

Autonomous Surface Vessels summary

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Overview

- What is an autonomous vessel (ASV)
- Brief marine time history
- Why use autonomous vessels?
- ASV risks and problems
- Sources of energy for ASVs
- Autonomous Vessels Applications
- ASV types
- ASV autonomy types
- ASV Examples
- Basic elements of ASV
- Sensor technologies for Situational Awareness (SA)

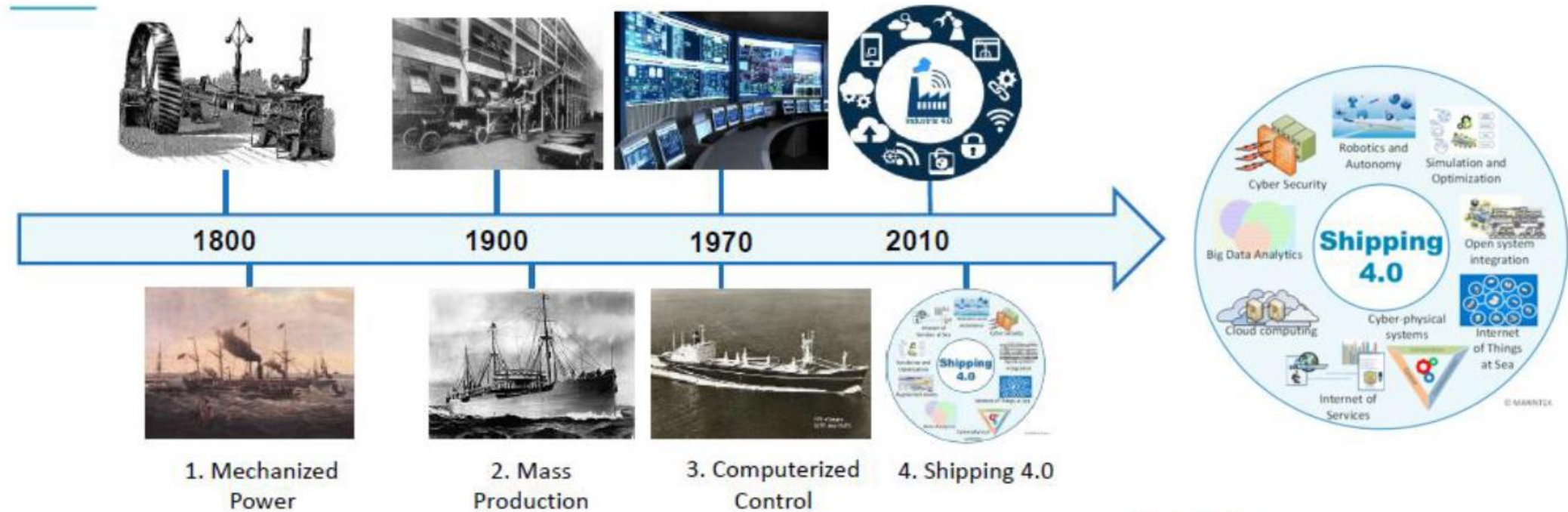
- Comparison of different marine SA sensors
- Comparison of different marine SA sensors
- Relationships among ASV subsystems (GNC)
- Classification of ASV GNU techniques
- ASV Kinematic model
- ASV dynamic model
- Special Marine Issues
- Symbol Dictionary
- Bibliography

Shipping



- **Shipping has very long history.**
- It is one the most important business sectors on the planet.
- Shipping enables world trade:
 - \$375 billion shipping industry that carries 90 percent of world trade.

