# Exploiting automation and autonomy in the maritime domain: Challenges and benefits

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March 24, 2021

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MRG
MARITIME RISK GROUP

# Contents

# Snapshots from the future



# Developments in Maritime Autonomy (EU)

massterly
a Kongsberg Wilhelmsen joint venture

| 2012 | 2013 | 2017 | 2018 | 2019 | 2020 | > 2025 |
|---|---|---|---|---|---|---|

**2012** – MUNIN

**MUNIN**

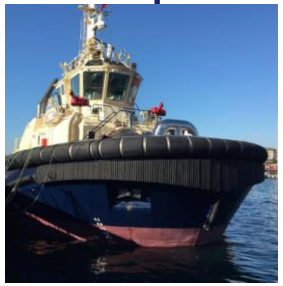
Critical design factors

**2013**


**DNVGL - ReVolt**

Concept Study

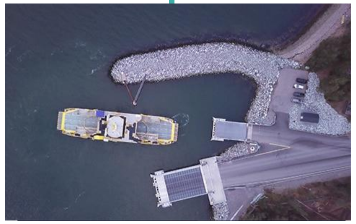
**2017**



**Svitzer Hermod**

Remote Control

**2018**



**Yara Birkeland Falco Demo**

Aim at large-scale operation

**2019**

AUTOSHIP
Autonomous Shipping Initiative for European Waters

**AUTOSHIP**

> TRL7 remote and autonomous vessels

**2020**

MOSES

Aegis

**MOSES, AEGIS**

Autonomous Short Sea Shipping

**> 2025**

**Autonomous Ships**

Large scale operation

# Developments in Maritime Autonomy

Maritime Autonomous Surface Ship "MASS" is defined as a ship which, to a varying degree, can operate independent of human interaction. (MSC. 100/5)

**Degrees of automation and human presence (MSC 101/5/4)**

**1**: Ship with automated processes and decision support

**2**: Remotely controlled ship with seafarers on board

**3**: Remotely controlled ship without seafarers on board

**4**: Fully autonomous ship

**Automation**:
the implementation of processes by automatic means, under specified conditions can function without human intervention

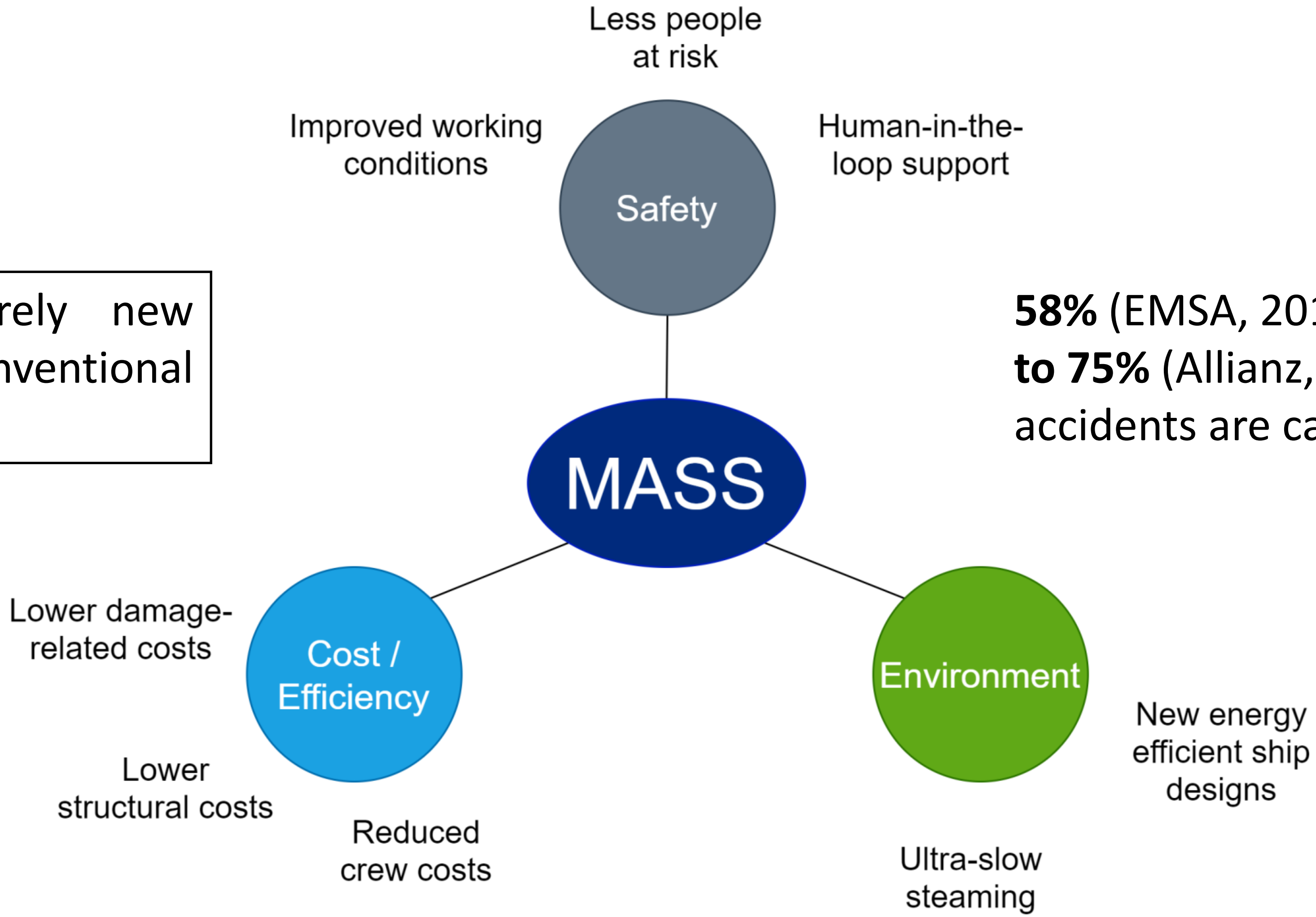
**Autonomous ship**:
uses automation to operate without human intervention (on one or more ship processes), for the full duration or in limited periods of the ship's operations or voyage

**Crewless ship**:
a ship with no crew on board

- MSC 102/5/18 (2020)

# Problems addressed

MASS is an entirely new design, not just a conventional ship without a crew!




**58%** (EMSA, 2018)
**to 75%** (Allianz, 2017) of marine accidents are caused by human error

# Problems addressed

- The necessary measures for dealing with the COVID-19 pandemic has disrupted many “normal” functionalities
- The maritime industry is faced with the related Crew Change Crisis


