Situational awareness for autonomous surface vehicles: Practical experiences and reflections

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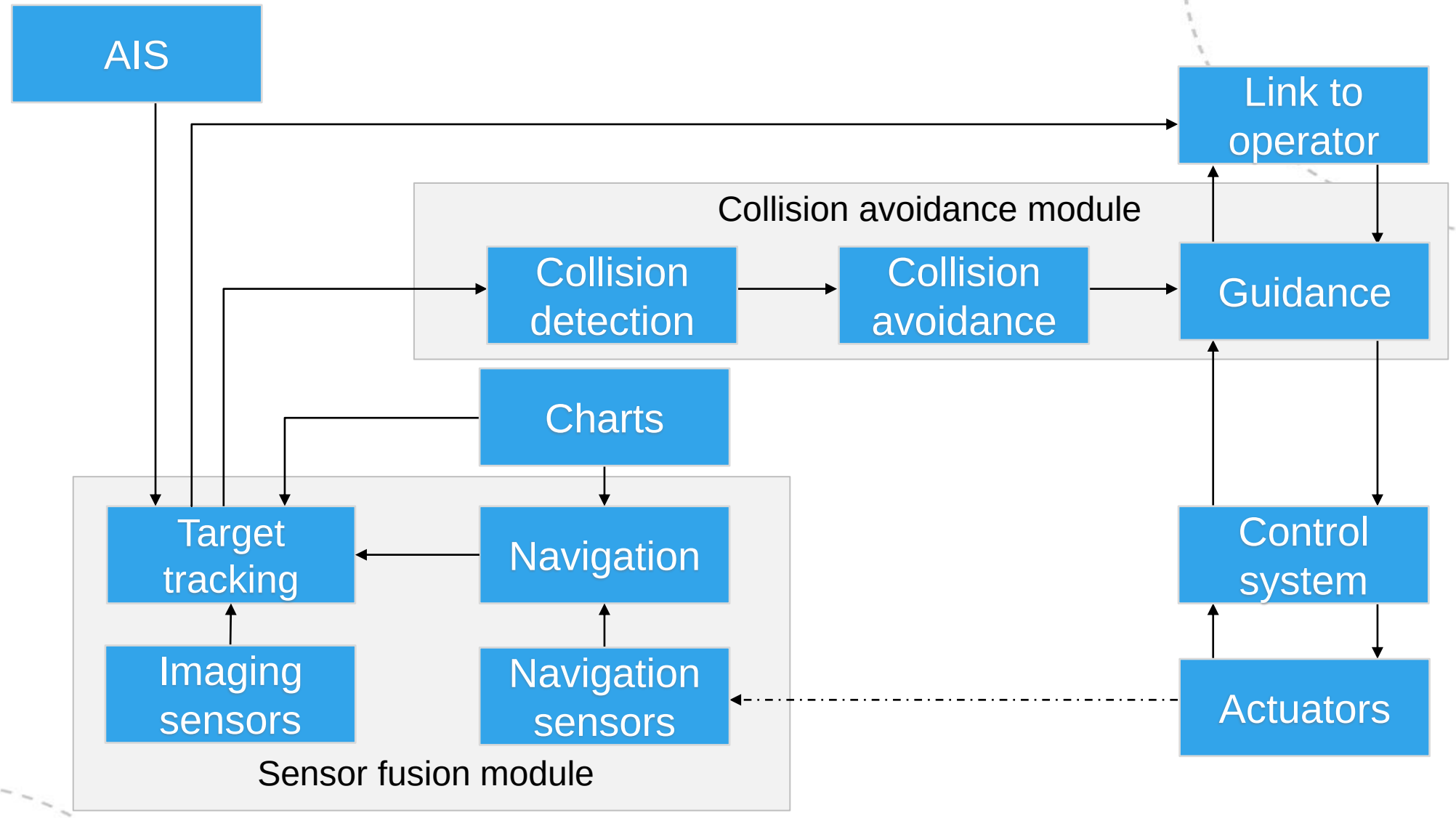
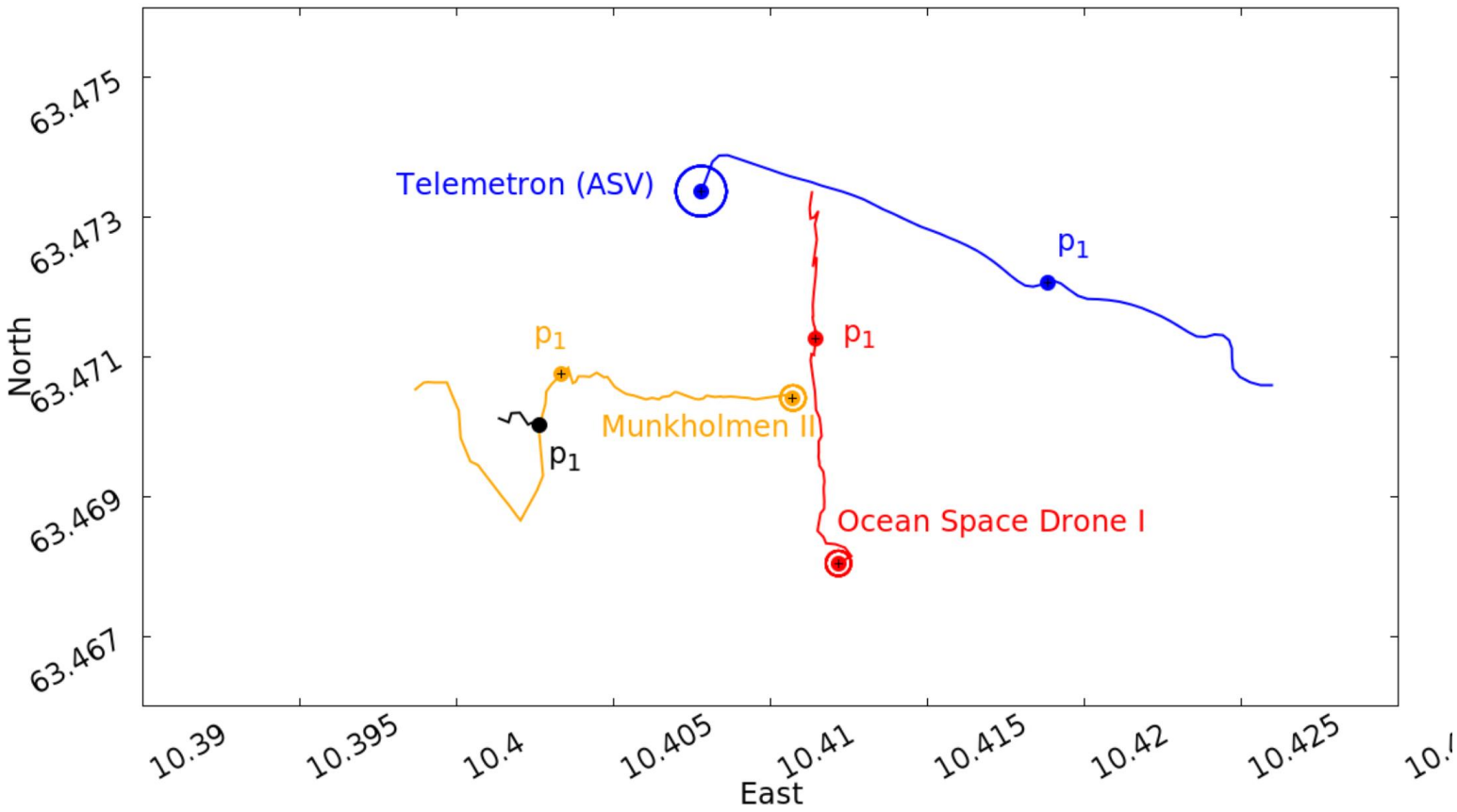
Collision avoidance for autonomous ships