Brief maritime history

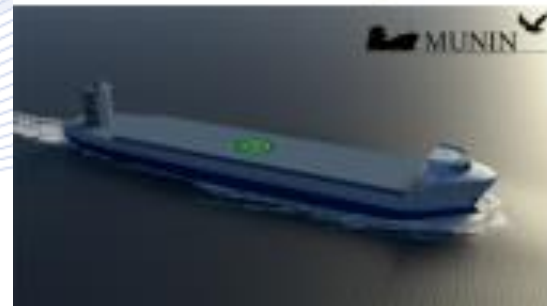


[SLI]

Autonomous ships

- Autonomous ships do not require a human operator.
- **Partly** autonomous ships: a shore control centre monitors the ship and intervenes whenever needed.
- **Unmanned ship** operates without crew.
- **Smart ship** is typically manned, but with advanced automation.

[MUN]

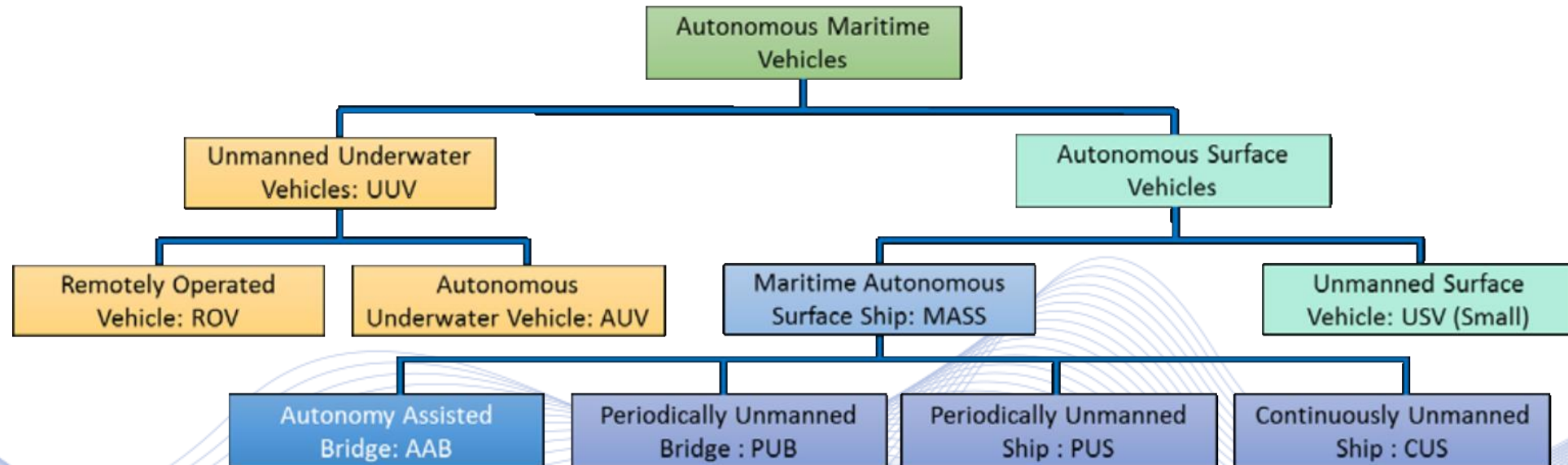


Autonomous ships: International bodies



International Maritime Organization (IMO) regulatory exercise [IMO].