Source: ITF Seafarers



- Autonomous ship concepts may be a viable/sustainable way forward…

# Challenges – Emerging risks

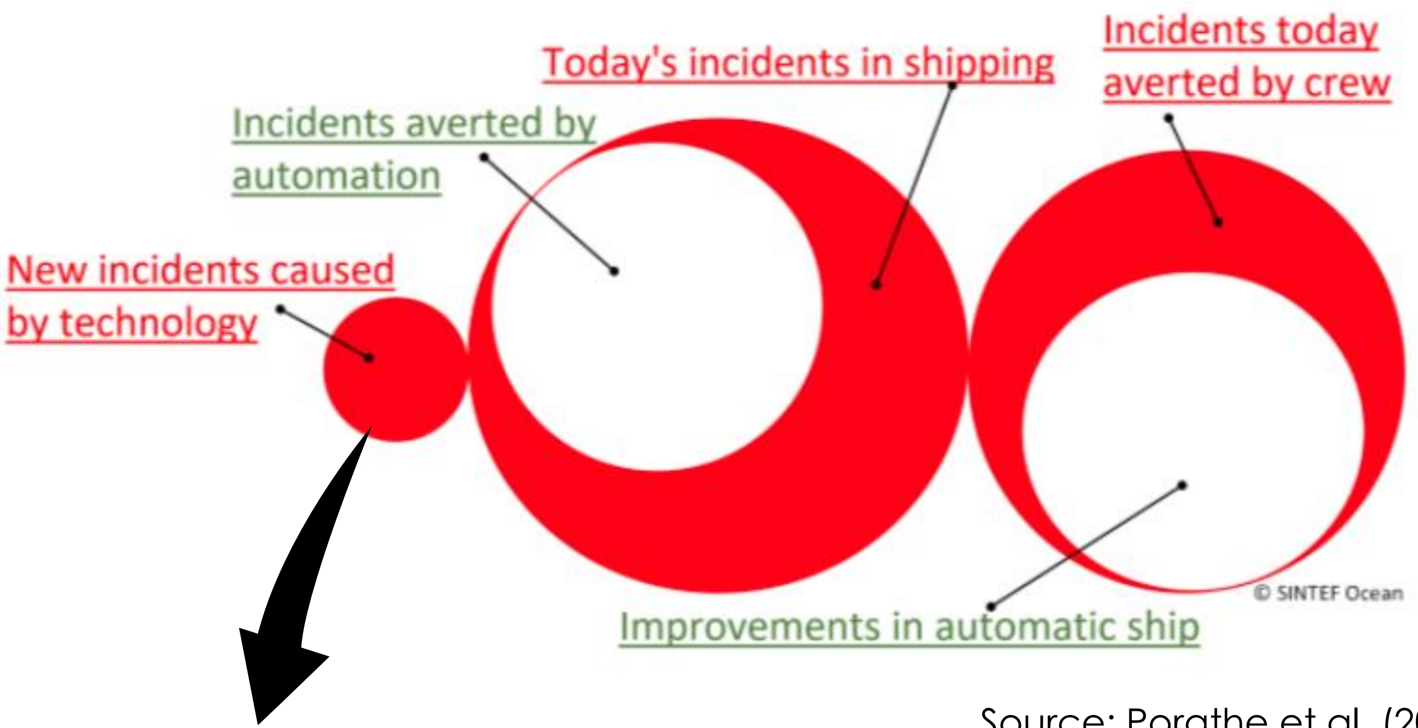
Increased complexity

+

Differentiated role for the human element

=

Safety Assurance?

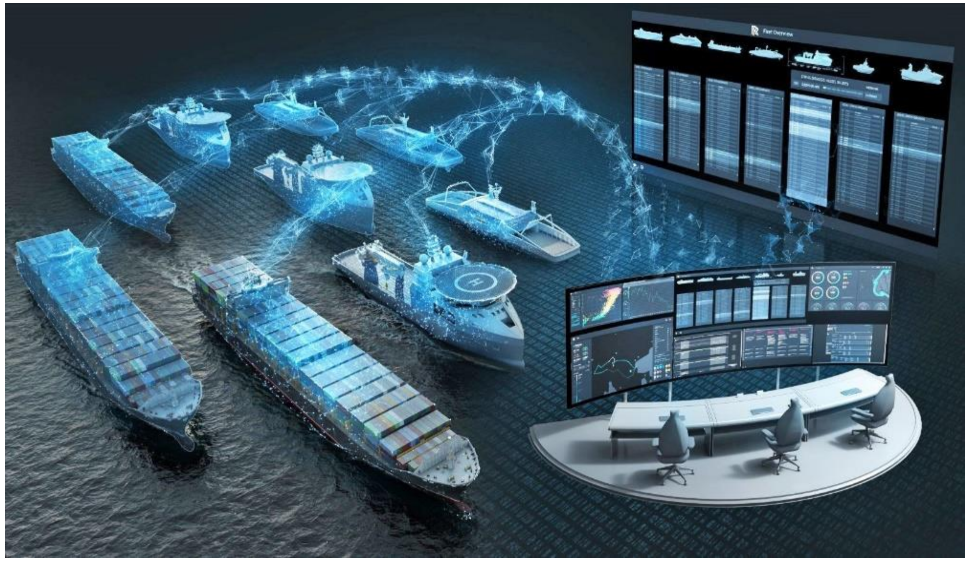



Source: Porathe et al. (2018)

- Automation bias, over-reliance on automation
- Information overload, reduction of vigilance
- Communication latency
- Erroneous prediction of the behaviour of ships with varying levels of autonomy (Ahvenjärvi, 2016)

# Challenges – Emerging risks

- Operational risk **not managed** by crew
- New interactions may result in **new hazards**
  - (unmanned ship in relation to Shore Control – imagine what could happen with a ship with advanced AI!)
- New interactions between manned and unmanned ships (**mixed traffic**)
- Human in the loop (HITL)



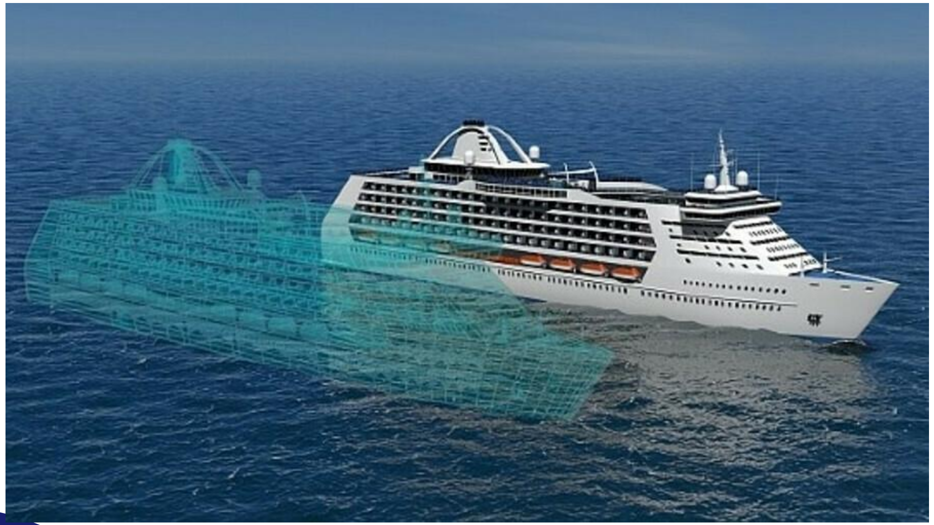
| | | |
|---|---|---|
| AL3 | 'Active' Human in the loop | Decisions and actions are performed with human supervision. Data may be provided by systems on or off-board. |
| AL4 | Human in the loop, Operator/Supervisory | Decisions and actions are performed autonomously with human supervision. High impact decisions are implemented in a way to give human Operators the opportunity to intercede and over-ride. |

