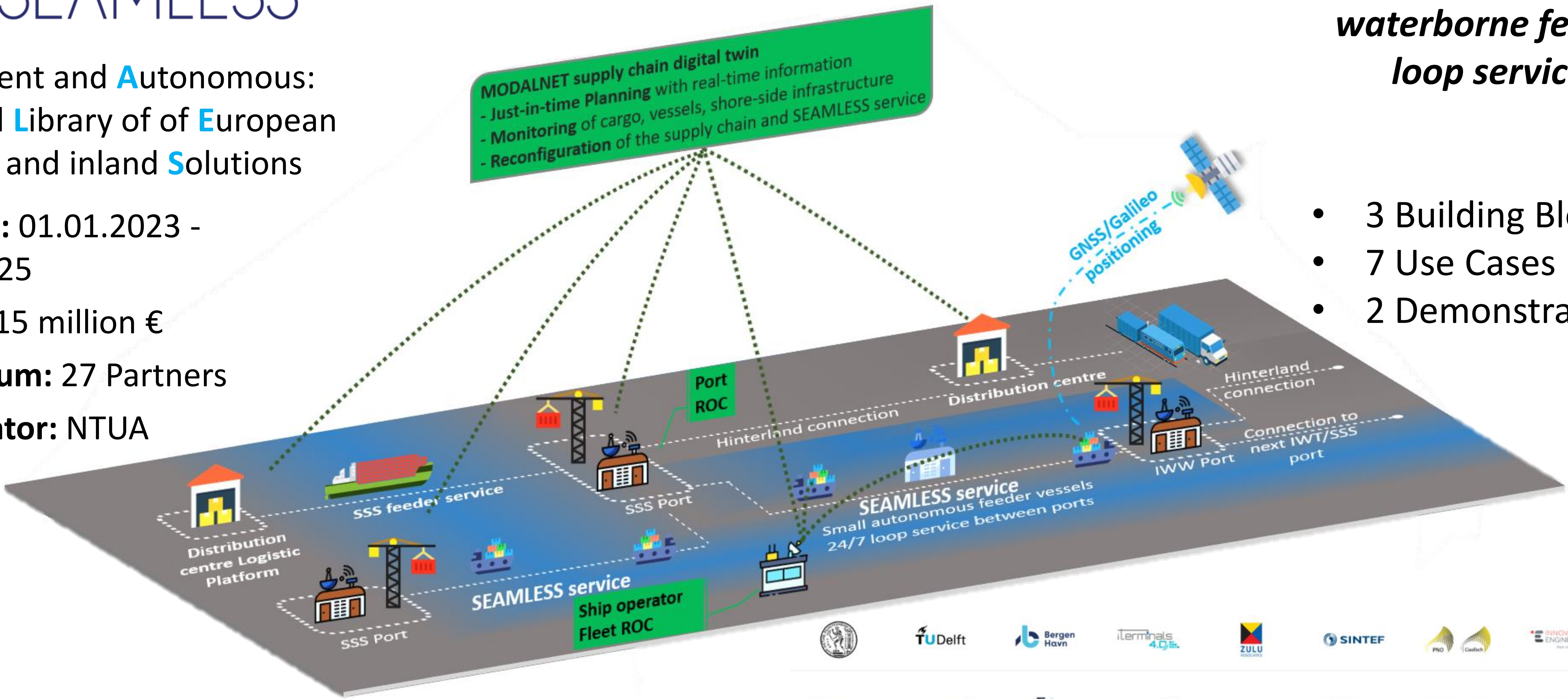
Port automations **interface** with automations of the supply chain

The SEAMLESS project

SEAMLESS

Safe Efficient and Autonomous: Multimodal Library of of European Shortsea and inland Solutions

- **Duration:** 01.01.2023 - 31.12.2025
- **Budget:** 15 million €
- **Consortium:** 27 Partners
- **Coordinator:** NTUA