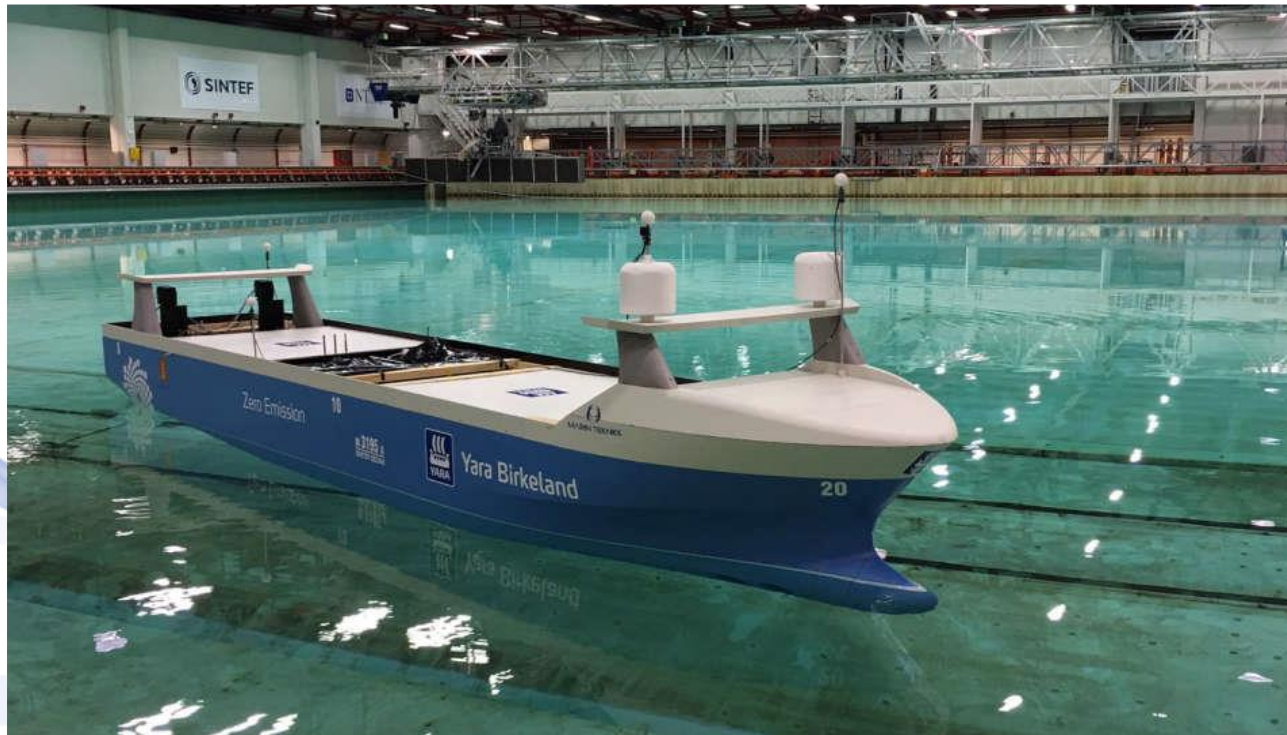
ASV types



ASV types [NFA2017]