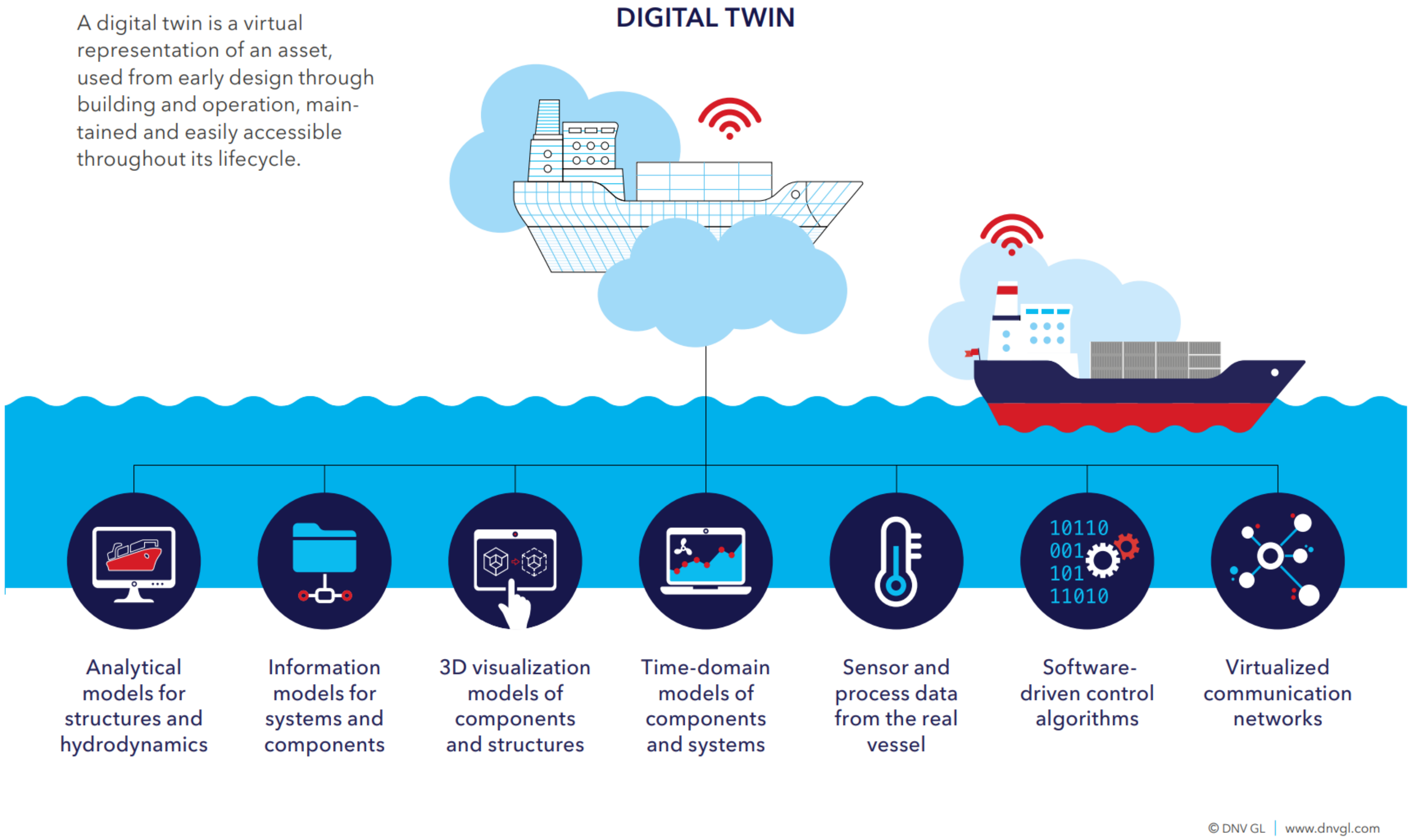
Autonomy Levels (AL) proposed by Lloyds Register (IMO MSC 99/55/6)

# New era for safety

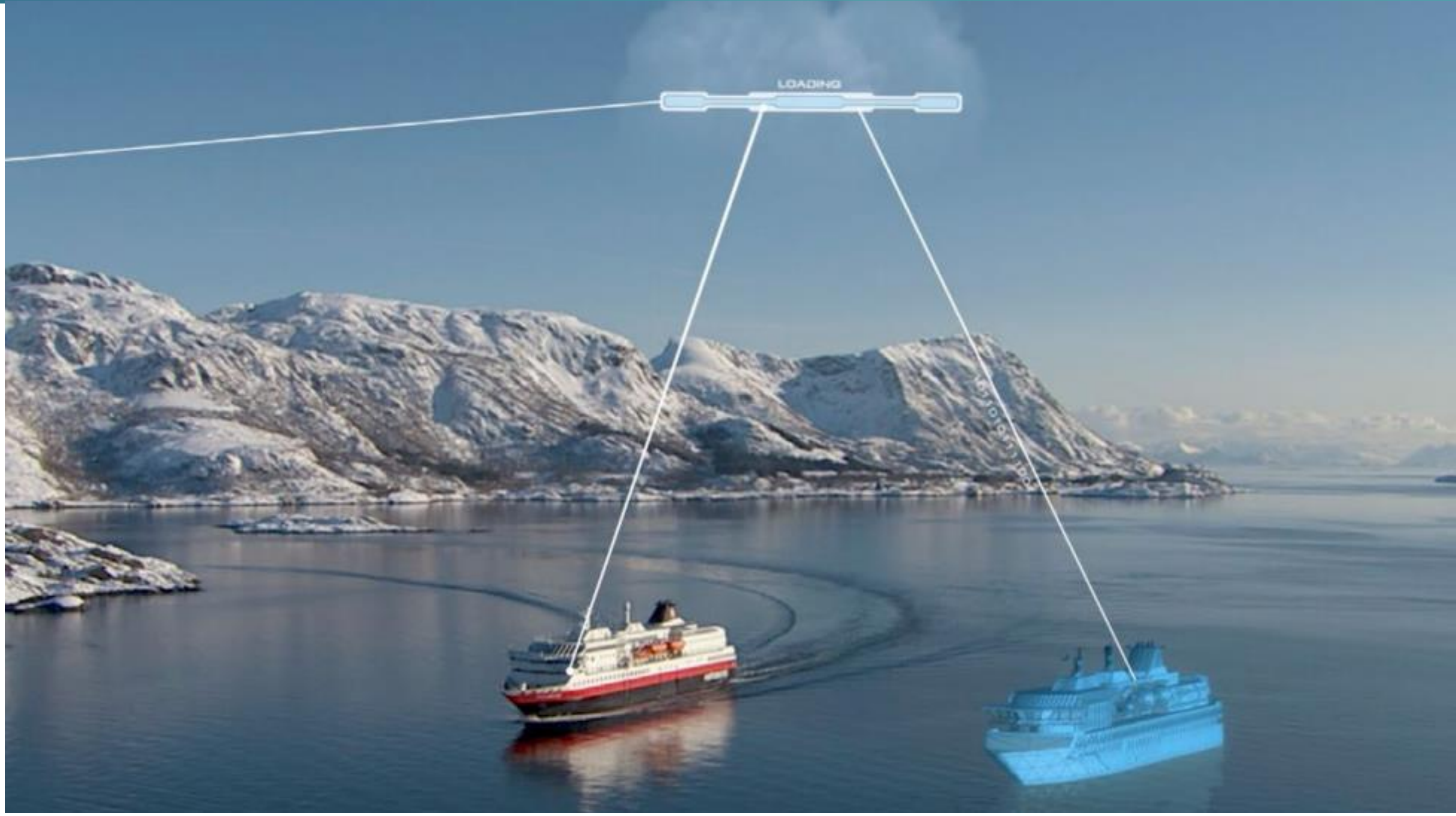
**Beyond traditional safety assessment**

- Simulation-based safety
- Digital twin





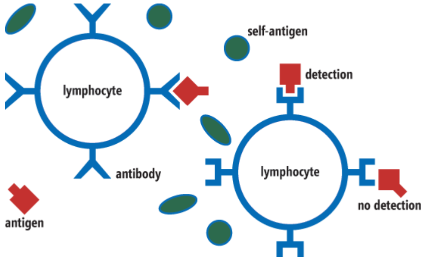
# New era for safety



## Life Cycle Safety Management

- Risk management conducted in design and throughout operational phases
- **Are new approaches needed to address emerging risks?**

**Bio-inspired**




Ventikos, N.P., Louzis, K., 2019. Introducing a bio-inspired Life-Cycle Framework for emerging risks in the maritime industry. Sustainable Development and Innovations in Marine Technologies: Proceedings of the 18th International Congress of the Maritime Association of the Mediterranean (IMAM 2019). Varna, Bulgaria. CRC Press, pp 527 - 536.

Ventikos, N. P., Chmurski, A., & Louzis, K., 2020. A systems-based application for autonomous vessels safety: Hazard identification as a function of increasing autonomy levels. Safety Science, 131:104919.