Lesson 1: Interface between belief and action.

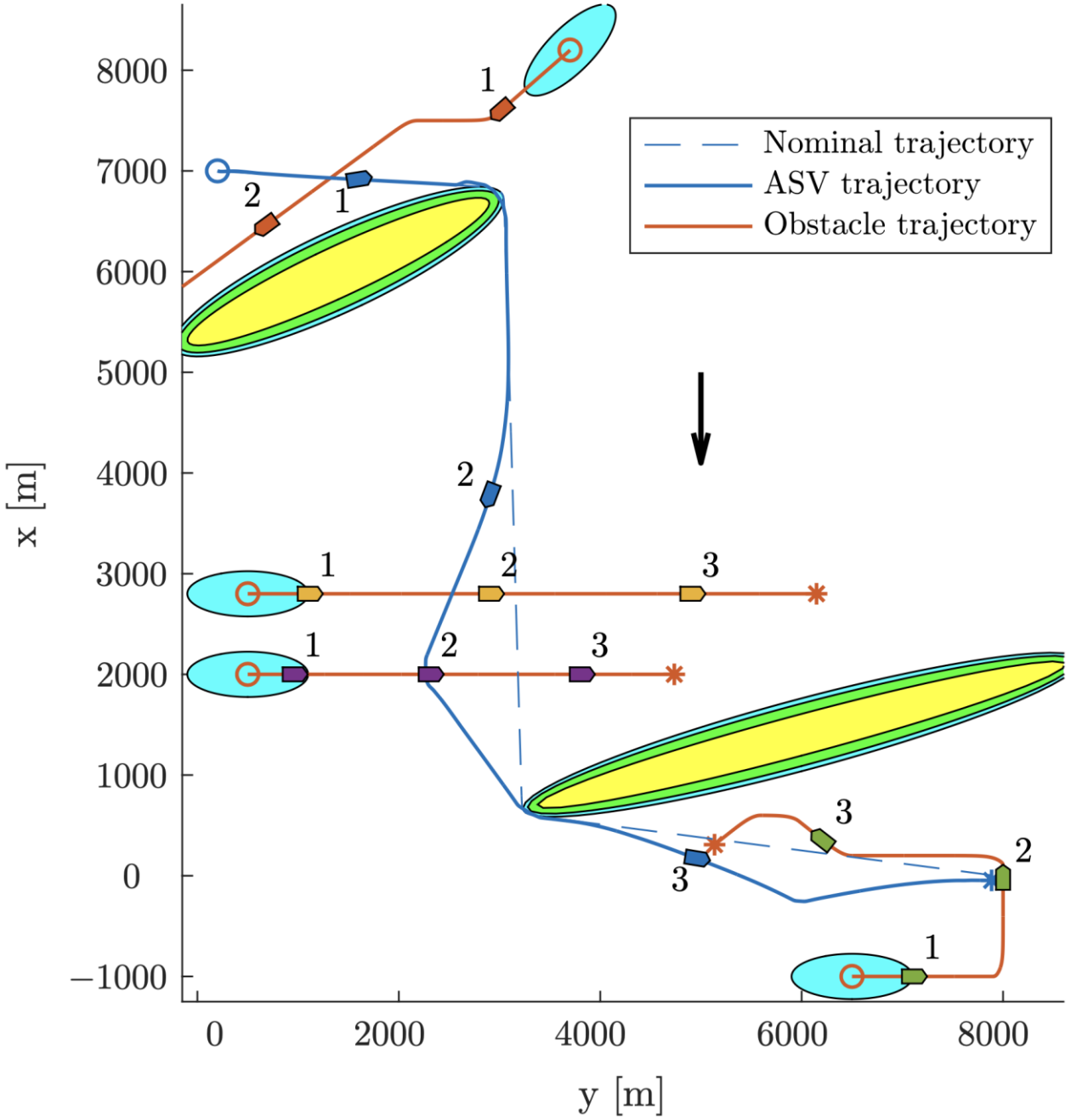
- An **obstacle management interface** maintains terminated tracks with a decaying factor.
- It prevents excessive reactive maneuvers by the ASV.



Kufoalor et al.: “Autonomous COLREGs-Compliant Decision Making using Maritime Radar Tracking and Model Predictive Control”, Proc. ECC, 2019. Courtesy EUCA.