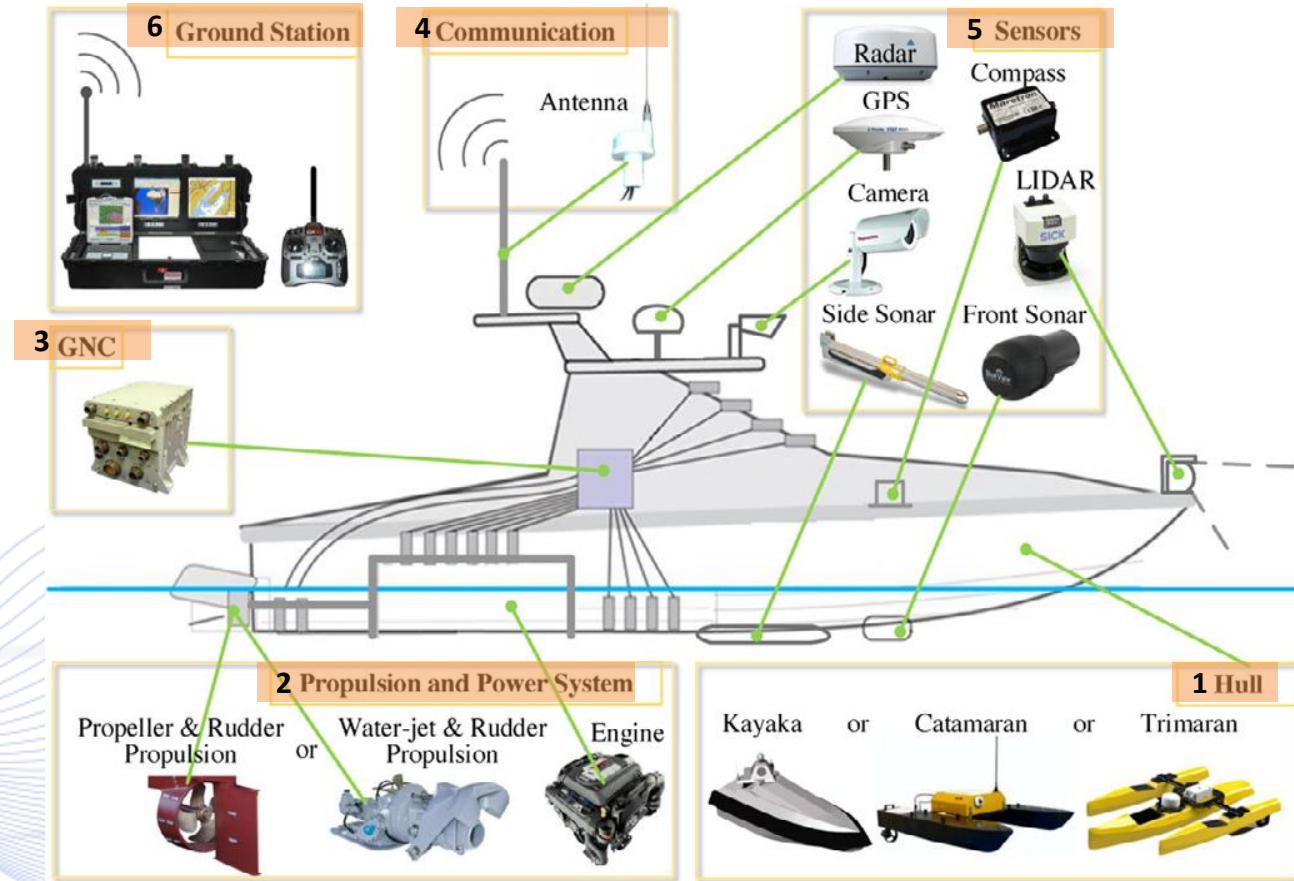
ASV Examples

Yara Birkeland [ØRN2017].



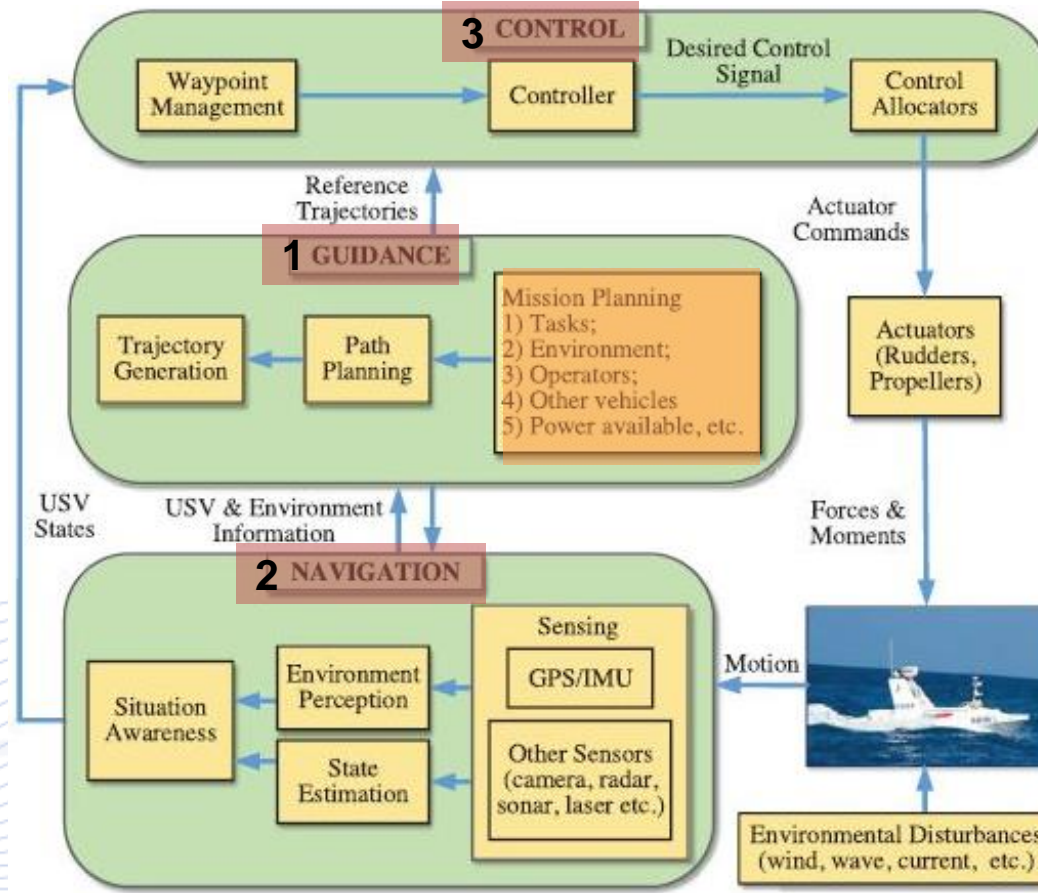
- Fully electric, battery powerd.
- Zero emission container ship.
- Autonomous sailing and mooring.
- Exports 20000 Containers a year.
- Replaces 40000 truck road trips a year.

