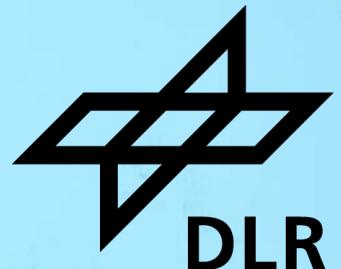


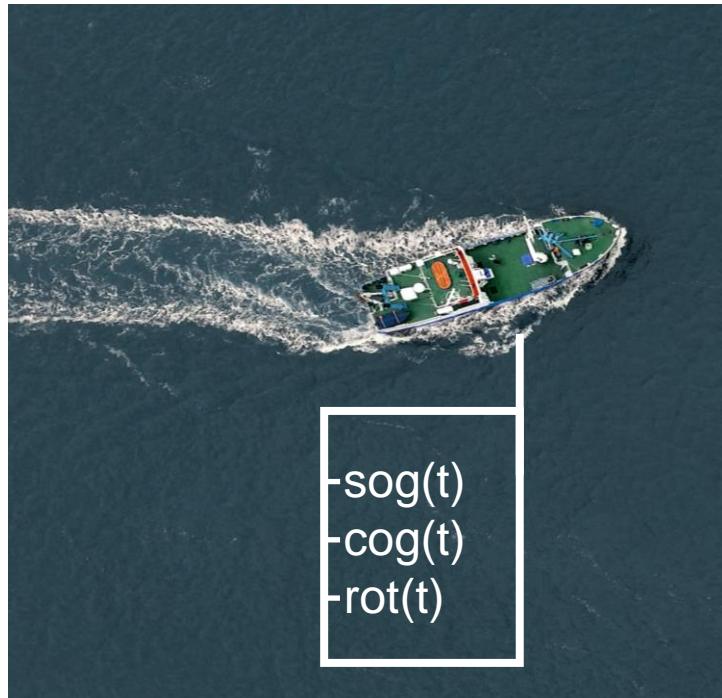
# A TEST ENVIRONMENT FOR SIMULATION-BASED TESTING OF MASS-FUNCTIONS IN TRAFFIC SEPARATION SCHEMES

HYDRO2025

Nina Wetzig, Anna Austel, Daniel Paland, Bernd Westphal



# Safety and Rule Compliance of MASS



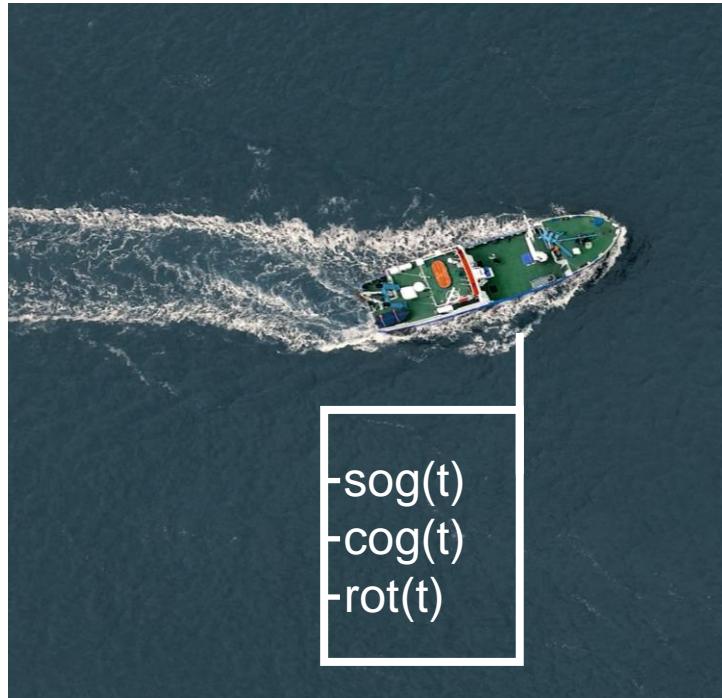
sog = speed over ground, cog = course over ground,  
rot = rate of turn

- MASS needs to behave in such a way that their drive is safe.
  - i.e. follow the rules and avoid collisions
- Safety/compliance with rules must be verified.