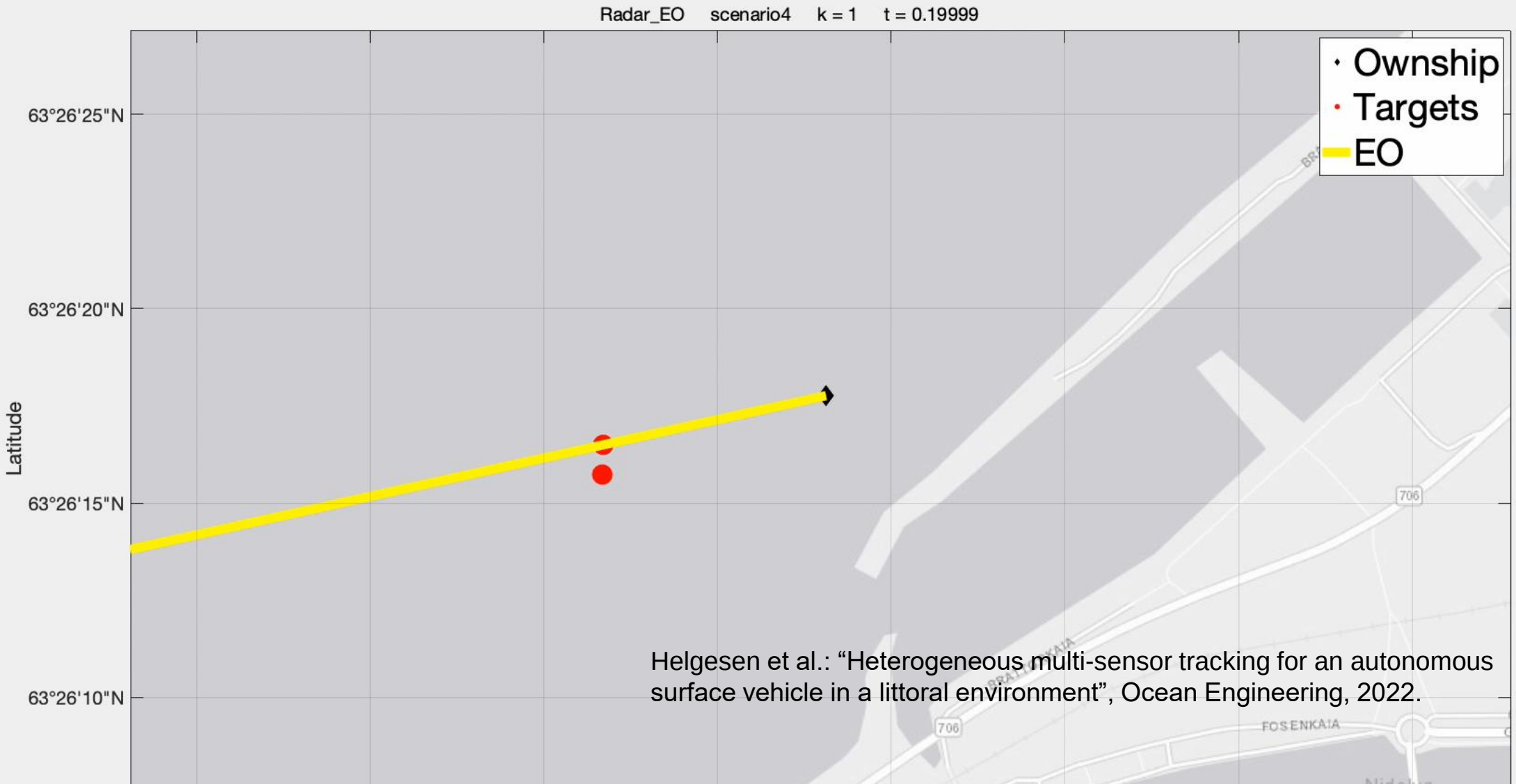
Lesson 2: Collision avoidance must be predictable.

- COLREGS asks for straight lines and substantial course changes.
- ... enabling mariners to understand intentions,
- ... also enabling a radar-based automated situational awareness to understand intentions.



Eriksen et al.: “Hybrid Collision Avoidance for ASVs Compliant With COLREGs Rules 8 and 13–17”, Frontiers in Robotics and AI, 2020.