# The future of MASS

- Safety assurance affects the public's perception of risk
- Adoption from ship owners and operators will depend on the strength of the business cases, to justify making such investments
- Development of international regulatory framework
- **New FSAs?**


**IMO Regulatory Scoping Exercise**

**Target**: consider whether international conventions require amendments to enable the safe and secure use of MASS

# The future of MASS

MASS

**Strengths**

- Optimized route by default
- Improved logistics
- Safer
- Seafarers can go home after their shift
- Can be more reliable with less errors
- No costly crew exchanges, no wasted crew time onboard
- More sustainable, increasing longevity

**Weaknesses**

- Fully autonomous ships cannot assist other ships in emergencies
- Lack of tripartite social-economic dialogue
- Lack of global-scale, international coordination
- Very little advertising of such projects
- Significantly reduced possibility for machinery failure mitigation
- Poor business case

**Opportunities**

- Other ship designs possible
- Strengthened multimodality
- Creating new maritime career paths
- Parallel revolution in automotive industry leads to knowledge exchange
- Incorporation of tech for greener fuels
- Improve working conditions for seafarers

**Threats**

- Lack of standardization from manufacturers
- Only ports which adapt accept autonomous ships
- Legal implications/ Lack of common framework
- Lack of demand from major ship operators
- Lack of reliability of machinery equipment
- Public trust in automation
- Assure operational safety level

Adapted from 2nd International Ship Autonomy and Sustainability Summit (Nov. 2020)

# Autonomous Short Sea Shipping

**The case for Short Sea Shipping (SSS):**

- Trade between a relatively limited number of ports
- National authorities can approve the use of the technology within national waters and ports
- Infrastructure needs are limited compared to larger vessels
- The market for SSS vessels can justify large scale investments for equipment providers

The most promising candidate for early adoption of autonomous applications is liner shipping operations – SSS.

(Rødseth 2017)

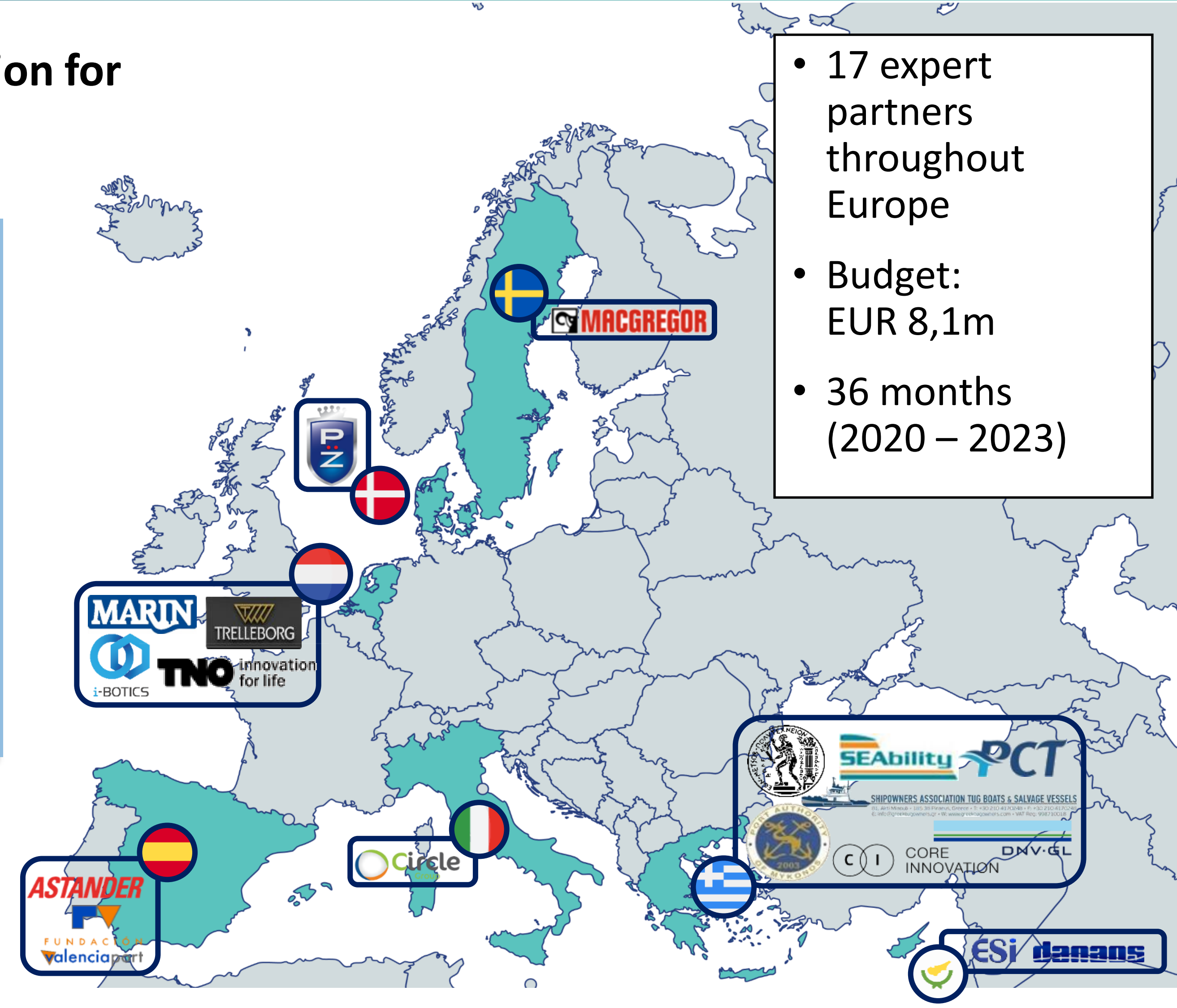
# The MOSES Project

**Automated Vessels and Supply Chain Optimisation for Sustainable Short Sea Shipping**

MOSES aims to significantly enhance the SSS component of the European container supply chain, following a two-fold strategy:

i) reducing the time to berth for deep sea shipping ports,

ii) stimulating the use of SSS feeder services to small ports with limited or no infrastructure.




- 17 expert partners throughout Europe
- Budget: EUR 8,1m
- 36 months (2020 – 2023)

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

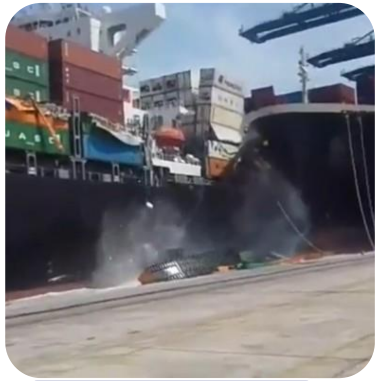
# MOSES Challenges


More containers globally need to be transported

Larger container ships bring more cargo to terminals that needs to be transshipped to the hinterland


Island ports with no infrastructure are usually serviced by trucks on Ro-Pax Ferries


This leads to congestion from heavy container truck traffic



Large and more container ships also lead to adverse consequences in terms of safety