*COLREG rule 10:*

*(b) A vessel using a traffic separation scheme shall:*  
*(i) proceed in the appropriate traffic lane in the general direction of traffic flow for that lane;*

# Safety and Rule Compliance of MASS



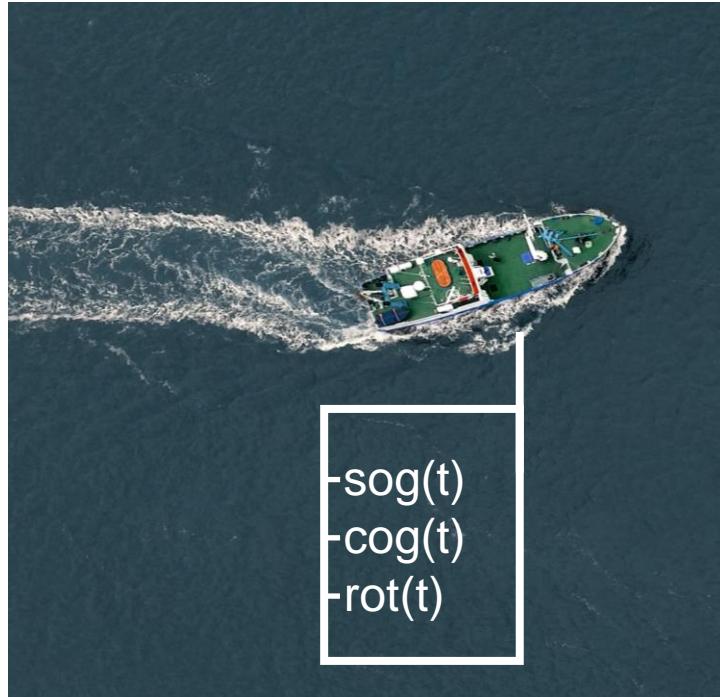
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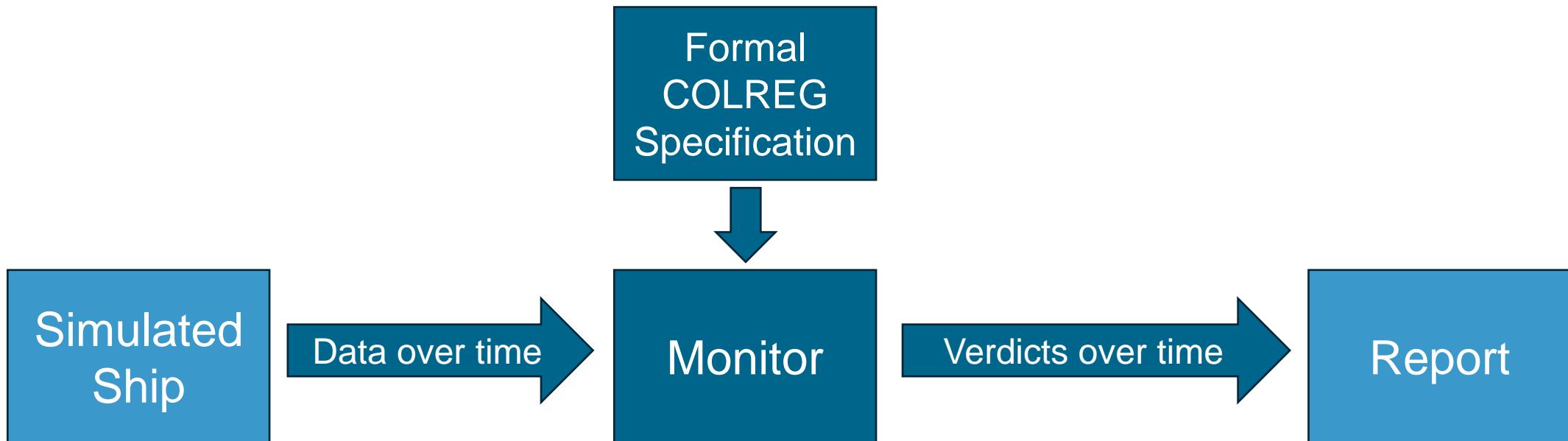
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## Problem statements

- For the automated evaluation of a MASS drive we need a formal specification of what is correct behaviour.
- And we also need monitoring software to compare the observable data of the drive with the specification.