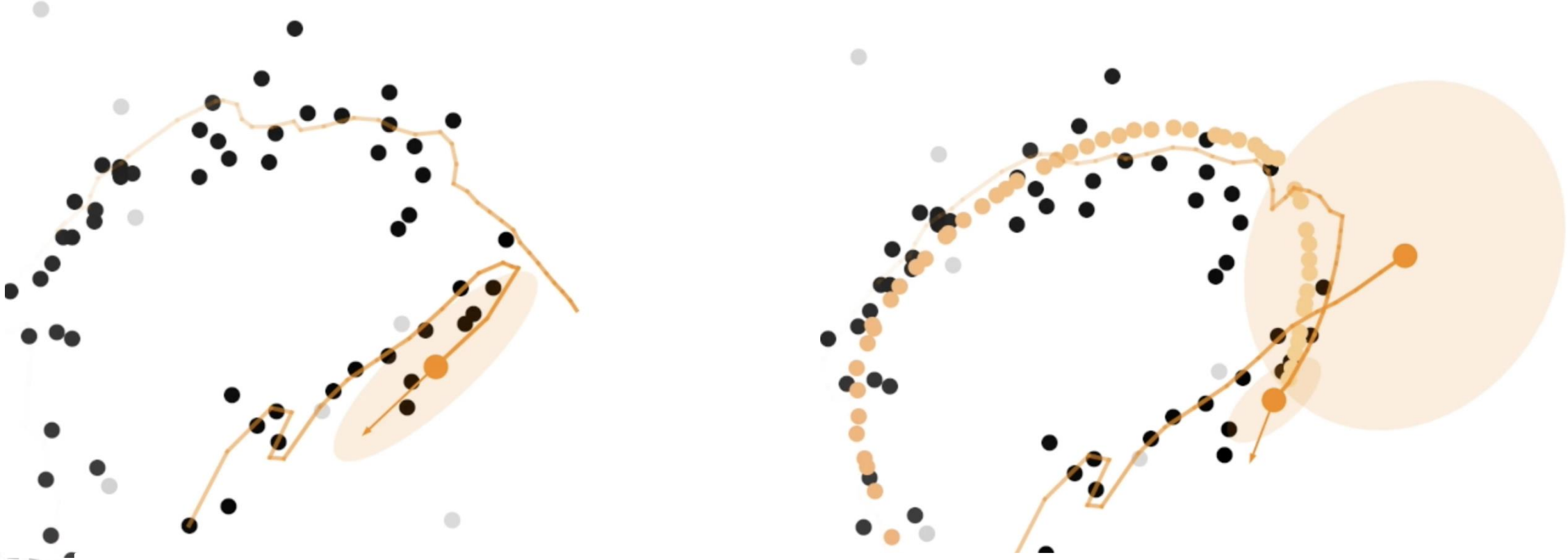
Lesson 3: Track initialization and course estimation are core challenges in situational awareness



Helgesen et al.: “Heterogeneous multi-sensor tracking for an autonomous surface vehicle in a littoral environment”, Ocean Engineering, 2022.