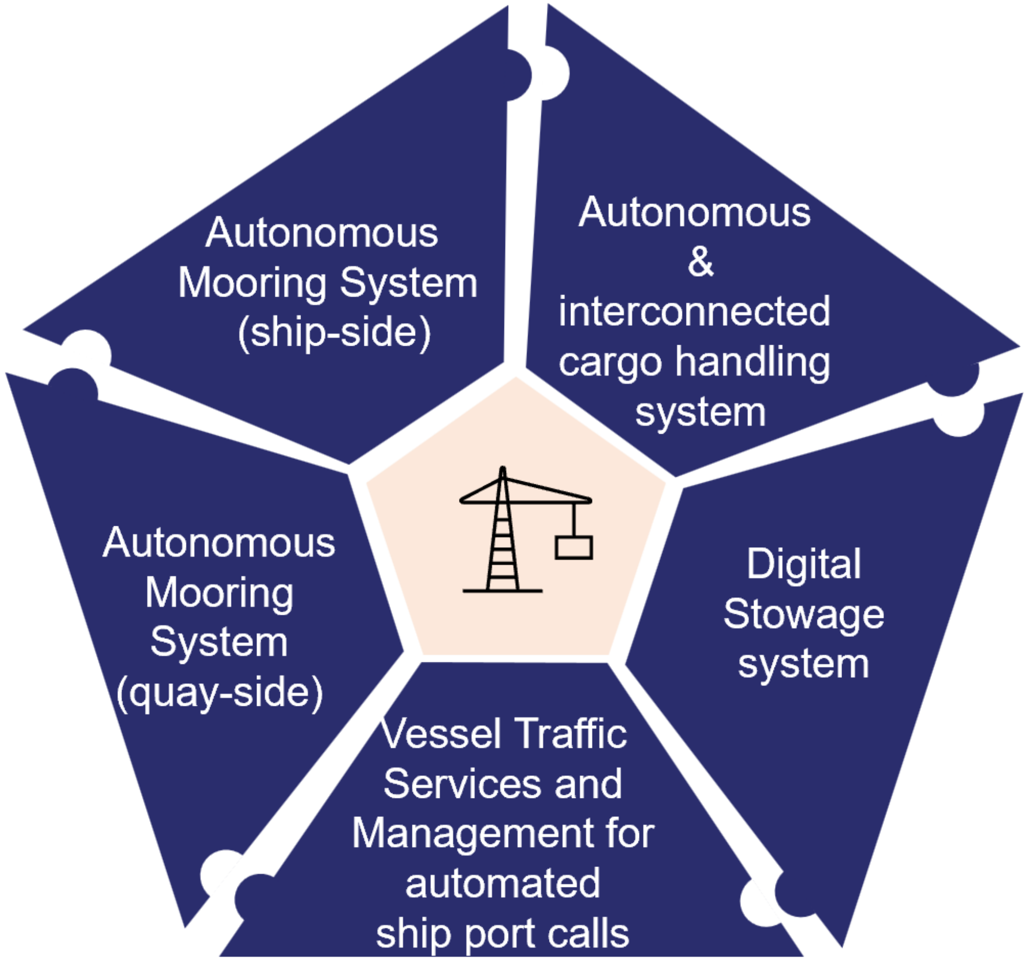
24/7 automated waterborne feeder loop service

- 3 Building Blocks
- 7 Use Cases
- 2 Demonstrations

The SEAMLESS project

Enabling Autonomous Port Operations

- Vessel – Port smart connectivity
- Cost effective port infrastructure
- Unlocking the potential of both small-rural ports and ports located within busy city centers



The SEAMLESS project

Autonomous Port Operations

SEAMLESS DockNLoad

Source: MacGregor

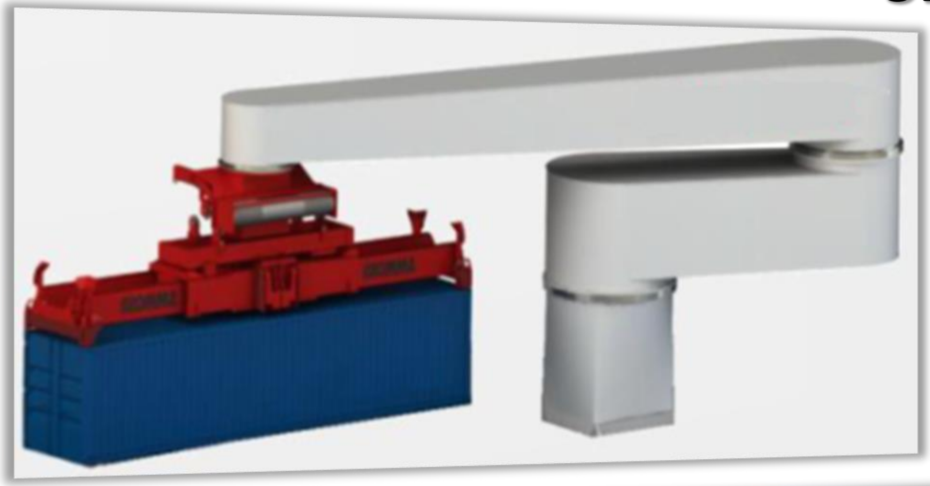
Automated Mooring Module

- Highly automated operation
- Use of a Robotic Arm
- Use of conventional mooring lines
- Compatible with legacy port infrastructure (e.g., bollards)
- Capability to charge ship's batteries via shoreside cable