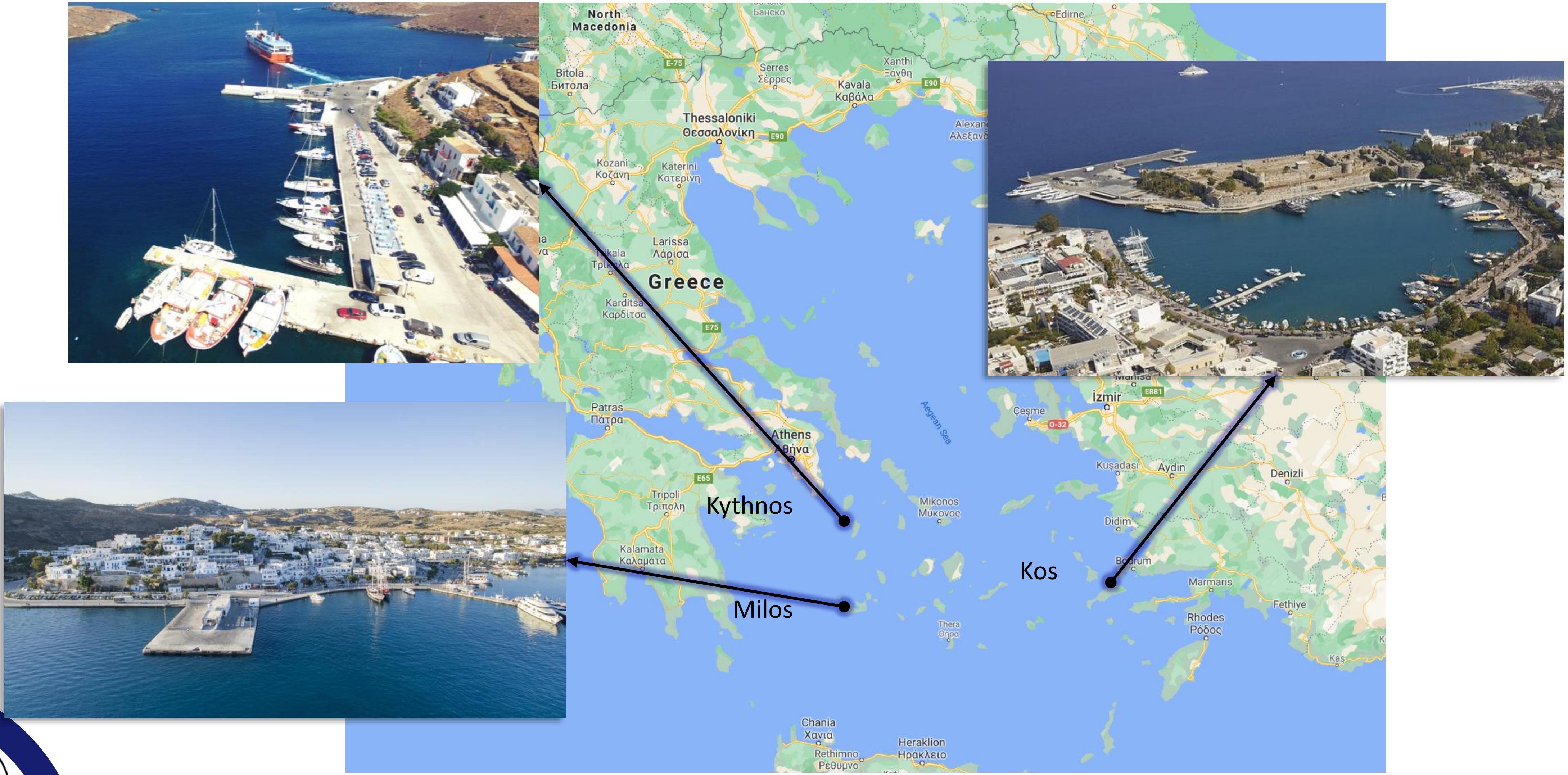
# MOSES Challenges


Short Sea Shipping to small ports with no cargo handling infrastructure could provide an alternative to land-based transshipment

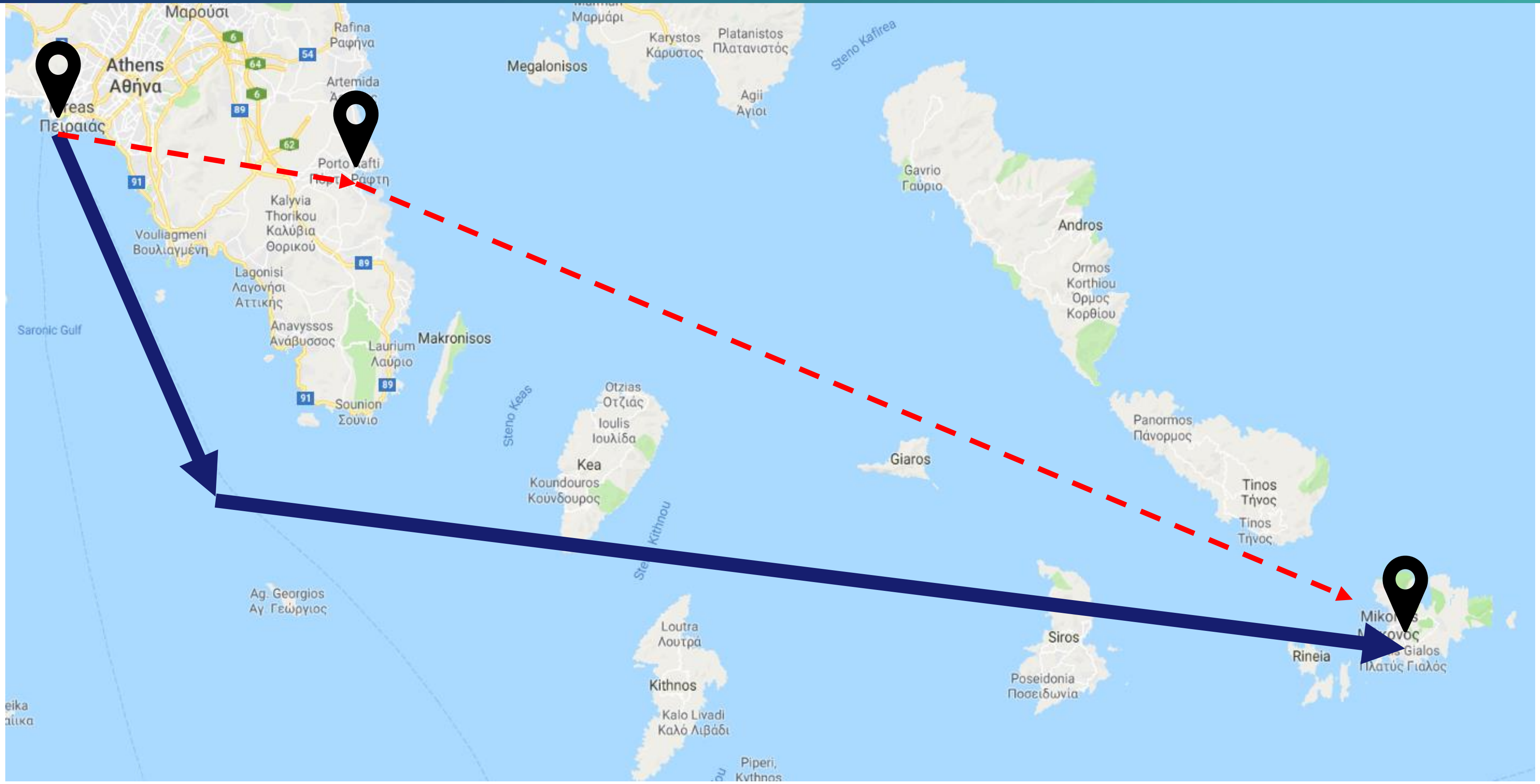
**Efficient** **Green** **Safe**

This potential is mostly untapped, because
- existing feeders cannot be served by small ports
- there is little incentive for carriers to choose maritime transport instead of road/rail modes.