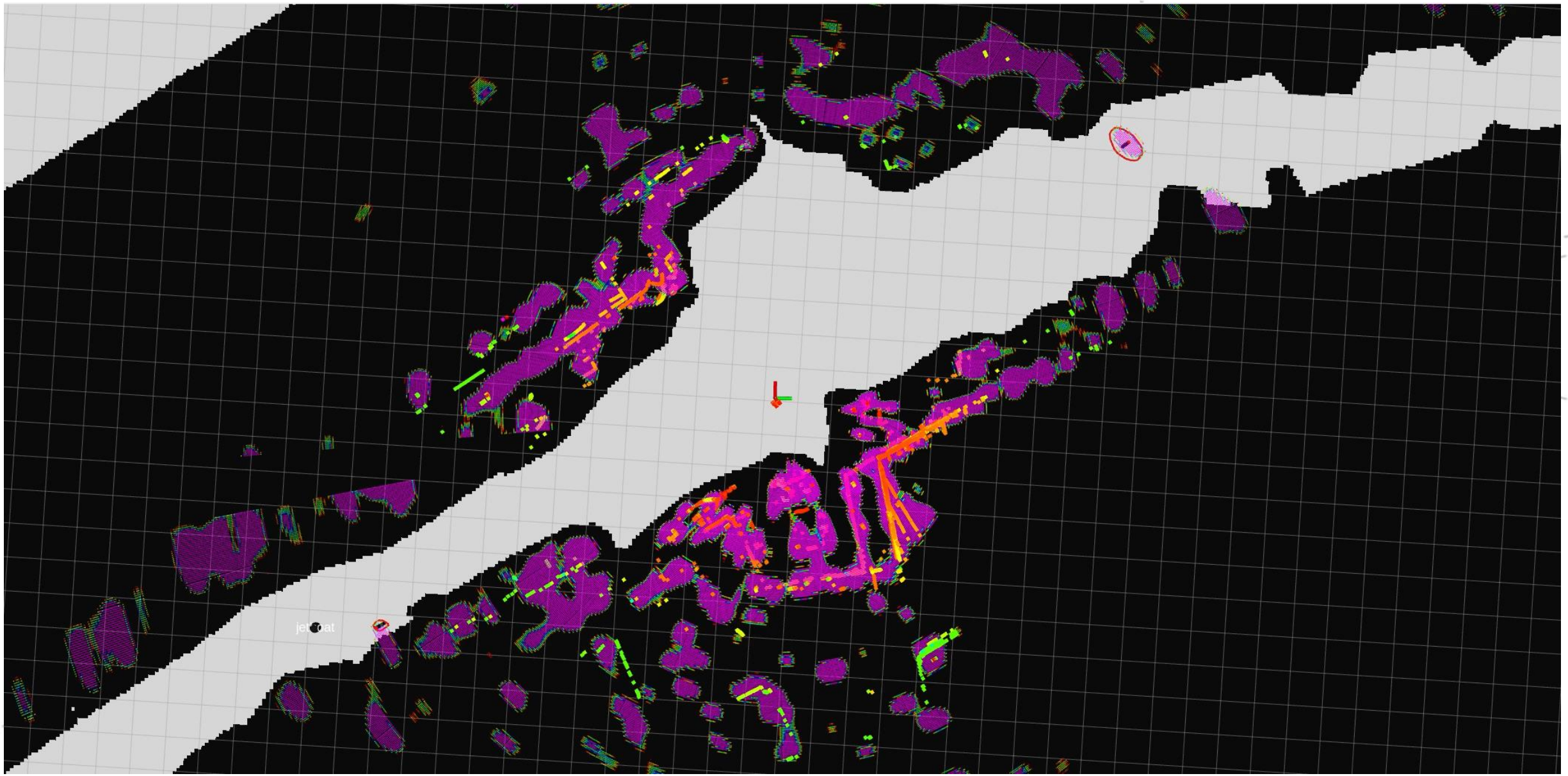
Another example: Radar-AIS fusion

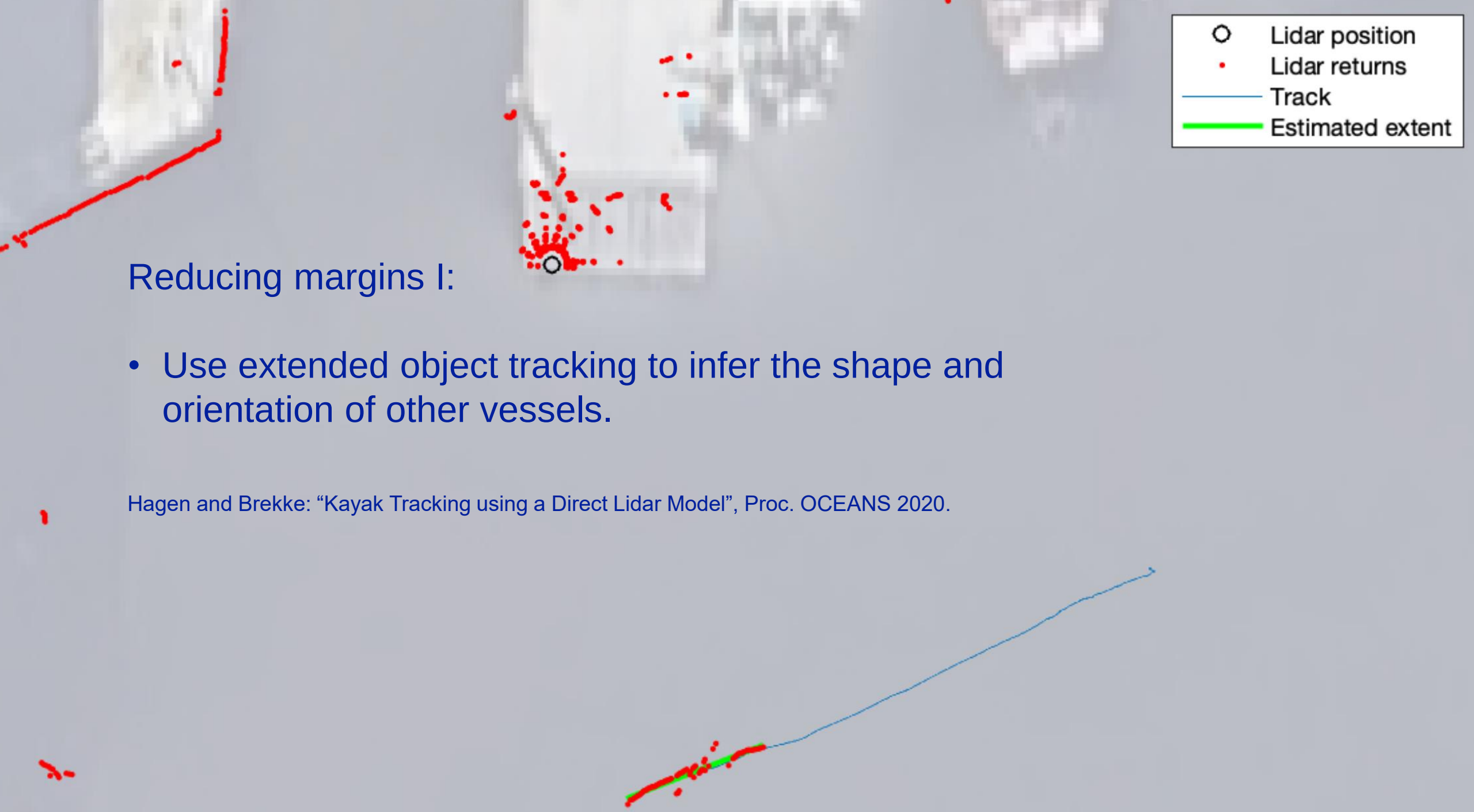
AIS prevents false track from stealing the radar measurements of the true track.