# Safety and Rule Compliance of MASS

We propose a Test Environment for automatic evaluation of simulated drives in regard to mTSC-Specifications of COLREG rules at runtime.

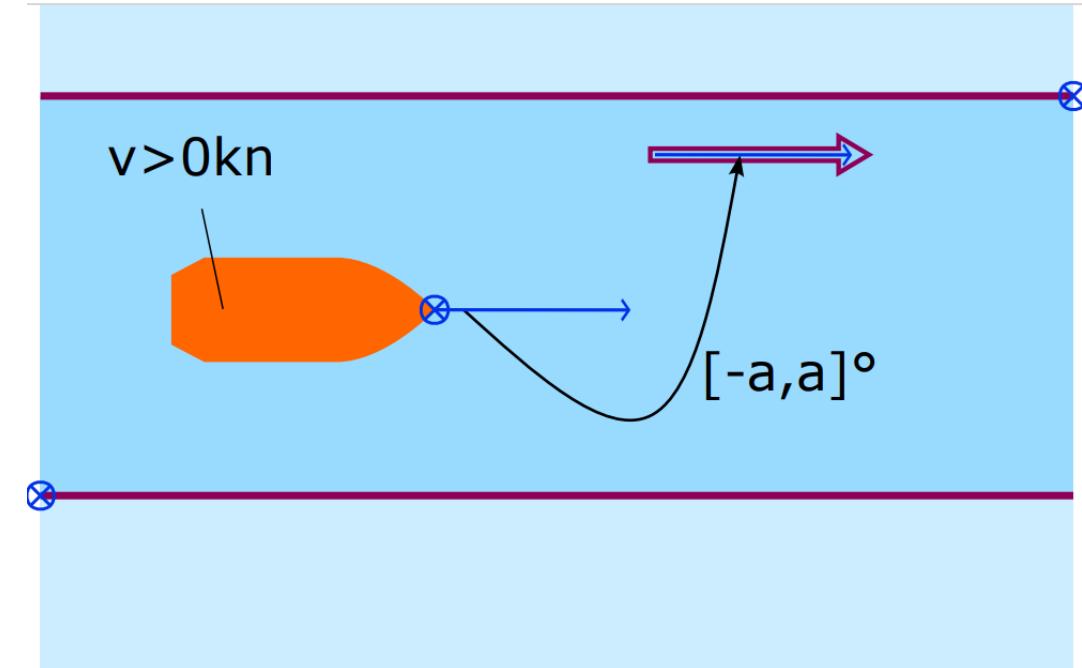


# Specification of Rule Compliance

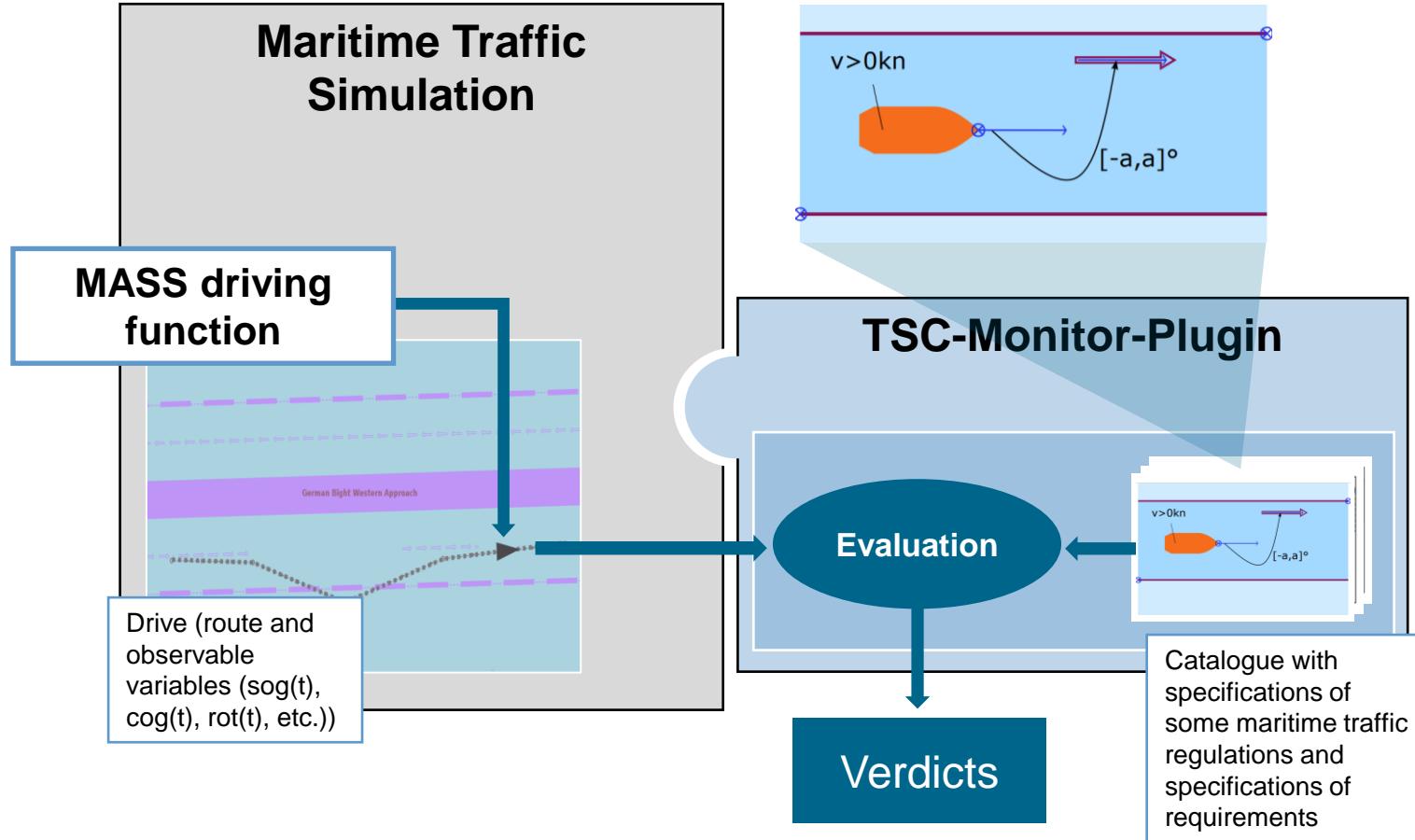
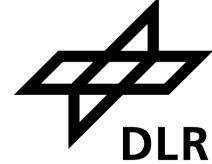
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# Test Environment for Simulation-based Monitoring



- We now have a mTSC-based Test Environment for automating the monitoring process.
- In our paper we demonstrate the functionality of this Test Environment with drives of vessels in interaction with TSS.

# Test Environment for Simulation-based Monitoring



Report

**Simulated MASS**

**Scheduler**

Application

Play

Stop

Speed Factor

Start offset

0,000

Simulation Time

01-01-1970 - 02:00:00

Simulation Duration

-1h -1sec 500ms

242981d 22mins 25sec

Overall Factor

-0,00

Factor Since Resume

0,00

last min (real) factor

last min (sim) factor

**Map**

**German Bight Western Approach**

**sog: 2 knots**

**cog: 96 °**

**rot: -5 °/min**

**TSC**

Step

**Job**

**Workspace**

**crossing-lane-fail.app**

Monitoring: WULF ISEBRAND (IMO: 0)  
54,1318201(Lat); 6,8392082(Lon); 105.89747853261741°(COG)  
WULF ISEBRAND's COG within the TSS-lane is inappropriate