# The case of a European Archipelago

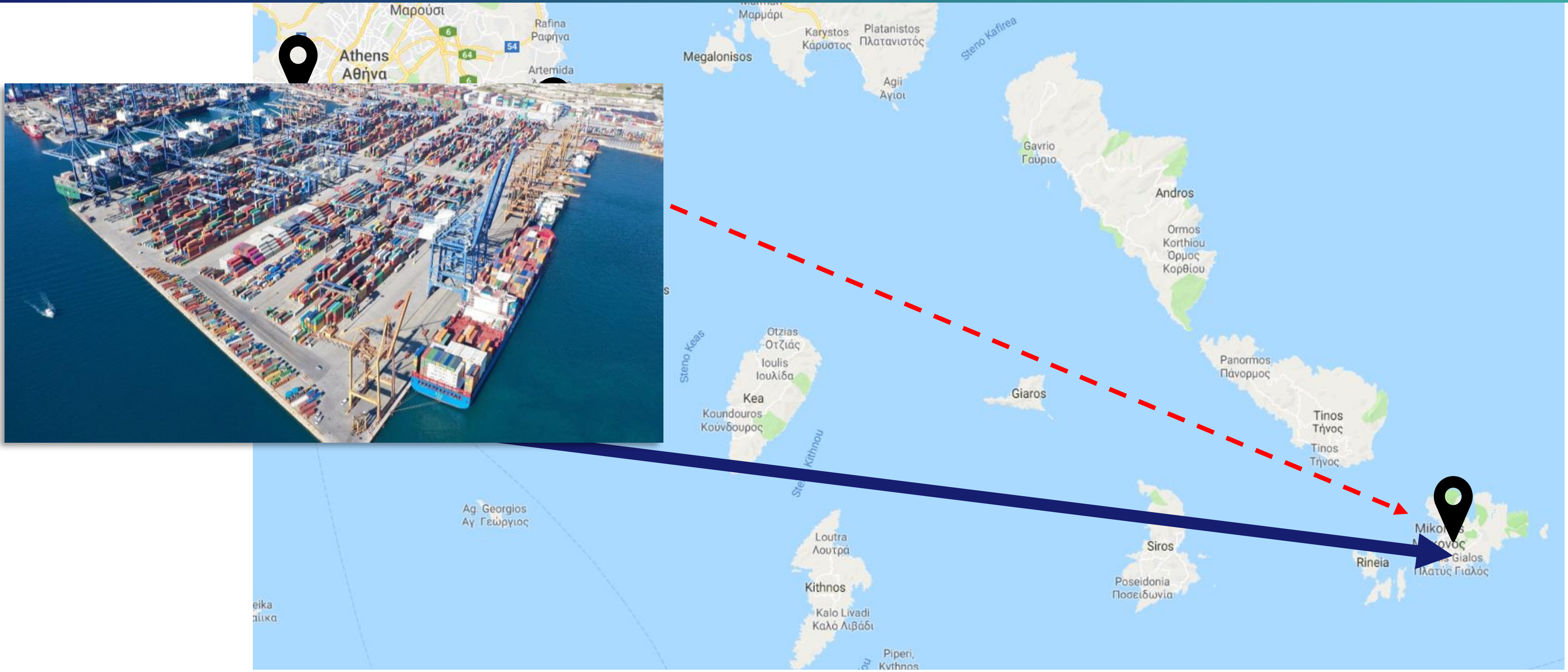


# The case of a European Archipelago



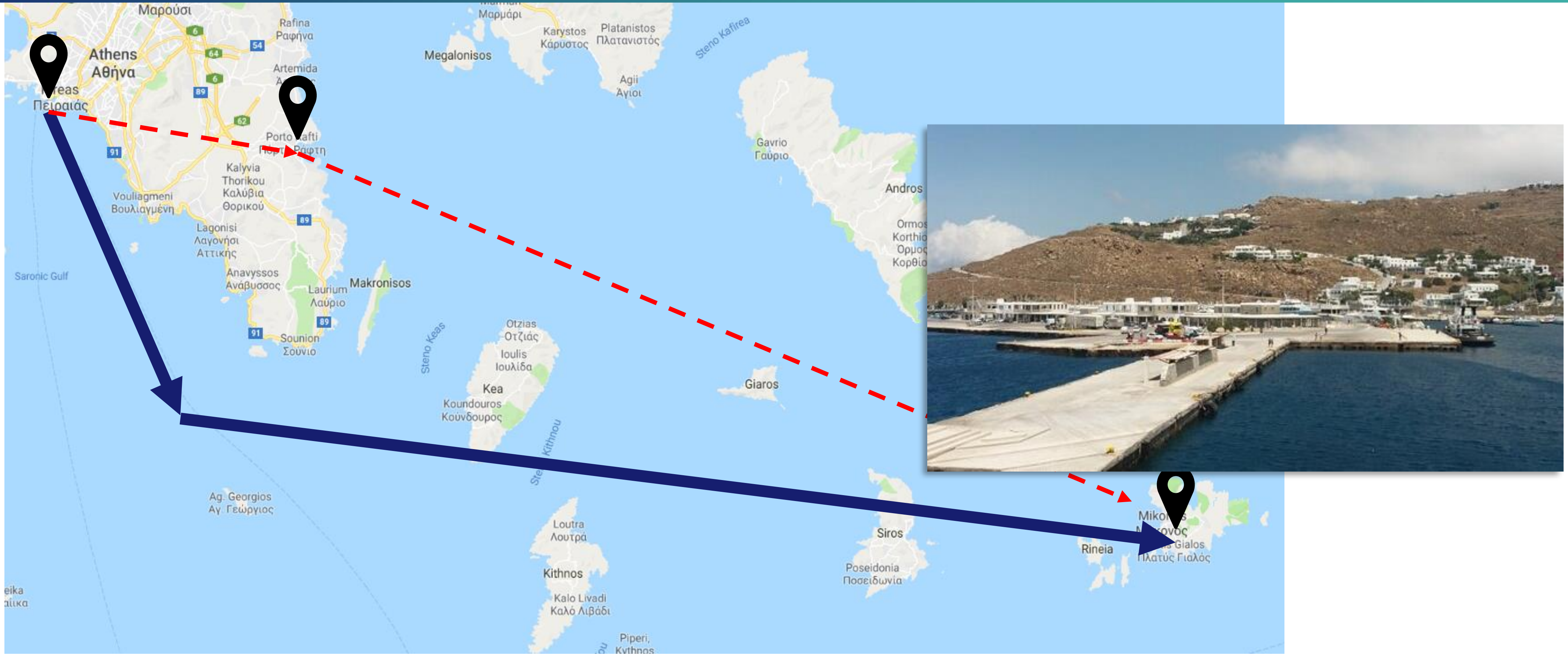

MOSES will create **new pathways** in the EU container supply chain by **integrating small ports** with no infrastructure into the EU container supply chain