The SEAMLESS project

Autonomous Port Operations

SEAMLESS DockNLoad



Source: MacGregor

Source: MOSES Project

Autonomous Cargo Handling Module

- Fully autonomous operation
- Reduced cargo swing due to novel design
- Designed for containerised cargo
- Either shore-side or onboard ship

The SEAMLESS project

Autonomous Port Operations

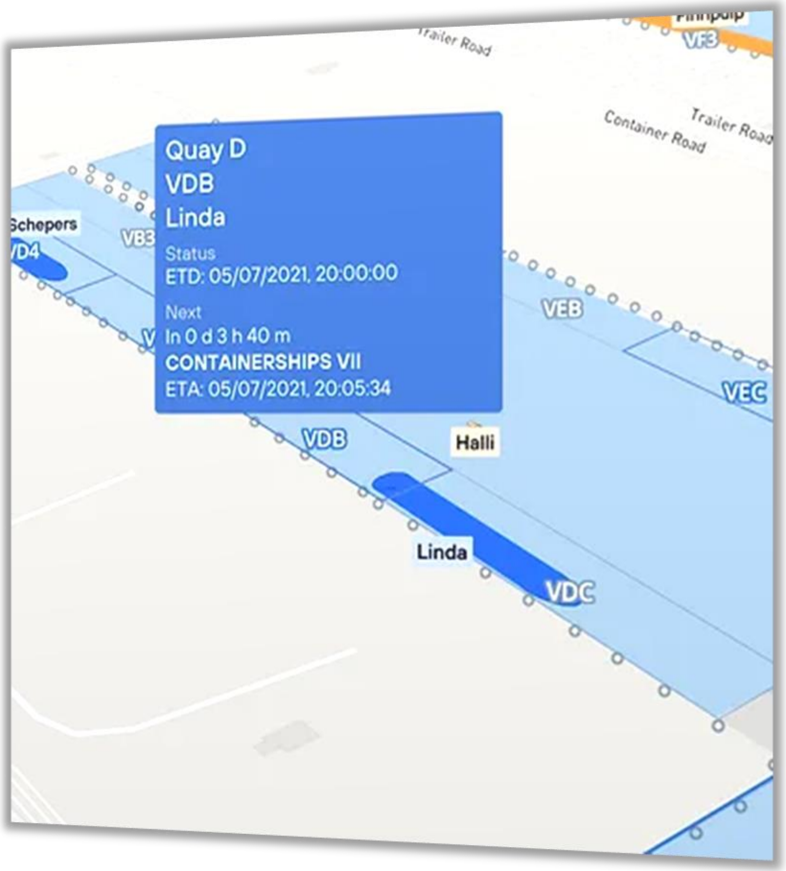
SEAMLESS DockNLoad

Automated Stowage Planning

- Optimisation of shore-side container stowage
- Dynamic planning based on input from ModalNET
- Applicable to SSS & IWT

Autonomous Vessels' Smart Port Manager (AVSPM)

- Automated port calls for MASS
- Compatible to existing port systems
- Port call management & negotiations
- Route planning optimisation (within the port)
- Emergency situations' management