Monitoring: WULF ISEBRAND (IMO: 0)  
54,1317878(Lat); 6,8394016(Lon); 105.89732127540208°(COG)  
WULF ISEBRAND's COG within the TSS-lane is inappropriate

Monitoring: WULF ISEBRAND (IMO: 0)  
54,1317554(Lat); 6,8395950(Lon); 105.89716401545462°(COG)  
WULF ISEBRAND's COG within the TSS-lane is inappropriate

Monitoring: WULF ISEBRAND (IMO: 0)  
54,1317231(Lat); 6,8397884(Lon); 105.89700675270447°(COG)  
WULF ISEBRAND's COG within the TSS-lane is inappropriate

Monitoring: WULF ISEBRAND (IMO: 0)  
54,1316907(Lat); 6,8399818(Lon); 105.89684948711248°(COG)  
WULF ISEBRAND's COG within the TSS-lane is inappropriate

Monitoring: WULF ISEBRAND (IMO: 0)  
54,1316584(Lat); 6,8401752(Lon); 105.89669221854403°(COG)  
WULF ISEBRAND's COG within the TSS-lane is inappropriate

Monitoring: WULF ISEBRAND (IMO: 0)  
54,1316261(Lat); 6,8403686(Lon); 105.89653496039323°(COG)  
WULF ISEBRAND's COG within the TSS-lane is inappropriate

Monitoring: WULF ISEBRAND (IMO: 0)  
54,1315937(Lat); 6,8405620(Lon); 105.89637769370215°(COG)  
WULF ISEBRAND is not on a TSS-lane

Monitoring: WULF ISEBRAND (IMO: 0)  
54,1315614(Lat); 6,8407553(Lon); 105.89622041784598°(COG)  
WULF ISEBRAND is not on a TSS-lane

**Model**

**[Application] TSC**

- startTIme [Time]
- initialTaskProvider [Combound]
- runtimeTaskProvider [Combour]
- provider [VesselSimulator]
- provider [TaskProvider]
- tasks [TSSLaneFollowMon]
- provider [TaskProvider]
- provider [TaskProvider]
- provider [TaskProvider]
- provider [TaskProvider]
- shutdownTaskProvider [Combo]
- scheduler [Scheduler]
- content [Environment]
- name [RSIdentifier] TSC