# The case of a European Archipelago



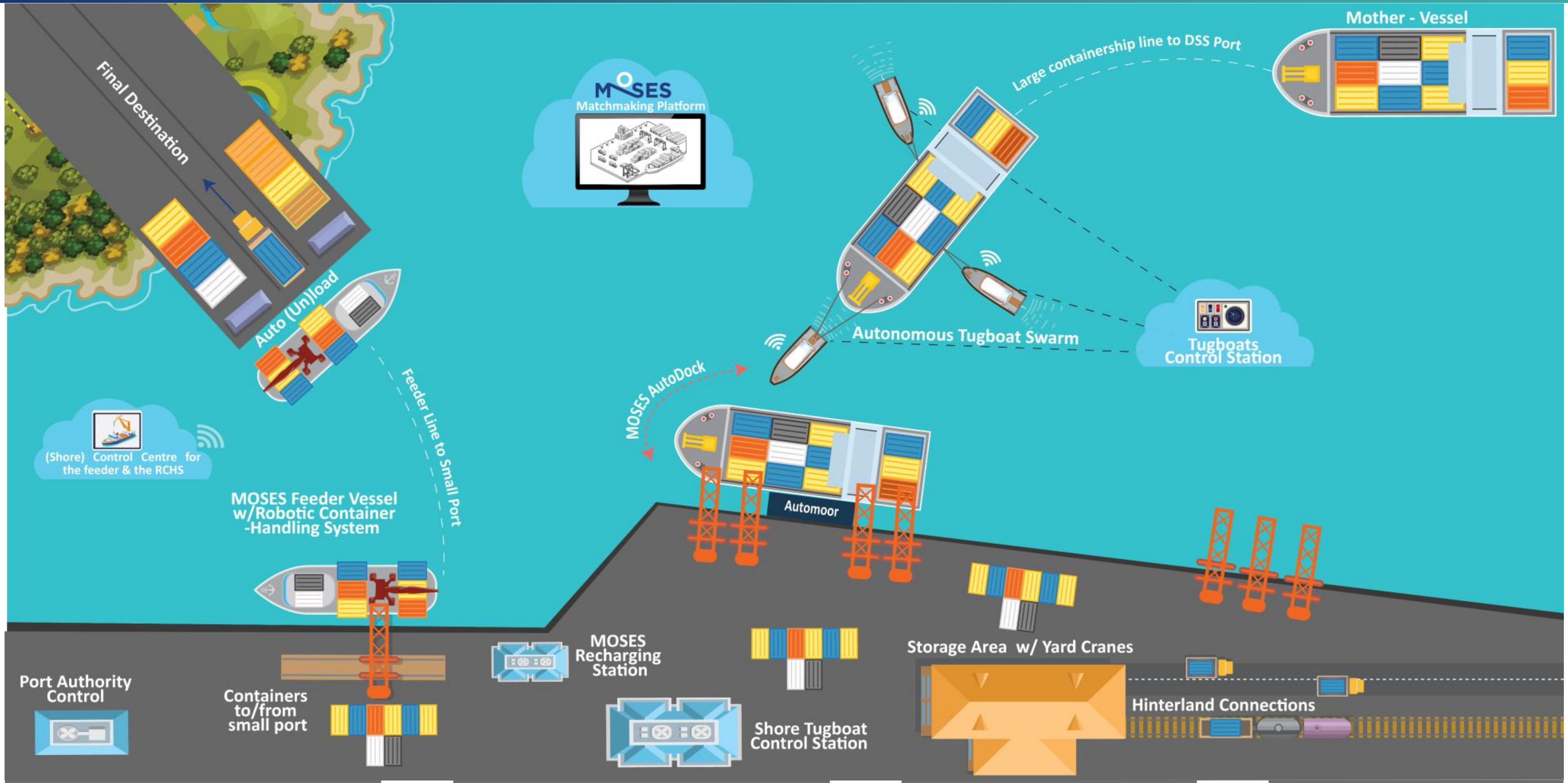

MOSES wants to take container cargo directly from large container terminals…

# The case of a European Archipelago




To small ports via Short Sea Shipping feeders

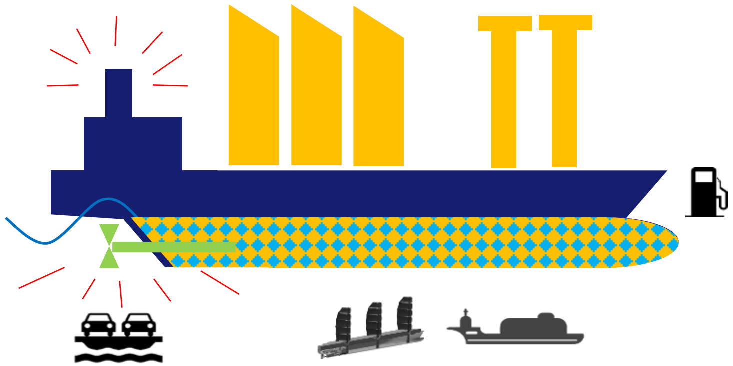
# The MOSES Concept



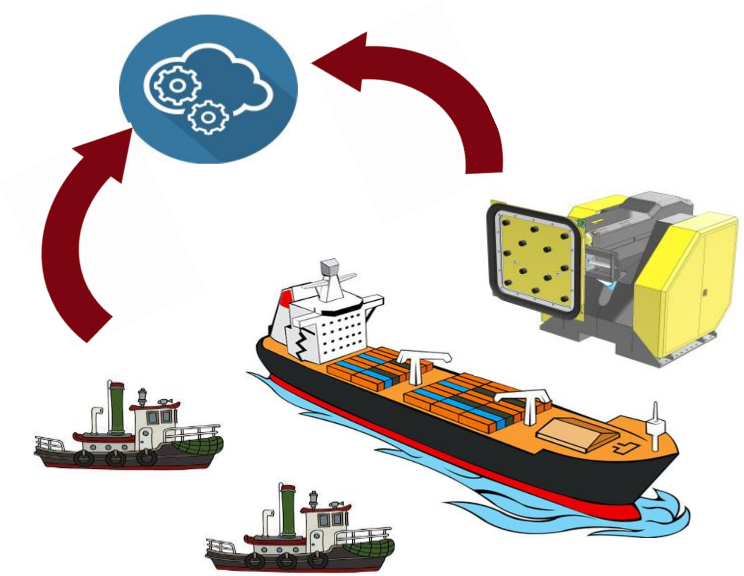

Ship design | Technologies | Processes | Software

# The MOSES Concept

**Innovative Feeder**
Concept design, feasibility for autonomous operation



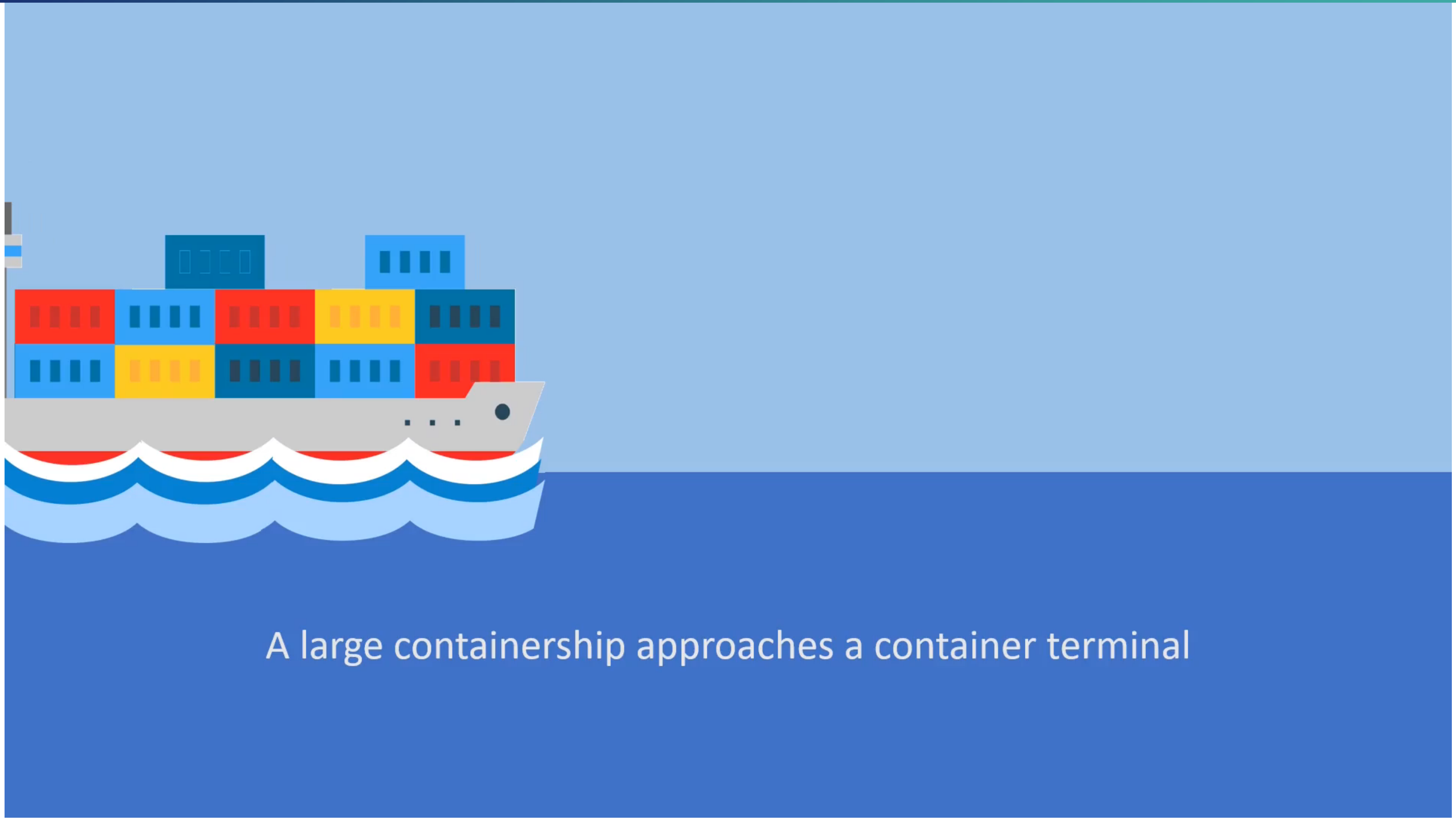
**AutoDock**
Autonomous Tugboat swarm collaborating with automated mooring