Basic elements of ASV



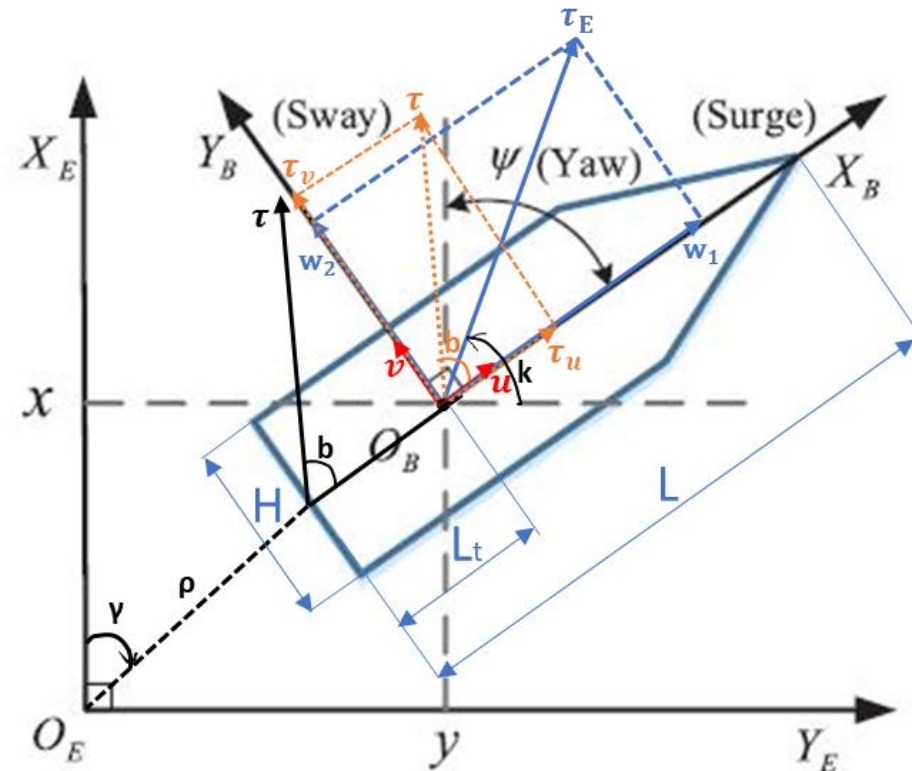
Fundamental architecture of a typical ASV [LIU2016].