activated

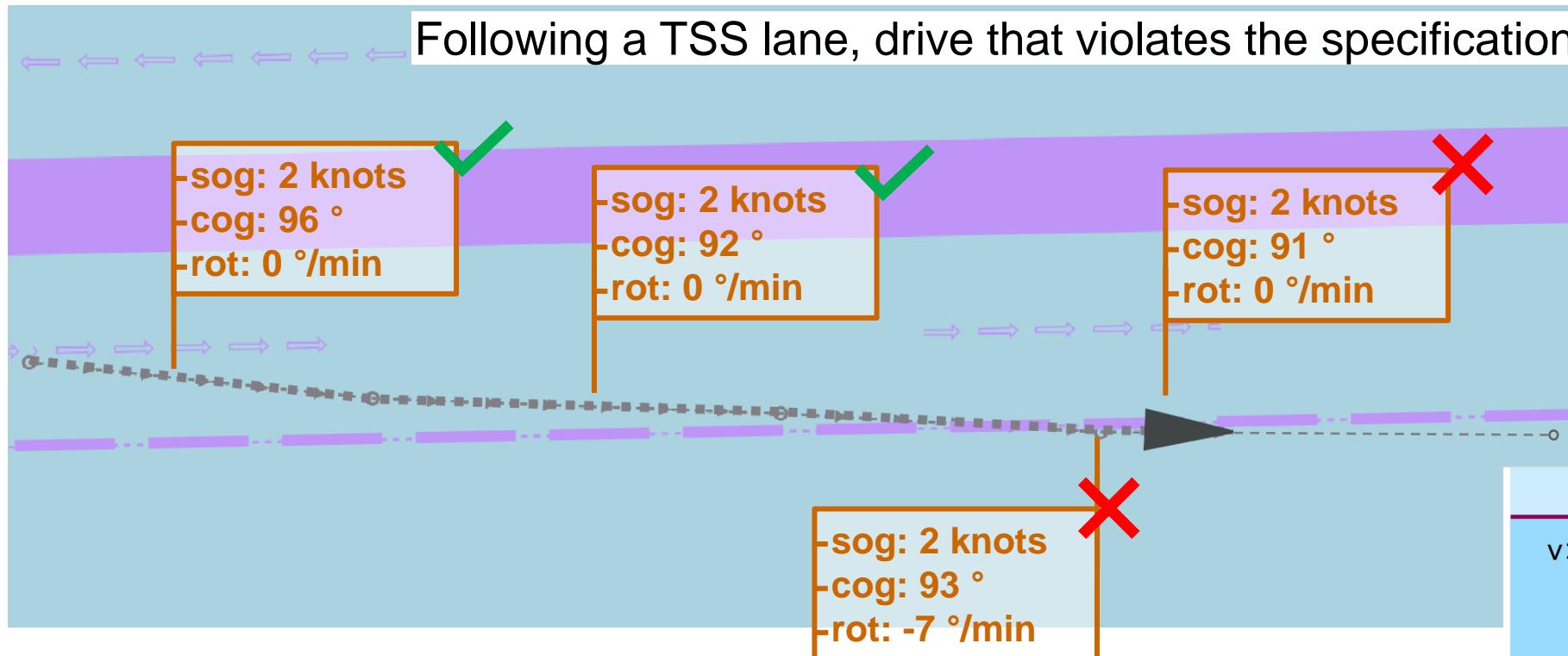
priority

firstStart

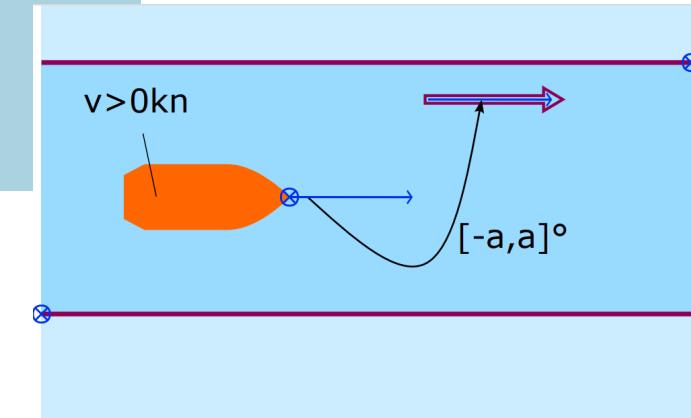
updateInterval

allowedDeviation

# Interpreting the Monitoring Report



- We specified three COLREG rules regarding TSS interactions and evaluated drives for each:
  - Entering a TSS from the side
  - Crossing a TSS
  - Following a TSS lane



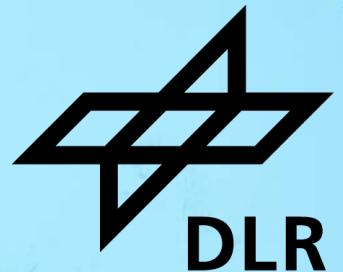
# Conclusion and Future Work



- We have a test environment to monitor and evaluate the behaviour of simulated MASS relative to mTSC-Specifications of COLREG rules.
- Further steps to improve the test environment include:
  - Formalizing further regulations (e.g. covering more COLREG rules)
  - Improving the user-interface for displaying the verdict and reporting relevant data
  - Further automating the activation of the monitoring



# THANK YOU FOR YOUR ATTENTION!



Topic: **A Test Environment for Simulation-based Testing of MASS-functions in Traffic Separation Schemes**

Date: 2025-10-28

Author: Nina Wetzig

Institute: Institute of Systems Engineering for Future Mobility

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