Hem, A. G.: “Maritime multi-target tracking with radar and asynchronous transponder measurements”, MSc thesis, NTNU, 2021

Lesson 4: It is all about margins





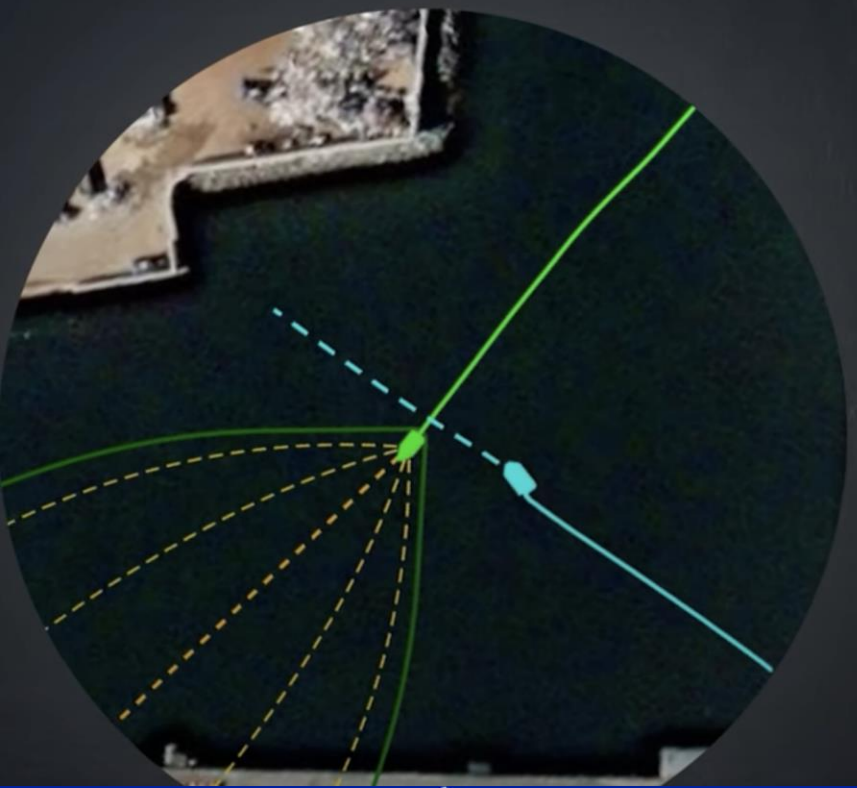
Reducing margins I:

- Use extended object tracking to infer the shape and orientation of other vessels.

Hagen and Brekke: “Kayak Tracking using a Direct Lidar Model”, Proc. OCEANS 2020.

Reducing margins II:

- Predict plausible future trajectories of target ships.
- Calculate risk of collision as part of MPC cost function.



Tengesdal , T.: “Risk-based Traffic Rules Compliant Collision Avoidance for Autonomous Ships”, PhD thesis, NTNU, 2022

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