ASV system architecture



General structure of ASV guidance, navigation, and control systems [LIU2016].

ASV dynamic model 2DOF



ASV dynamic model.

ASV dynamic model

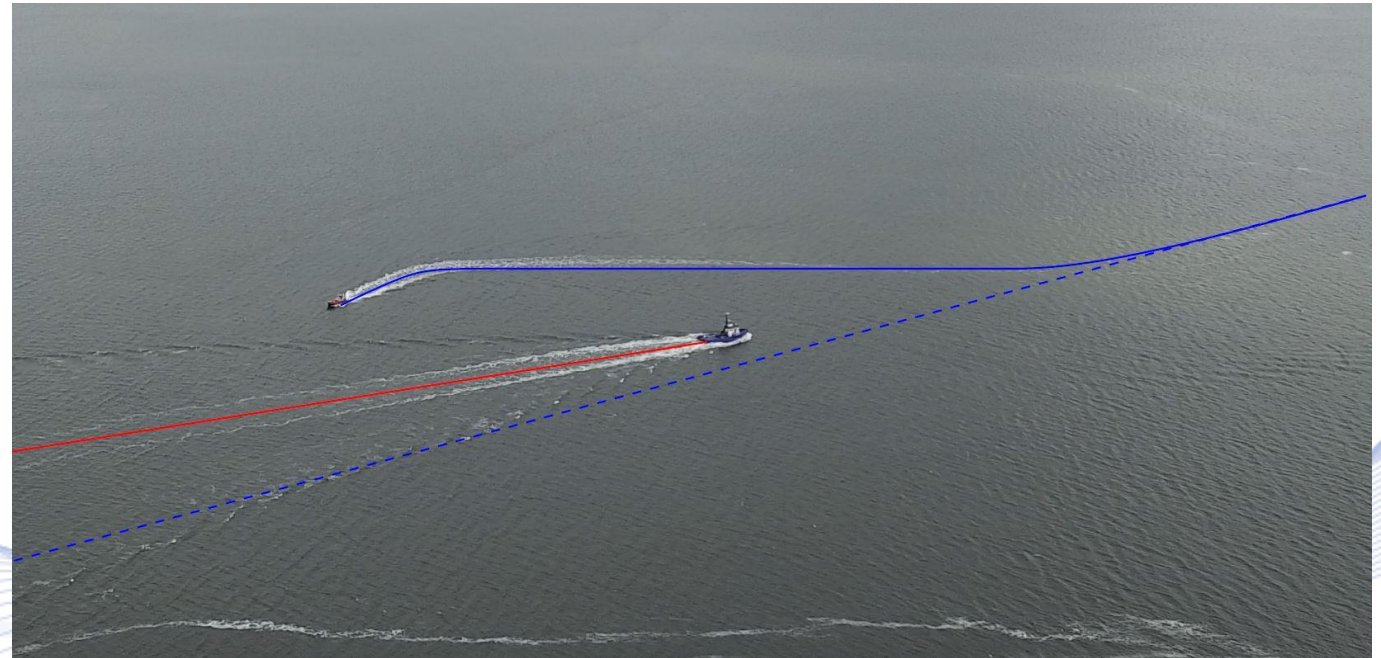
The above kinematic assumptions are employed in the widely used ASV dynamic model [FOS1994]:

$$\mathbf{M}\dot{\mathbf{v}} + \mathbf{C}(\mathbf{v})\mathbf{v} + \mathbf{D}(\mathbf{v})\mathbf{v} + \mathbf{g}(\boldsymbol{\eta}) = \boldsymbol{\tau} + \boldsymbol{\tau}_E.$$

The physical meanings of these symbols are as follows:

Collision avoidance

Collision avoidance:
Autosea project



Example of collision avoidance [AUT].

Q & A

Thank you very much for your attention!

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