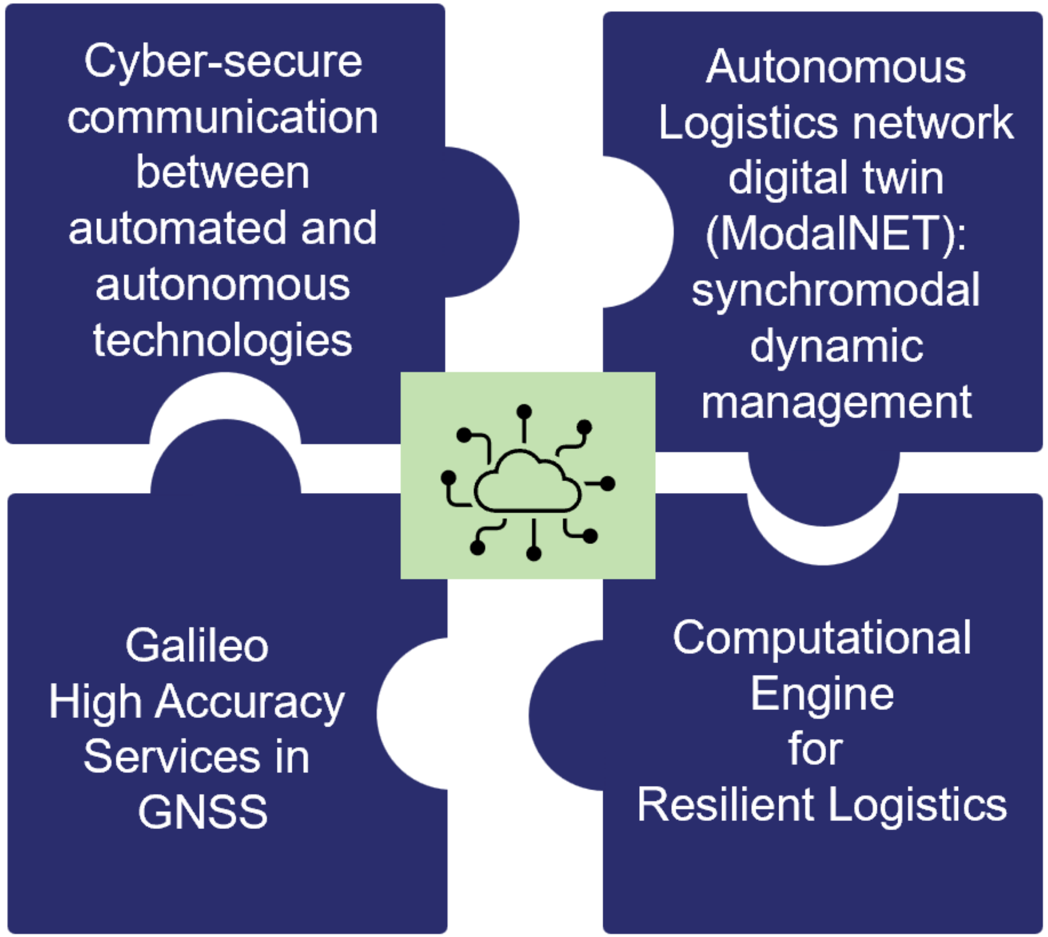


Source: AWAKE.AI

The SEAMLESS project

Digitalising Logistics Operations

- Cooperation with other logistics platforms
- Logistics Network Digital Twin for a real-time, bird's eye view
- Coordinated Fleet Operations
- Enhancing Synchromodality



Automation does not mean no humans!

- The rapid evolution of technology is leading to the ***significant increase of automations*** onboard the vessels and changes the role of human within the ship system *(Wróbel et al., 2019)*
- ***Confusion*** in the ***role of human*** within the system *(Thieme et al., 2021)*
- Despite the expected benefits from the autonomous operations, port automation does not mean having no ***people in the loop***
- The ***ideal amount of automation***, as well as what the ***role of the human element*** is an aspect of major importance

The role of human in autonomous systems

Different approaches to how ***humans*** should ***interact*** with automated systems

Role	Definition / Description
Human in the loop (HITL)	The capability of human intervention ***in every decision cycle of the system.***
Human on the loop (HOTL)	The capability for human intervention ***during the design cycle*** of the system and ***monitoring the system's operation.***
Human in command (HIC)	The capability for ***human to oversee the overall activity*** of the AI/Autonomous system (including its broader economic, societal, legal and ethical impact) ***and the ability to decide when and how to use the system in any particular situation.*** This can include the decision not to use the system in a particular situation, to establish levels of human discretion during the use of the system, or to ensure the ability to override a decision made by a system.

EU High-LEvel Group on Artificial Intelligence (AI HLEG, 2019)

Will intelligent ports,
ships and supply chains
be the norm in the future?

What's next?

- ***The research agenda for ports in the future*** focuses on environmental issues, e.g.:
  - Onshore Power Supply
  - Infrastructure for multiple alternative fuels
  - Calculation of pollutants, so that they can enforce the regulatory requirements to limit them
- Port automation needs to serve the ***environmental objectives*** and the ***supply chain***
- Humans will never be out of the loop – need to find the ***right amount of automation***

(Thieme et al., 2018; Ventikos & Koimtzoglou, 2022)

> ***Ships and ports are ripe for operation without humans - but only if the maritime industry can work through the practical, legal and economic implications first***
>
> *(Negenborn et al., 2023)*

Thank you!

Please don’t hesitate to contact me:

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