**Robotic Container Handling System**
Automated infrastructure

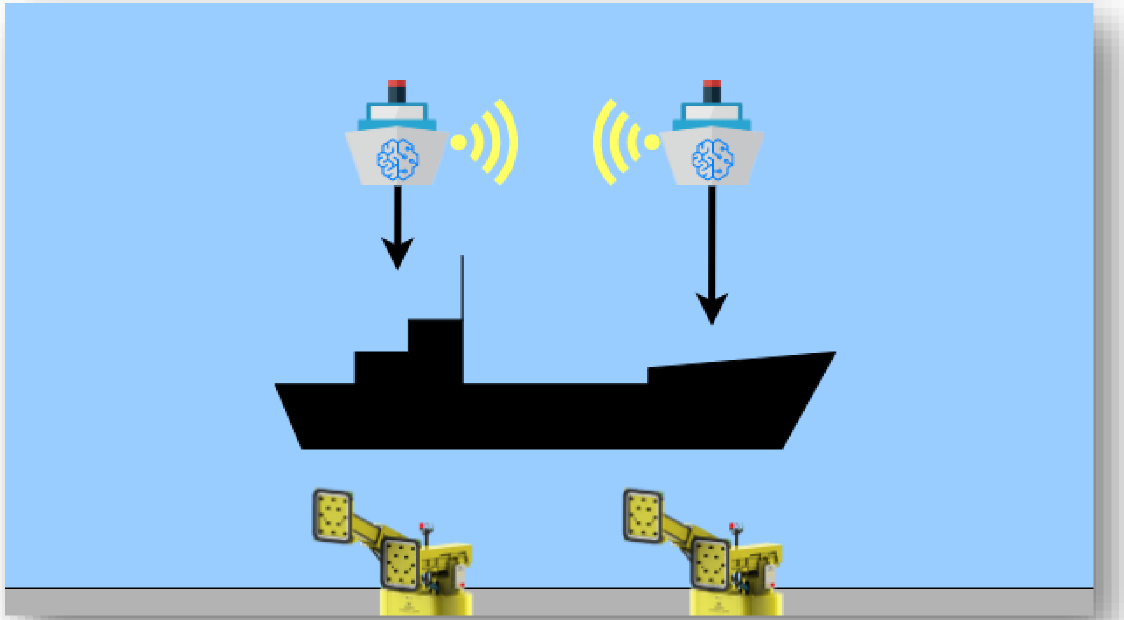

**Matchmaking Platform**
Matching demand and supply of cargo

# The MOSES Concept



# MOSES Impact on sustainable SSS

**Autonomous Tugboat swarm collaborating with automated mooring**



## Safety

Minimize human error in towing
Reduce accident during berthing

## Environment

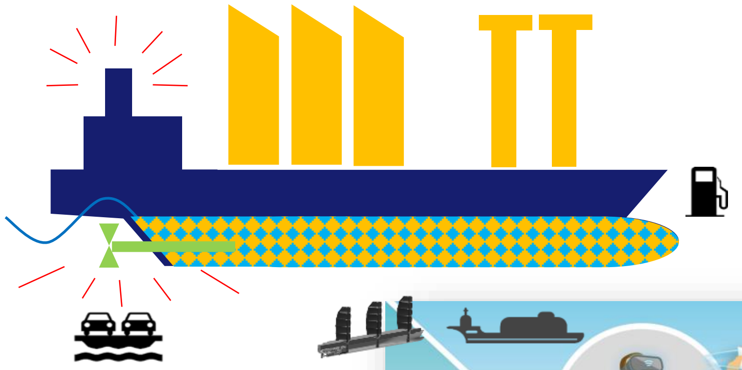
Reduce air emissions, tugs will use electric propulsion

## Efficiency

Reduced time to berth
More reliable towing services
Increase service availability

# MOSES Impact on sustainable SSS

**Innovative feeder with robotic container-handling system**




## Safety

Minimize risk in cargo handling

## Environment

Green propulsion technologies
Reduce total emissions/TEU
Reduce road congestion in port areas

## Efficiency

Delivering cargo where no infrastructure is available

# MOSES Impact on sustainable SSS

**Matchmaking platform**


## Environment

Promote environmentally-friendlier alternative to land-based transshipment

## Efficiency

Ensure viability of SSS services based on innovative feeder

Increase freight using SSS

# MOSES Stakeholder Needs (ind.)

**Environment**

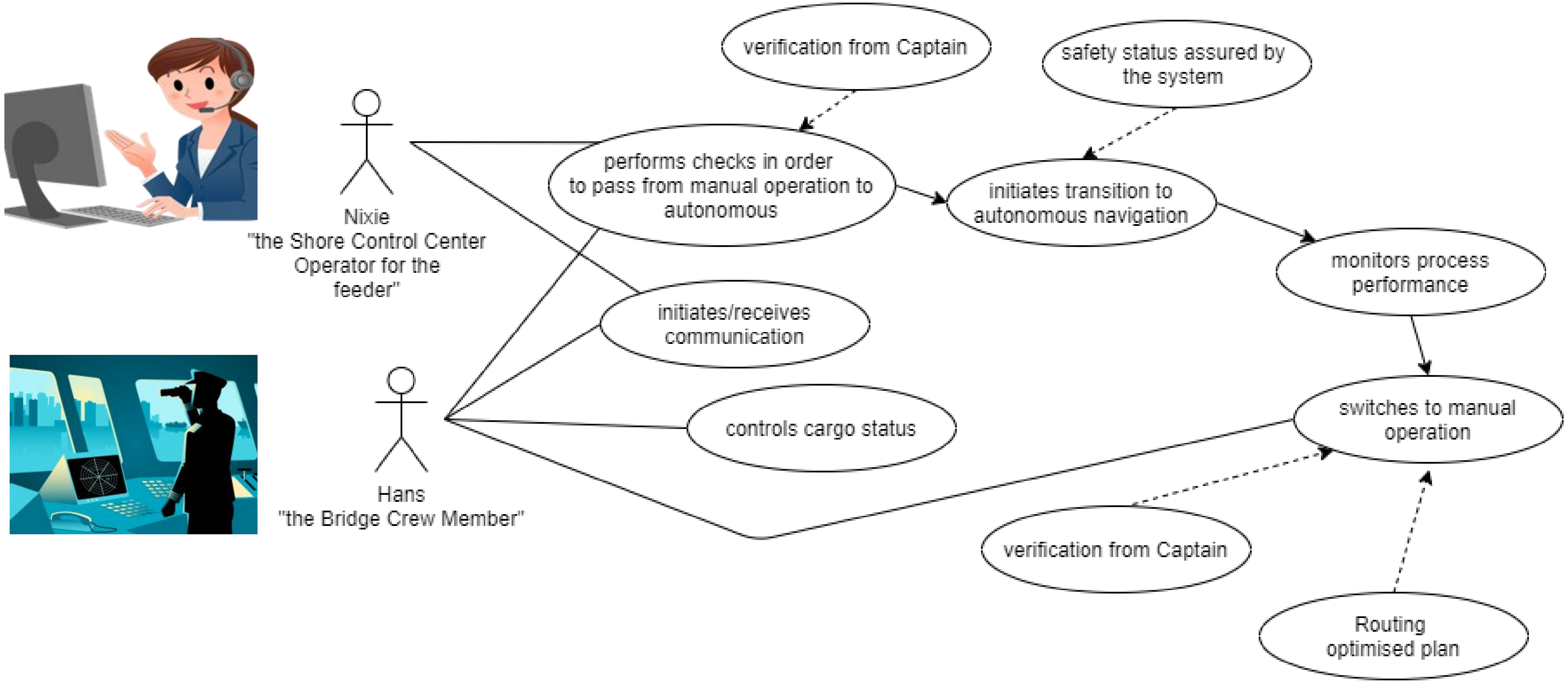
- Investigate deeper into zero-emissions possibilities, including any market-related aspects.
- Other environmental aspects should be considered, such as noise footprint.

**Automation**

- Clear terminology about the level of automation/autonomy.
- Determine which functions will be automated.
- Impact of automation on existing port operations and competencies of port workers.

# MOSES Use cases (ind.)

## Innovative feeder / Sea passage (autonomous navigation)



# MOSES – Towards the future of SSS

**Automated** technologies/processes
**Autonomous** operation

Safety + Efficiency

**Sustainable SSS feeder services** to small (and remote) ports without infrastructure

Special thanks to my student
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# Thank you very much for your attention!


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